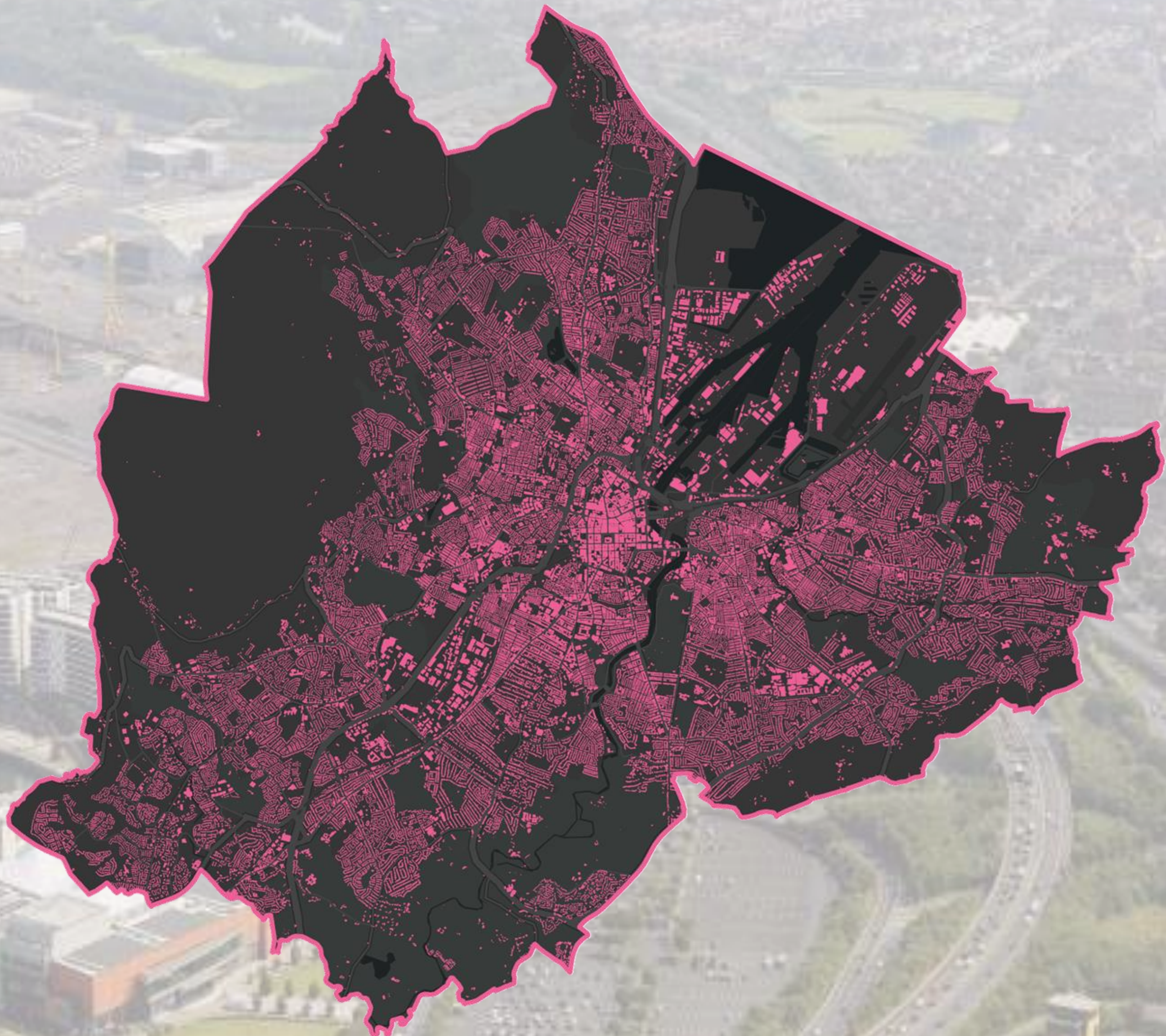
Belfast Local Area Energy Plan

Belfast City Council

Catapult Energy Systems



March 2024

Acknowledgements

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This plan is funded by BCC.

Contributors

The development of this LAEP has been supported by a Steering Group consisting of BCC, as the lead Government Organisation, plus utility operators in the region, trade associations, and Government Owned Companies (GoCo) under the Department for Infrastructure (DfI), Department for Communities (DfC), and Department for Economy (DfE). The Steering Group have been instrumental in shaping the LAEP by being accountable for decision making, supporting data gathering, providing local context and characteristics, defining the modelling Scenarios, examining model assumptions, and reviewing and commissioning the LAEP.

Further support was provided by local stakeholders who also contributed to the decision-making process, the data gathering, and the understanding of local context and characteristics.

LAEP Steering Group

Definition of Terms and Abbreviations

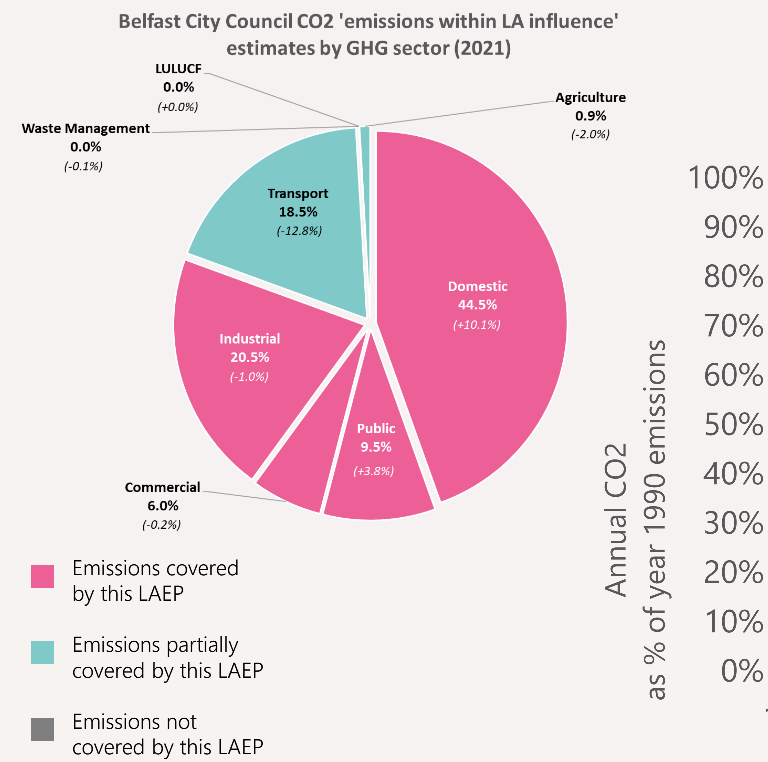
Term / Abbreviation	Definition	Term / Abbreviation	Definition
ASHP	Air Source Heat Pump	**Low Regrets**	A key component of the LAEP pathway. These are actions/projects which are common under various Scenarios but may require further Enabling Action before they can be progressed. These could occur in the near-term but may require longer-term resolution of uncertainties or market conditions to evolve naturally.
BCC	Belfast City Council	LT	Low Temperature
Data Zone	A statistical output geography, introduced in Northern Ireland by NISRA and OSNI after the 2021 Census	LV	Low Voltage
DfC	Department for Communities	NIHE	Northern Ireland Housing Executive
DfE	Department for Economy	NISRA	Northern Ireland Statistics and Research Agency
DfI	Department for Infrastructure	NDB	Non-Domestic Buildings
DHN	District Heat Network	NI	Northern Ireland
Enabling Actions	A key component of the LAEP pathway. Enabling Actions mostly occur in the near-term to develop market conditions which enable scale up activities in the long-term. Often these are not under Local Government control.	OPPs	Outline Priority Projects
EPC	Energy Performance Certificate	**Opportunity Areas**	An area of Belfast where an intervention is recommended in high numbers but may have uncertainties or barriers associated with delivery.
ETP	Eastern Transport Plan	OSNI	Ordnance Survey of Northern Ireland
EV	Electric Vehicle	Outline Priority Projects	Near-term components on the Pathway that provide the local area with projects that can immediately be implemented to make progress towards net zero
Focus Zones	An area of Belfast where an intervention is recommended in high numbers and with high certainty (low-regrets) and enablers for near-term delivery.	**Pathway**	The most cost-effective and co-beneficial way for Belfast to achieve a Net Zero energy system.
GB	Great Britain		
Green Gas or Renewable Gas	Biomethane or Hydrogen	**Primary Stakeholders**	Stakeholders who are responsible for creating the LAEP (typically lead government organisation and network operators)
GoCo	Government Owned Companies	PoP	Plan on a Page
GSHP	Ground Source Heat Pump	PV	Photovoltaics
HP	Heat Pump	**Quick Wins**	A key component of the LAEP pathway. Quick Wins are near-term actions/projects of short duration and with high confidence that the intervention is the correct choice. A Quick Win requires fertile market conditions and has relatively few barriers to implementation.
HT	High Temperature	ROI	Republic of Ireland
HV	High Voltage	**Scale-up**	A key component of the LAEP pathway. These are long duration major decarbonisation activities not expected to happen naturally in today's market conditions. Typically preceded by a Key Decision Point in situations of low certainty or an Enabling Action in situations of high certainty.
Innovation and Demonstrator Projects	A key component of the LAEP pathway. These projects help navigate aspects of uncertainty or bring longer-term solutions into the near-term. Often these feed into Key Decision Points on the Pathway.	Scenario	Scenarios provide a vision of the future energy system and are a common modelling approach to establish the optimal Pathway for the local area.
Interventions	The types of measures that can be taken to enact decarbonisation upon the local energy system.	**Secondary Stakeholders**	Stakeholders who are responsible for supporting the creation of the LAEP by contributing to the decision-making process (may include local citizens, other local government organisations and departments, industrial and commercial energy users, community energy groups etc)
Key Decision Points	A key component of the LAEP pathway. Key Decision Points are a milestone that indicate a fork in the pathway between decarbonisation options. These are typically preceded by Enabling Actions or Innovation & Demonstrator Projects and typically feed into Scale Up activities	**Small Area**	A statistical output geography, used in Northern Ireland prior to the 2021 Census
LAEP	Local Area Energy Plan	TBC	To Be Confirmed
LCT	Low Carbon Technology	**UK**	United Kingdom
LIDAR	Light Detection and Ranging		

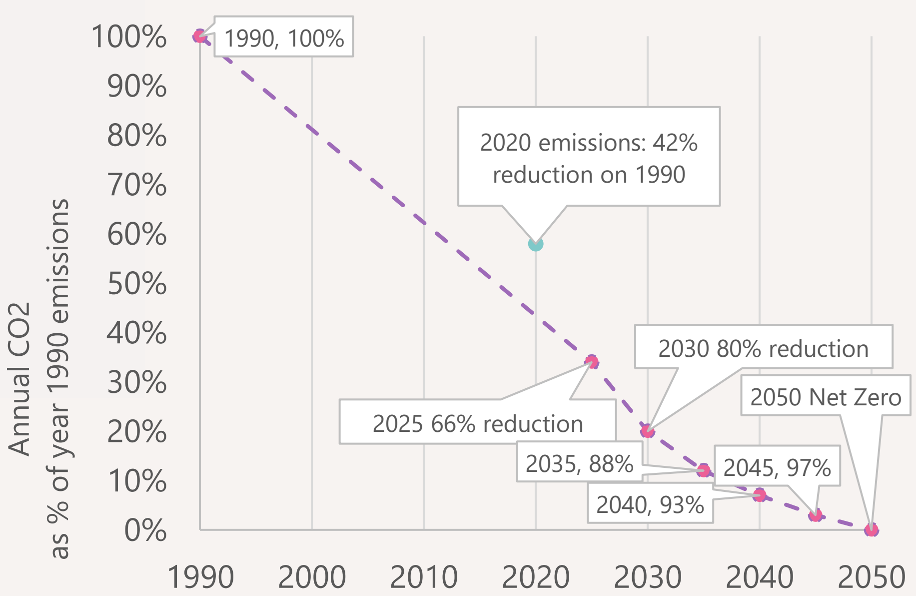
Contents & Structure

Executive Summary

LAEP Context

This LAEP builds a strategic case for local energy system decarbonisation in Belfast. The evidence base is guided by existing ambitions, plans, and strategies for Belfast stakeholders and the wider Northern Ireland context (see examples above). Analysis uses Belfast's existing emissions (below left) and reduction targets (below centre) applied to the Local Government area boundary (below right).





Summary of Numbers

To reach a Net Zero energy system by **2050**, Belfast requires capital investment of:

£16.6 - £17.9 bn*

In total
This is a 6.2% - 14.5% increase over the BaU investment of £15.6bn

Including up to:

£2.5 - £2.6 bn*

in domestic properties (including building fabric upgrades and heating systems)

~£500 m*

of domestic and non-domestic **rooftop solar PV**

Bringing **potential local co-benefits** of:

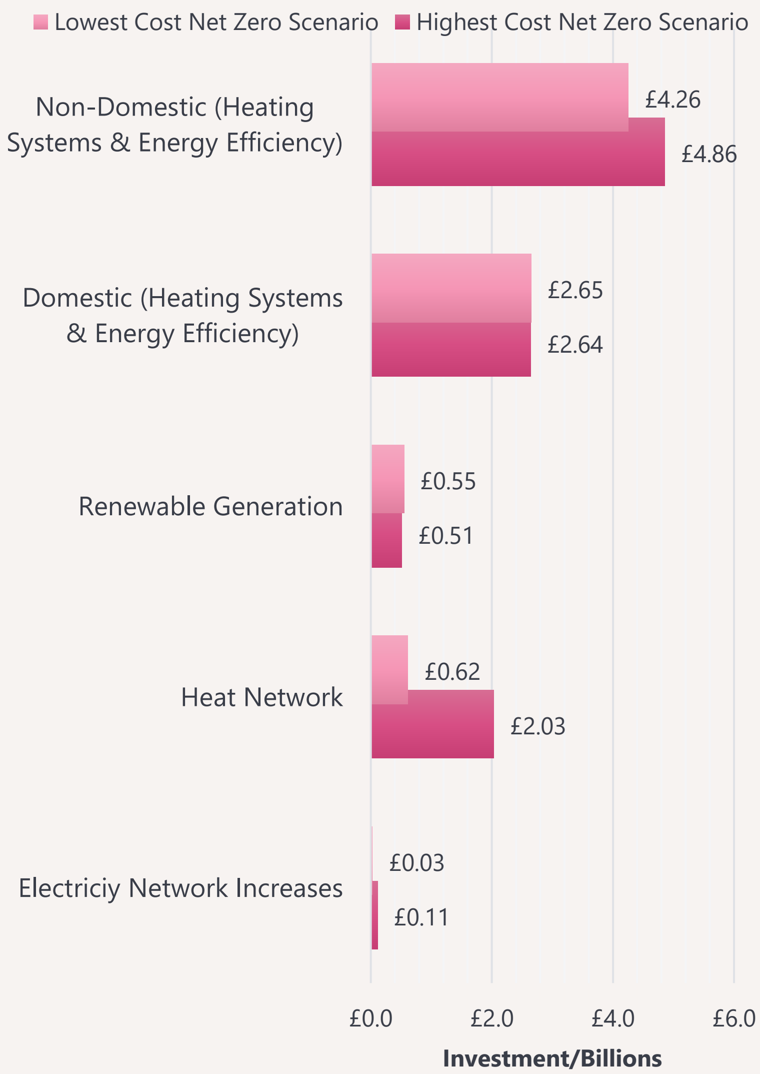
> 500 jobs*

Additional Full-Time Equivalents (FTE) supported (to 2050) relative to BAU

Up to £130 m*

of **monetisable health benefits**

Investment Breakdown to 2050*



By 2050 Belfast's energy system will have been **transformed**, with:

66,000 – 86,000*

heat pumps installed in dwellings

0.4 – 1.1 TWh/year

total demand from District Heat Networks including

23,000 – 110,000* new

domestic connections to **District Heat Networks**

~108,000 domestic properties

retrofitted with measures to improve **building fabric and energy efficiency** (insulation and glazing)

4,400

public electric vehicle charge points installed

1.1 GW

of renewable electricity generation from domestic and non-domestic **rooftop solar PV**

10.5 Mt CO2 saved

cumulatively to 2050 relative to BAU. This is equivalent to 16 return flights from Belfast to New York for every person in Belfast**.

**Numbers quoted are Scenario dependent. Explanation of Scenarios and comparison of results across Scenarios are detailed throughout this document. Costs shown exclude fuel costs which are provided in this document and supporting annexes.*

***https://co2.myclimate.org/en/flight_calculators/.*

Summary of Intervention Areas

This LAEP provides a Pathway, co-developed with the support of local stakeholders, for Belfast to achieve a Net Zero energy system by 2050. The Pathway is based on techno-economic modelling from multiple Scenarios, which describe possible futures for Belfast, with analysis of local co-benefits and impacts of energy system change. The Pathway highlights changes which are considered low regrets, and some which remain uncertain requiring future decisions to be made. The LAEP signposts opportunities for investment, which could bring significant local benefits, such as employment creation, air quality improvements, bill savings and healthier homes. Key risks to the successful implementation of the projects, actions, and recommendations of this LAEP are also identified. Key features by intervention area are summarised as follows:

Fabric Upgrades

Fabric and energy efficiency upgrades (insulation and/or glazing replacement) is identified as a low regrets measure for many homes in Belfast. 38% of homes could benefit from loft insulation, with 26% benefitting from wall insulation, and 4% requiring single glazing window replacement. It could be beneficial to steer the natural end-of-life replacement of windows towards high thermal performance options, such as triple glazing. Belfast's Retrofit Delivery Hub, will be crucial to galvanise the supply chain and provide support to homeowners, landlords, and businesses to deliver retrofit at the required scale and pace.

Low Carbon Heating

Most homes are currently heated by fossil fuel systems (66% on gas boilers and 29% on oil boilers). Belfast's most cost-effective Net Zero energy future is dominated by District Heat Networks (DHN) and Heat Pumps (HPs) but there is space to consider the emergence of biomethane at scale which remains an uncertainty. Belfast has natural resources such as geothermal aquifers and the river Lagan which may prove valuable in supporting the deployment of renewable heating technologies. The solutions for non-domestic buildings are similar to homes, with DHN and HPs being the most likely path to Net Zero depending on the availability of biomethane in the local gas grid.

Electric Vehicle Infrastructure

Transport modal shift through reduced dependence on private cars and a 15-minute city centre are the preferred features of Belfast's Net Zero future. A switch from petrol and diesel vehicles to Electric Vehicles (EVs) will also be required at scale to reach Net Zero by 2050. Public transport and active travel options become an enabler for this modal shift. The deployment of electric vehicle infrastructure aims to support these ambitions whilst recognising the need to make public EV charging an inclusive resource across Belfast with nearly 4,500 public charge points made available by 2050. Up to 43% of homes are fitted with an EV charge point particularly in the outer areas away from the city centre.

Local Renewable Generation

The potential to generate renewable energy locally, is dominated by rooftop solar photovoltaics (PV) due to the vast urban area. As much as 1.1 GW from both domestic and non-domestic buildings may be deployed if the electricity network can accommodate. Future engagement and decisions will be required to determine ownership and business models for this scale of renewable electricity deployment.

Energy Networks

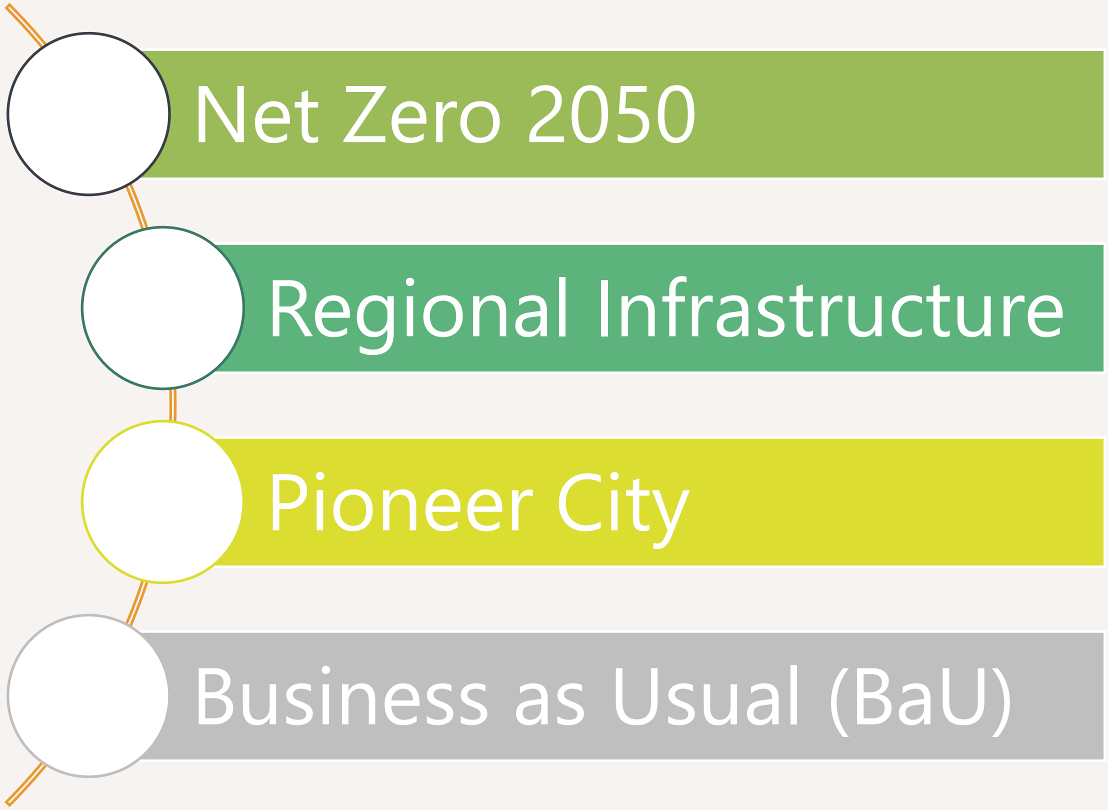
This LAEP illustrates the importance of investment in the electricity network to ensure sufficient capacity is available to support other Interventions such as electrification of heat and transport and the roll out of decentralised solar PV generation throughout the city. Co-ordination with the local electricity distribution network operator will be key to identify where network upgrades could occur in the near-term to enable the rapid growth of local carbon technologies. Flexibility from technologies such as smart energy meters and batteries can help reduce or delay network upgrades, or expediate the installation of low carbon technologies in network constrained areas. The demand from increased EV charging and the significant switch to the electrification of heat are accounted for in the electricity network assessment of this LAEP.

An important and somewhat unique consideration (in a UK context) for Northern Ireland will be the decarbonisation strategy for the agricultural and land use sectors which may lead to the emergence of biomethane production at scale. This LAEP assesses the impact of that emergence and suggests how Belfast should respond. This will be an important consideration in terms of the future purpose and operation of Belfast's gas network which is already well placed to distribute hydrogen through its predominantly plastic pipework. The cost-effective pathway in the LAEP modelling shows a potential role for hydrogen (both heating and industrial processes), but this emerges in the 2040s and remains uncertain, especially if biomethane and hydrogen compete for dominance. Hydrogen related decisions may be aligned to regional and national policies, but this should not impact near-term actions for other Interventions in Belfast.

Scenarios for Belfast

Scenario Overview

Scenarios provide a vision of the future energy system and are a common modelling approach to establish the optimal Pathway for the local area. Scenarios should be based upon aspirations, desires, hopes for the future energy system. Scenarios should focus on areas of specific interest or uncertainty (including stakeholder views that are polarising). Scenarios are modelled through fixing and varying of parameters and assumptions.



Note: Some technologies such as thermal storage, wave, hydro and offshore wind have not been included in the LAEP modelling. It is likely that these technologies will play an important part of the future energy mix with local, regional, and national contexts.

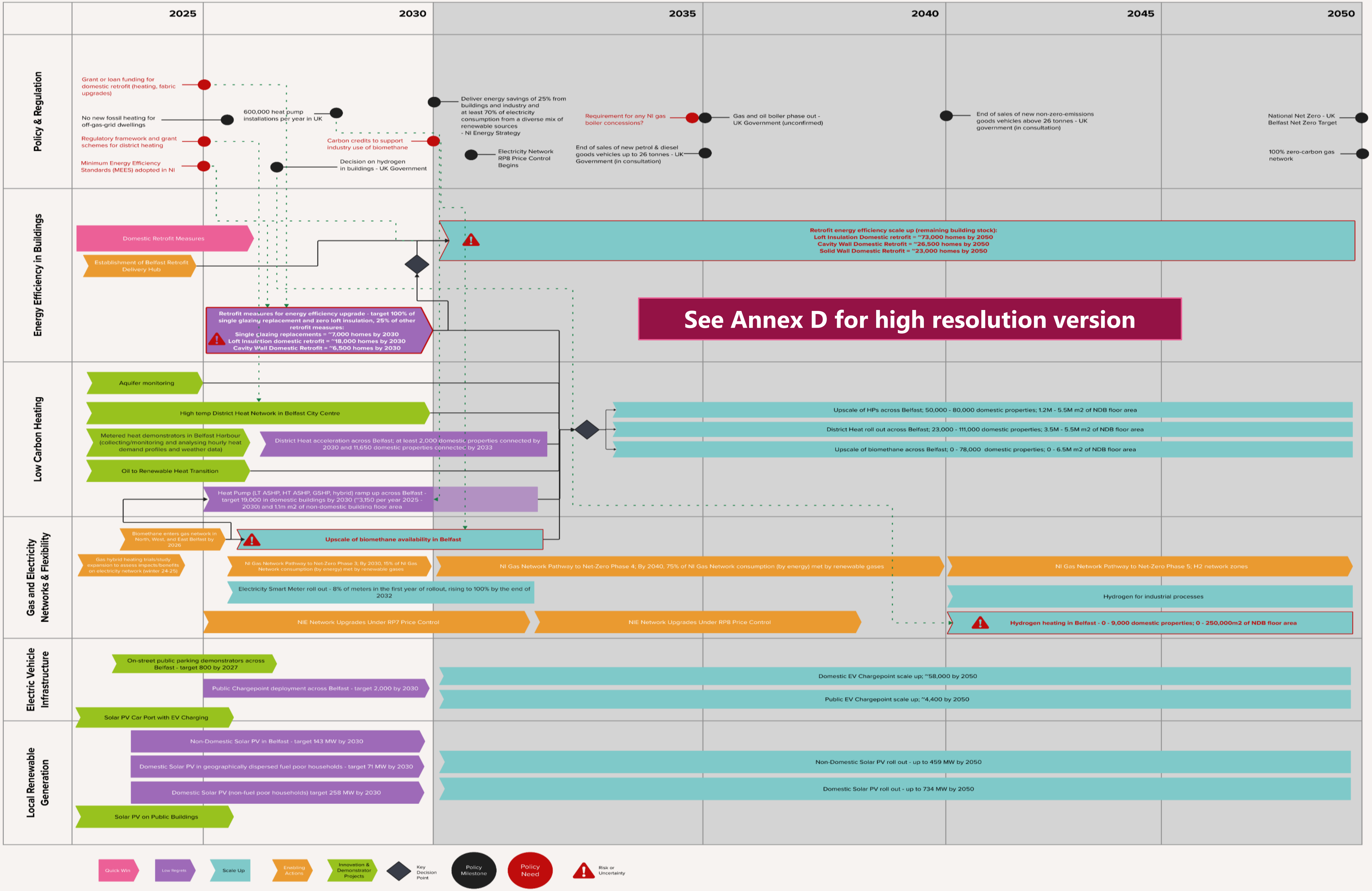
Net Zero 2050 Scenario aims to find the cost optimal path in line with the carbon targets set by the Northern Ireland Assembly; 56% reduction by 2025, 78% reduction by 2030, Net Zero by 2050 (against 1990 baseline). **This Scenario does not impose any constraints that would prioritise or accelerate any Belfast or Northern Ireland specific technologies.**

Regional Infrastructure Scenario aims to meet the same carbon targets, with the **assumption that there is significant regional investment in low carbon infrastructure to unlock the potential of large-scale technologies related to hydrogen and biomethane.** The hydrogen narrative is supported by regional developments such as Ballylumford power-to-X where a high regional capacity of wind generation leads to curtailment and enables the production of hydrogen in parallel with 24/7 operation of wind turbines in a co-benefit solution. Biomethane is made available from agricultural waste and feedstocks through anaerobic digestors located across rural Northern Ireland. Salt caverns in Larne Lough provide the opportunity for storage of both clean gases in large volumes.

Pioneer City Scenario also aims to meet the same carbon targets, with the assumption that Belfast looks inward to take control of its journey to Net Zero irrespective of wider regional developments. Priority is given to local measures which maximise unique opportunities and accelerate decarbonisation. **This Scenario allows for investment in an aquifer-based ambient loop district heat system, accelerated smart meter roll out, higher uptake of solar PV and a higher transport modal shift resulting in fewer EVs.** The hydrogen narrative is supported by local developments such as Belfast power-to-X and small quantities of biomethane are also made available.

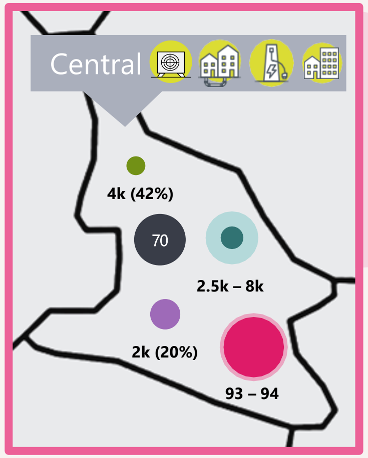
A '**Business-as-usual**' ('do nothing') **Scenario** is also modelled where no decarbonisation actions take place beyond already committed investments and peripheral decarbonisation progress (e.g. electricity grid). **This Scenario provides a counterfactual for cost and carbon impacts and other comparison purposes.** This is not required to meet the same local carbon targets and is not a Net Zero Scenario.

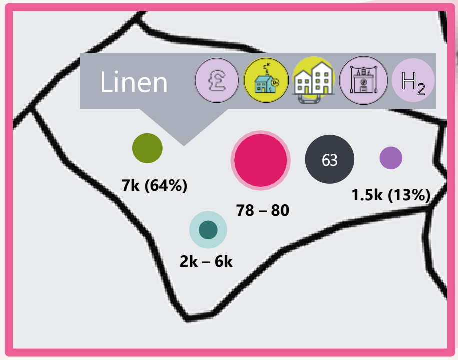
Belfast's Pathway to Net Zero

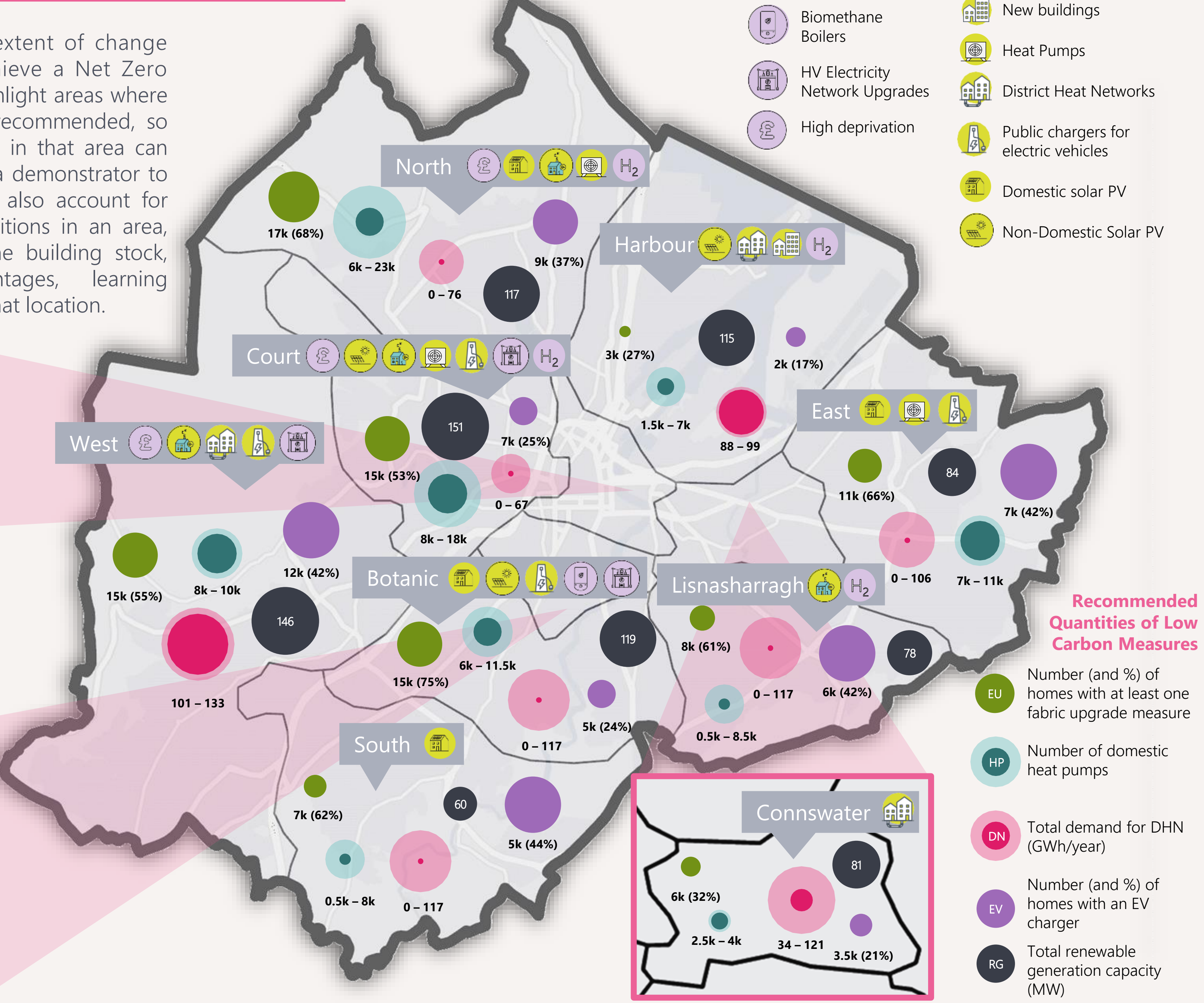


Belfast's Net Zero Future

This **Plan on a Page (PoP)** shows the extent of change required in each area of Belfast to achieve a Net Zero energy system by 2050. Focus Zones highlight areas where a concentration of a certain solution is recommended, so directing efforts towards delivery at scale in that area can lead to significant progress and serve as a demonstrator to other parts of Belfast. Focus Zones may also account for factors such as the socio-economic conditions in an area, network capacity, or characteristics of the building stock, which could bring specific advantages, learning opportunities or challenges to delivery in that location.



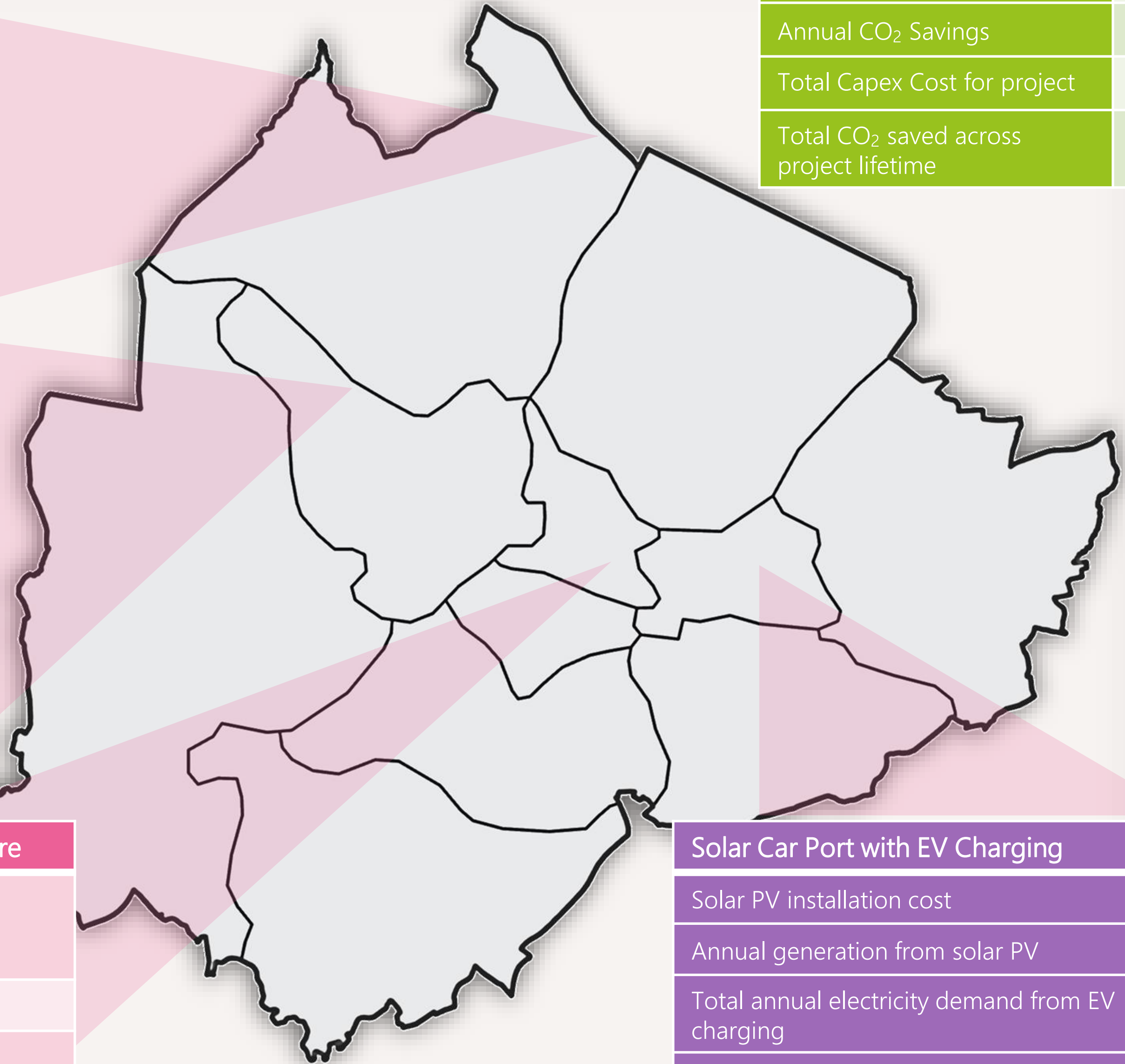




Outline Priority Projects

Solar PV on Public Buildings	
Number of buildings	20
Annual energy generated	903 MWh
Annual CO_2 Savings	40 tCO2e
Total Capex Cost for project	£1.0m
Total CO_2 saved across project lifetime	606 tCO_2e

Oil to Low Carbon Heating Transition	
Number of homes transitioning	500
Annual CO2 Savings (per household)	4,400 $kgCO_2e$
Total Capex Cost for project	£7.0m
Total CO2 saved from project	2.2 $ktCO_2e$



Domestic Retrofit Measures	
Number of Dwellings	Up to 2,000
Capital Investment	£2.7m – £5.6m
Annual bill savings per dwelling	£123 – £520
Annual carbon savings per dwelling	420 – 1,500 $kgCO_2e$
Additional benefit	Fuel poverty reduction

High Temperature District Heat Network in City Centre	
Potential annual energy demand (phase 1: Non-Domestic Buildings only)	2.8 GWh
Capital Investment	£4.2m
Additional benefit	Expansion to domestic properties in phase 2

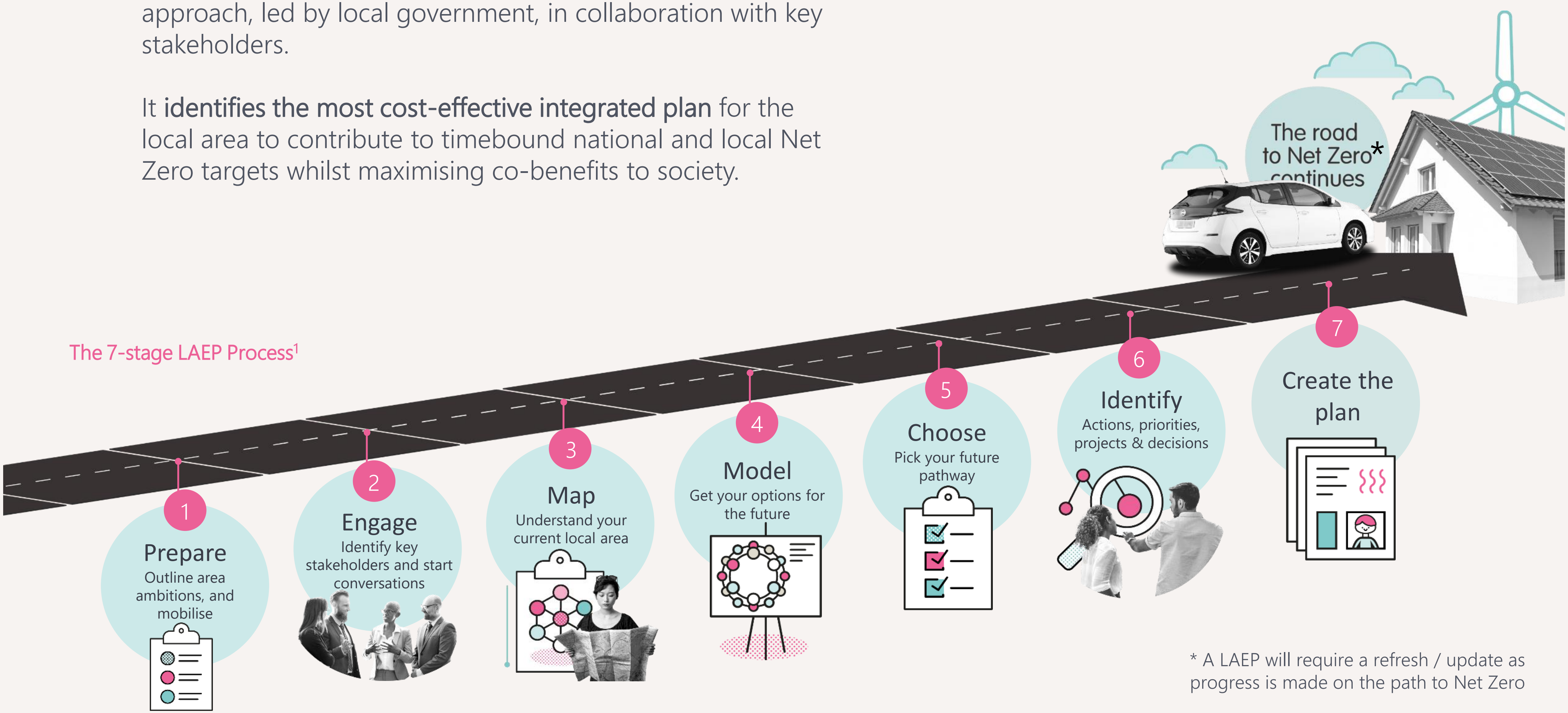
Solar Car Port with EV Charging	
Solar PV installation cost	£21,100
Annual generation from solar PV	47,800 kWh
Total annual electricity demand from EV charging	3,432 MWh
Demand coverage from installed solar PV	1.4%
Annual CO_2 Savings	2,140 $kgCO_2e$

Introduction

What is a LAEP?

> A Local Area Energy Plan (LAEP) is a **whole energy system** approach, led by local government, in collaboration with key stakeholders.
>
> It **identifies the most cost-effective integrated plan** for the local area to contribute to timebound national and local Net Zero targets whilst maximising co-benefits to society.

The 7-stage LAEP Process[1]



* A LAEP will require a refresh / update as progress is made on the path to Net Zero

1. https://es.catapult.org.uk/guide/guidance-on-creating-a-local-area-energy-plan/

What is in a LAEP?

A Local Area Energy Plan (LAEP)[1] sets out the change required to transition an area's energy system to Net Zero against a specified timeframe. The LAEP approach uses continuous stakeholder engagement to drive an evidence-base that is led by data and built on common goals. It aims to identify the most effective route for the local area to meet both its decarbonisation goals and national Net Zero targets. This is achieved by exploring a range of technologies and Scenarios through whole energy system modelling and wider system analysis to identify the most cost-effective pathway to Net Zero whilst realising co-benefits for the local area. A LAEP is led by local government but developed collaboratively with key stakeholders from the local area incorporating their data, knowledge and future plans.

The LAEP provides a fully costed and spatial plan that identifies near-term actions and projects wrapped up in a long-term vision. The LAEP provides stakeholders from council planners to network operators to community groups with a basis for taking action and prioritising investments by detailing the 'what, where, when and by whom'. The level of detail is equivalent to an outline design or master plan for a local area. Additional detailed analysis is generally required to deliver the priority projects and specific recommended actions made by the LAEP[2]. Thus, it provides a high-level vision for the area rather than defining how the area should be designed and built.

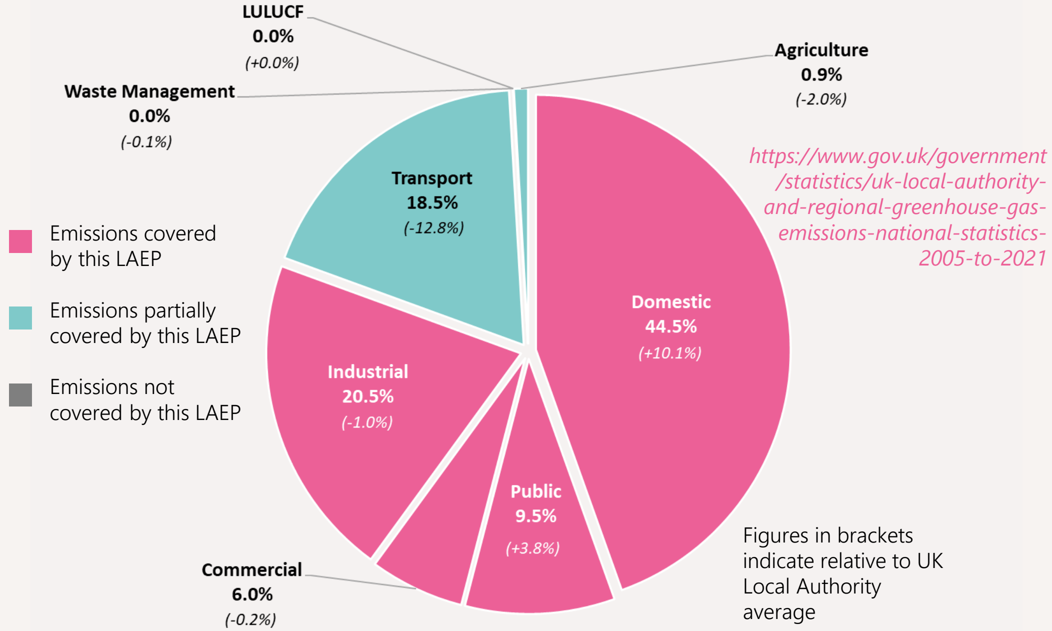
A LAEP should be updated approximately every 3–5 years (or when significant technological, policy or local changes occur) to ensure the long-term vision remains relevant.

Scope of the LAEP

The UK Government's 2021 Net Zero Strategy estimates that **82% of the UK's emissions are "within the scope of influence of local authorities"**

The scope of the LAEP covers the present day and future (projected out to 2050) energy generation, distribution, and demand, plus associated emissions, in a defined local area. The LAEP considers electricity, heat, and gas networks, Green Gas potential (such as biomethane or hydrogen), the built environment (domestic, public, commercial, and industrial buildings – including agricultural buildings) its fabric and supporting systems such as heating, electricity storage and renewable energy generation, and decarbonised transport e.g., Electric Vehicle (EV) charging infrastructure.

Belfast City Council CO2 'emissions within LA influence' estimates by GHG sector (2021)



[1]https://es.catapult.org.uk/report/the-future-of-local-area-energy-planning-in-the-uk/ and https://es.catapult.org.uk/guide/guidance-on-creating-a-local-area-energy-plan/

[2]As an example, a LAEP identifies a zone that is best suited to a district heat network by assessing the types of buildings in the zone, their characteristics, and density; however, to deliver the district heat network it would require a full feasibility assessment by an appropriately qualified installation / design company, along with assessment of commercial viability and delivery mechanisms.

[3]CO_2e represents an amount of a greenhouse gas emissions whose atmospheric impact has been standardized to that of one unit mass of carbon dioxide (CO_2), based on the global warming potential (GWP) of the gas. Mt is millions of tonnes.

Purpose of this LAEP

The purpose of this LAEP is to support the city of Belfast in meeting its carbon targets, enabling transition to an affordable and decarbonised energy system as well as supporting wider socio-economic goals.

This LAEP provides a vision of how the local energy system could look in a Net Zero Greenhouse Gas (GHG) emissions future, and the pathways and steps which can be taken to get there, starting from the present day. It is intended to be used for several purposes by different stakeholders including as:

A primer

- The LAEP provides a high-level overview of the future Net Zero whole energy system, the investment required to achieve this, and priority projects to deliver immediate progress and decarbonisation impact.

A communication aid

- Visualisations of the changes involved can be a powerful engagement tool to give stakeholders clarity and consensus around the energy transition.

A detailed description

- Accelerating the planning process by providing the what, where, when, and how much for a range of decarbonisation Interventions deployed across the local area. The LAEP may help to provide clarity and key insights to drive critical decision-making processes.

A catalyst for investment

- An evidence base containing investment figures, key enablers, supporting infrastructure requirements can help build the strategic case to attract the capital needed for the energy transition. For example, the evidence base may help to inform investment in energy network upgrades or investment in impactful community energy schemes.

BCC aims to use this LAEP to support the strategic case for investment and prioritisation of projects. With the support of local stakeholders, the city aims to become a place-based decarbonisation leader.

Local Context

LAEP Stakeholders

The delivery of this LAEP will require all stakeholders in the local area to take forward the recommendations and work together in the context of wider collective Net Zero goals. To support the LAEP decision making, BCC has selected a community of stakeholders who have the power to influence the LAEP and are best placed to advise on the local interests through the governance structure offered by the LAEP process.

Primary Stakeholders help shape the LAEP by making key decisions as part of the steering group. This group also supports data gathering, provides local context and characteristics, defines the modelling Scenarios, examines model assumptions, and reviews and commissions the LAEP.

Secondary Stakeholders are relevant organisations, groups, or individuals from the local area who can support the LAEP process through data gathering and helping the understanding of local context and characteristics. Secondary Stakeholders need to be kept informed of the LAEP process, but they are not key decision makers.

Belfast Local Government District is home to a population of approximately 348,000 people [1]. Belfast is a city ambitious about Net Zero and building resilience towards climate change. In October 2019, Belfast elected members declared a climate emergency. In 2020, Belfast Climate Commission developed a Net-Zero Carbon Roadmap [2] which identifies a range of cost-effective measures that can be taken to reduce emissions. Subsequently they proposed the following emissions targets which were formally adopted in 2022 [3]:

- 66% by 2025 [reduction in scope one and two CO_2 emissions compared to 1990 levels].
- 80% by 2030 [1990 levels].
- 100% by 2050 [1990 levels].

Commitment to these ambitions is recognised in the most recent Carbon Disclosure Project scores (November 2023) when Belfast received an 'A' score for the second year in a row [4]. More than 900 cities around the world have been scored with only 119 (13%) receiving the sought after A. Belfast has also ranked the highest in Northern Ireland in the 2023 Council Climate Action Scorecards, scoring 43% with the region's average 21%. The assessment covers all UK councils and consists of 91 questions based around topics that include buildings, heating, transport, planning and land use, and governance and finance. Belfast City Council (BCC) is working with partners to reduce emissions from all sectors of the economy. Belfast is currently a member of the Global Resilient Cities Network, Core Cities Network, Eurocities Network, the ICLEI Network, and the PCAN Network. Belfast recognises the contribution that the local energy system will play in achieving those ambitions and has identified several key enablers to reduce carbon emissions in the energy related sectors including:

- Investing in renewable energy, such as solar and wind power.
- Promoting energy efficiency in buildings and low-carbon heat.
- Developing a low-carbon transport system.
- Supporting the development of a green economy and the circular economy.

The Electricity Distribution Network Operator (DNO) for NI is Northern Ireland Electricity (NIE) Networks. NIE supplies electricity to every home, farm, community and business in Northern Ireland via its distribution network. NIE are committed to investing c.£3bn in network performance and upgrades by the early 2030s. This is realised through a one-year extension to RP6 (price control mechanism for NI 2017 – 2024) and their proposed Business Plan for the subsequent RP7 price control period (2025 – 2031) subject to draft determinations expected in late 2023 [5]. NIE work closely with System Operator Northern Ireland (SONI). SONI plans the future of the electricity transmission system and are responsible for day-to-day operation. This includes interconnecting to neighbouring grids and running the wholesale electricity market as well as balancing generation and demand via NIE Networks distribution system. SONI have plans for transmission expansion to cover 10 years' worth of load growth much of which may provide significant capacity headroom for widespread electrification of Belfast. SONI's System Needs Assessment document, 'Tomorrow's Energy Scenarios 2020 [6] has informed NI energy policy and aspects of the Scenarios in this LAEP.

[1] https://www.nisra.gov.uk/publications/2022-mid-year-population-estimates-northern-ireland

[2] https://www.belfastcity.gov.uk/netzero

[3] https://www.belfastcity.gov.uk/Business-and-investment/Resilient-Belfast/Climate-change

[4] https://www.cdp.net/en/cities/cities-scores

[5] rp7-business-plan-full-report-april-2023.aspx (nienetworks.co.uk)

[6] https://www.soni.ltd.uk/media/documents/TESNI-SNA-2020.pdf

The upscaling of Electric Vehicles and associated infrastructure brings the transport system and electricity system together in an emerging sector. Reports from the CCC and NIE Networks forecast between 250,000 and 350,000 EVs would be required by 2050. NIE Networks proposed Business Plan for RP7 assumes that 80% of EVs have access to off-street charging and 25% of EV owning households are on the dual rate economy 7 tariff which provides lower rate electricity overnight. In Belfast, only 40% of households have access to off-street parking. The regional transport operator, Translink, is taking a leading role in the transition from fossil fuelled transport to renewably produced electricity and green hydrogen. Translink have already made significant decarbonisation steps in Belfast with 80 Electric buses and 20 Hydrogen buses already operational across the city by early 2023. Translink have their own decarbonisation objectives which includes 70% reduction in GHGs by 2030 and Net Zero by 2040. Translink are also developing electrolysis capabilities for local production of green hydrogen in collaboration with NI Water. The increased modal shift towards public transport is further justified by the lack of socialising of charges for electricity network upgrades which has proven a barrier to development of EV infrastructure in NI relative to other parts of the UK. There is – in late 2023 – an ongoing consultation regarding the socialisation of these charges. Translink and Belfast more generally, see a vision for a wider use of public transport, supporting ambitions to be a thriving "15-minute" city centre reaping the co-benefits of clean air and affordable mobility for everyone in support of a Just Transition. In the wider picture, an all-island rail review shows the level of investment and commitment in the region to transport modal shift with 30 recommendations being implemented over an estimated 25 years at an estimated cost of £29.2bn [1]. BCC are also supportive of The Eastern Transport Plan (ETP) 2035, being developed by the Department for Infrastructure [2] (DfI) which will set the framework for making transport policy and investment decisions up until 2035.

With its modern plastic pipes suitable for re-purposing to renewable gases, Northern Ireland's £1 billion gas network is a strategically important asset that could support the decarbonisation of multiple sectors by replacing the natural gas currently flowing through the gas grid with Biomethane and Hydrogen; two technologies that this LAEP aims to provide a sound evidence-base to support future decision making. There are significant opportunities in both forms of low carbon gas in the wider regional areas of NI. On this scale, there is relatively high biomethane potential of approximately 4 - 7 TWh per year [3] and a recognised market opportunity for e-fuels and "export" to GB, Republic of Ireland (RoI), and Europe. Phoenix Energy, who operate the gas network in Belfast, have a future strategy for deployment of biomethane targeting 80% penetration of the market with 25% energy efficiency with biomethane expected to enter the Belfast gas supply in West Belfast, East Belfast and North Belfast in 2025. This is anticipated to be realised through the deployment of domestic hybrid heating systems which are currently being trialed. Hydrogen activities are abundant around NI with significant innovation projects such as the Islandmagee project [4], which aims to develop salt caverns 1500m underneath Larne Lough offering long duration storage of clean gas to provide energy flexibility and support seasonal peaks in electricity demand. An "all-island" approach with the RoI presents links to Europe and notably the market opportunity arising from initiatives such as the German-Irish Hydrogen Council [5]. Belfast's gas network , with its plastic pipes, is already well on its way to becoming hydrogen-ready with the remaining cost of upgrade expected to be less than many other local areas across the UK and RoI.

[1] https://www.bbc.co.uk/news/uk-northern-ireland-66297150

[2] https://www.infrastructure-ni.gov.uk/articles/eastern-transport-plan-etp-2035

[3] Utilising Northern Irelands' Agriculture Sector to Decarbonise Heat

[4] https://www.harland-wolff.com/investors/projects/islandmagee-gas-storage-project/

[5] https://www.german-irish.ie/en/hydrogen-council

Agriculture forms an important part of the economy of Northern Ireland, as the country's biggest industry and the biggest sector contributor to GHG emissions [1]. 75% of Northern Irish land is used for agriculture – an average of 5.4km^2 of agricultural land per 1,000 people which is 3 times higher than the UK's average (1.8km^2) [2]. The Northern Irish agriculture industry is dominated by livestock holdings, and this brings with it many environmental challenges ranging from methane production, attributed to livestock, to elevated levels of ammonia and eutrophication resultant from high levels of run-off of manure and other wastes into fresh water supplies. The latter is an ongoing concern in Northern Ireland [3] and a current topic reaching the mainstream media [4]. Despite only accounting for 6% of the UK's land mass, Northern Ireland is responsible for 12% of ammonia emissions with 97% of these coming from agricultural sources, largely cattle farming, and a smaller proportion from poultry, pigs, and fertiliser. Manure management is the key driver of this, accounting for 80% of agricultural ammonia emissions [5]. Excess ammonia can lead to soil and water acidification and a build-up of nitrogen in the environment. Critical levels of ammonia are already exceeded in 90% of protected habitats in Northern Ireland [6]. Improving the handling of agricultural waste is key to reducing this and will also help to reduce the volumes of methane produced by the sector.

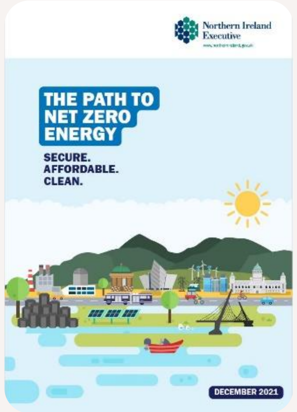
Biomethane can be produced from agricultural waste, such as manure, underused silage, or dedicated feedstocks. Biomethane may be used in the existing gas network as a direct replacement for natural gas. This has the potential to provide better control over the production of agricultural nutrient emissions, in addition to reducing the carbon intensity of the gas network without requiring changes to gas boilers already installed in buildings. There is potential for biomethane to stimulate a negative emissions value chain [7]. However, there are challenges in that value chain to ensure methane leakage is minimised at the production plant and in distribution or transportation. It is likely that livestock farming will need to decrease in intensity to meet carbon targets,[8] which may affect the volume of biomethane available in future; and might be more difficult to achieve that decrease if producing biomethane for the supply to the energy system becomes financially attractive. Additionally, the availability of silage for production of biomethane is sensitive to year-on-year variations in environmental conditions. For example, a drought in summer may mean that there is no surplus silage available for contribution to [9].

As it stands, Northern Ireland is exporting agricultural waste – largely to RoI – to help combat pollution issues in the area. For example, a quarter of poultry wastes are being exported [10]. Regardless of the uncertain long-term sustainability of Biomethane, it could be – and already is – used in the short term as a better solution to this issue. Biomethane is currently being injected at small volumes into the gas grid, and there is ambition to quickly increase this [11]. Despite this, there remains uncertainty over the environmental impacts, costs, and feasibility of a Northern Ireland wide gas network based on biomethane. A goal of this LAEP will be to assess the impact that differing quantities of biomethane will have on other aspects of the future local energy system.

[1] https://www.gov.uk/government/statistics/uk-local-authority-and-regional-greenhouse-gas-emissions-national-statistics-2005-to-2021
[2] https://friendsoftheearth.uk/latest/food-and-farming-northern-Ireland (75% NI vs 50% UK agriculture. Scaling applied to 2021 Census population to determine 5.4km^2 vs 1.8km^2
[3] https://www.daera-ni.gov.uk/articles/review-sensitive-areas
[4] https://www.belfasttelegraph.co.uk/news/environment/explainer-what-is-causing-lough-neagh-to-turn-green/a1382464686.html
[5] https://www.daera-ni.gov.uk/articles/ammonia-emissions-northern-Ireland
[6] https://ejni.net/wp-content/uploads/2021/01/EJNI-Briefing-4-Ammonia.pdf
[7] Mehta, N., Anderson, A., Johnston, C. R., & Rooney, D. W. (2022). Evaluating the opportunity for utilising anaerobic digestion and pyrolysis of livestock manure and grass silage to decarbonise gas infrastructure: A Northern Ireland case study. *Renewable Energy*, *196*, 343-357. https://doi.org/10.1016/j.renene.2022.06.115
[8] https://www.theguardian.com/environment/2022/apr/22/northern-ireland-faces-loss-of-1-million-sheep-and-cattle-to-meet-climate-targets
[9]. https://www.sciencedirect.com/science/article/pii/S095965262101057X#bib15
[10] https://www.theguardian.com/environment/2021/jun/23/poo-overload-northern-ireland-could-be-forced-to-export-a-third-of-its-animal-waste
[11] https://www.bbc.co.uk/news/uk-northern-ireland-67469656

Energy Related Policy & Strategy

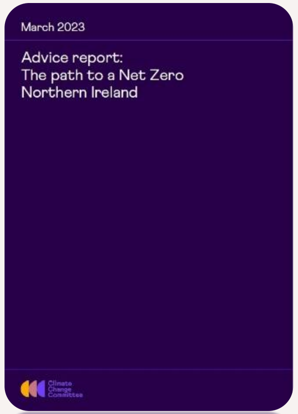
This LAEP considers a range of local, regional, and national policies and strategies relevant to the local energy system and any wider ambitions for decarbonisation and socio-economic, environmental, or political prosperity and justice. Some of those key documents are highlighted and sumnmarised over the next 4 pages.



Energy Efficiency:
- Deliver energy savings of 25% from buildings and industry by 2030;

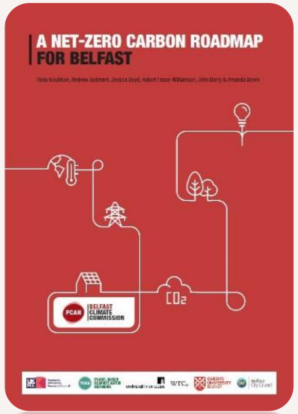
Renewables:
- Meet at least 70% of electricity consumption from a diverse mix of renewable sources by 2030.

Green Economy:
- Double the size of low carbon and renewable energy economy to a turnover of more than £2 billion by 2030.



Balanced Pathway:
- 83% reduction in NI emissions by 2050 (compared to levels in 1990)

Stretched Ambition:
- 93% reduction in NI emissions by 2050 (compared to levels in 1990). Requires engineered removal based on carbon capture and storage (CCS) from both solid biomass grown in NI and anaerobic digestion of wastes to produce biomethane



Current State:
Belfast has 14m tonnes of carbon budget to maintain global warming at 1.5°C. Belfast is currently emitting 1.5m tonnes of carbon a year. At this rate, the budget will be used up by 2030.

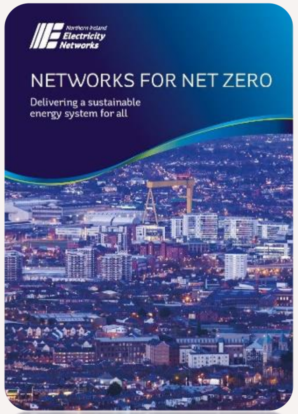
Cost Effective Options:
- Improved deep retrofitting of heating, lighting and insulation in houses
- Improved cooling and insulation in offices, shops and restaurants
- Modal shift to non-motorised transport and the wider up-take of electric vehicles.

Aims of the Plan (RP7):

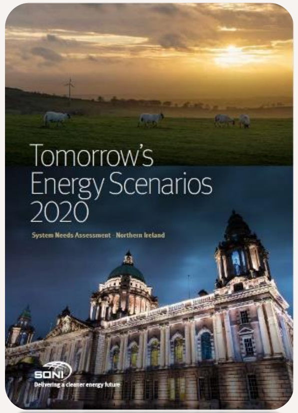
- Additional network capacity with a more flexible and digitally enabled operating approach.
- Maintain a safe, reliable and resilient network with minimal customer outages.
- Develop new and more digitalised methods for customers to interact with the network.
- Addressing the challenges of environmentally sustainable operations, greater digitalisation and workforce resilience.

Investment & Innovation:

Network investment aims to facilitate 300,000 electric vehicles, 120,000 heat pumps and 3,900 MW of renewable generation in NI by 2030.

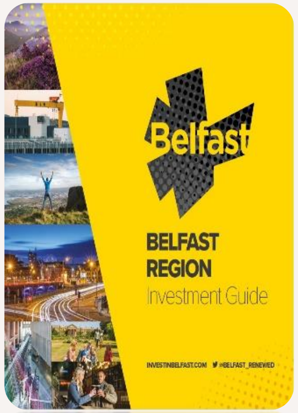


- **Highlights of the Study:**
- With the right policy decisions, NI can achieve its Net Zero commitments as outlined in the CCC's 6th Carbon Budget.
- The electrification of demand and moving away from fossil fuels in generation, heating and transport could reduce the demand on primary energy sources by as much as 48% by 2050 compared to today. It could also increase overall electricity consumption by between 50% and 70% by 2050.



Key Messages:

- Bulk supply points - substations which take electricity from the transmission network and supply it to the distribution network to meet demand – are not expected to experience many issues related to growth in demand from electric vehicles and electric heating until beyond 2030.
- By 2040, however, many bulk supply points may require the delivery of additional capacity to accommodate the growth in demand from electric heat and transport. This risk could be brought forward if government pursues ambitious requirements for these technologies.
- High levels of growth in large scale solar PV generation, may ultimately require a clustering policy, similar to that which was used for onshore wind in Northern Ireland.



Near-Term Action Plan for Green Hydrogen:

- Whole-system Planning: to decide the most efficient balance of energy across all vectors, optimise infrastructure, and minimise the costs of decarbonisation.
- Public Funding: made available for the sector to bridge the cost gap between green hydrogen and incumbent fossil fuels.
- Regulatory Adjustment: to enable blending, network adaptation/roll-out, and certification.
- Hydrogen Governance Body: Implemented to align responsibilities and capabilities of relevant government bodies in driving and implementing the sector's development.
- Hydrogen Catapult: Established as identified in the Energy Strategy to ensure NI keeps up pace with global efforts and demand for further progressing hydrogen technologies

Net Zero and Climate Resilience:

Belfast ranked eighth in the Global Destination Sustainability Index (2022).
Achieved an A score in its 2022 submission to the Carbon Disclosure Project global reporting framework.

Key Projects Underway

- Established the Belfast Retrofit Hub and the Belfast Electric Vehicle Infrastructure (EVI) Strategy.
- Belfast One Million Trees.
- UPSURGE: reusing council owned vacant land to test nature-based solutions co-designed with local communities (Funded by Horizon 2020).
- UP2030: designing Net Zero neighbourhoods (funded by Horizon Europe)

In Summary, the LDP will:

- Provide a 15-year plan framework to support economic and social needs in the city, in line with regional strategies and policies, while providing the delivery of sustainable development;
- Facilitate growth by coordinating public and private investment to encourage development where it can be of most benefit to the wellbeing of the community;
- Allocate sufficient land to meet the needs of the city;
- Provide more certainty for where development in Belfast should take place.

Commitments Relevant to Energy for Next 4 Years:

Actions:

- Develop a pipeline of investable local energy projects arising from the LAEP
- Accelerate project development, including concept development, feasibility studies and business cases
- Identify and respond to emerging funding opportunities and secure funding for projects
- Develop appropriate governance and delivery structures for projects as they emerge
- Engage with investors and financial institutions to explore new financial models
- Develop and adopt the Belfast EV Strategy and its targets for the period to 2027 and beyond
- Establish a Belfast EV group which oversees implementation of the EV Strategy
- Accelerate the retrofit of buildings including commercial and public buildings, and domestic housing through the Belfast Retrofit Hub
- Start delivering the Belfast Retrofit Programme
- Undertake preliminary work for a Heat Network for Belfast City Centre
- Provide energy sector expertise to community-based organisations which are developing local energy projects.
- Scope, benchmark, aggregate and upscale feasible local energy projects as part of a project pipeline across the City.

Stretch Goals:

- Develop a pipeline of Net Zero projects up to the value of £1.6bn
- At least 2 projects arising from Belfast Local Area Energy Plan in implementation phase
- Adopt new financial models to scale decarbonisation investments
- Develop a Phase 2 bid to the Shared Island Fund to scale solar PV across the city in partnership with Cork City Council
- Deliver the Belfast EV Strategy and implementation plan in 2023
- Support the installation of at least 800 electric vehicle charging devices for public use by 2027
- Secure funding for public EV charging infrastructure
- Develop and implement the Belfast Retrofit Programme including neighbourhood pathfinder projects through the Belfast Retrofit Delivery Hub
- Deliver energy savings of at least 15% from participating buildings
- Develop a full business case for a Heat Network for Belfast City Centre
- Develop at least two local energy projects (compliant with all current and future energy and carbon regulatory obligations and aligned with international best practice)

[1] https://yoursay.belfastcity.gov.uk/25730/widgets/75246/documents/45372

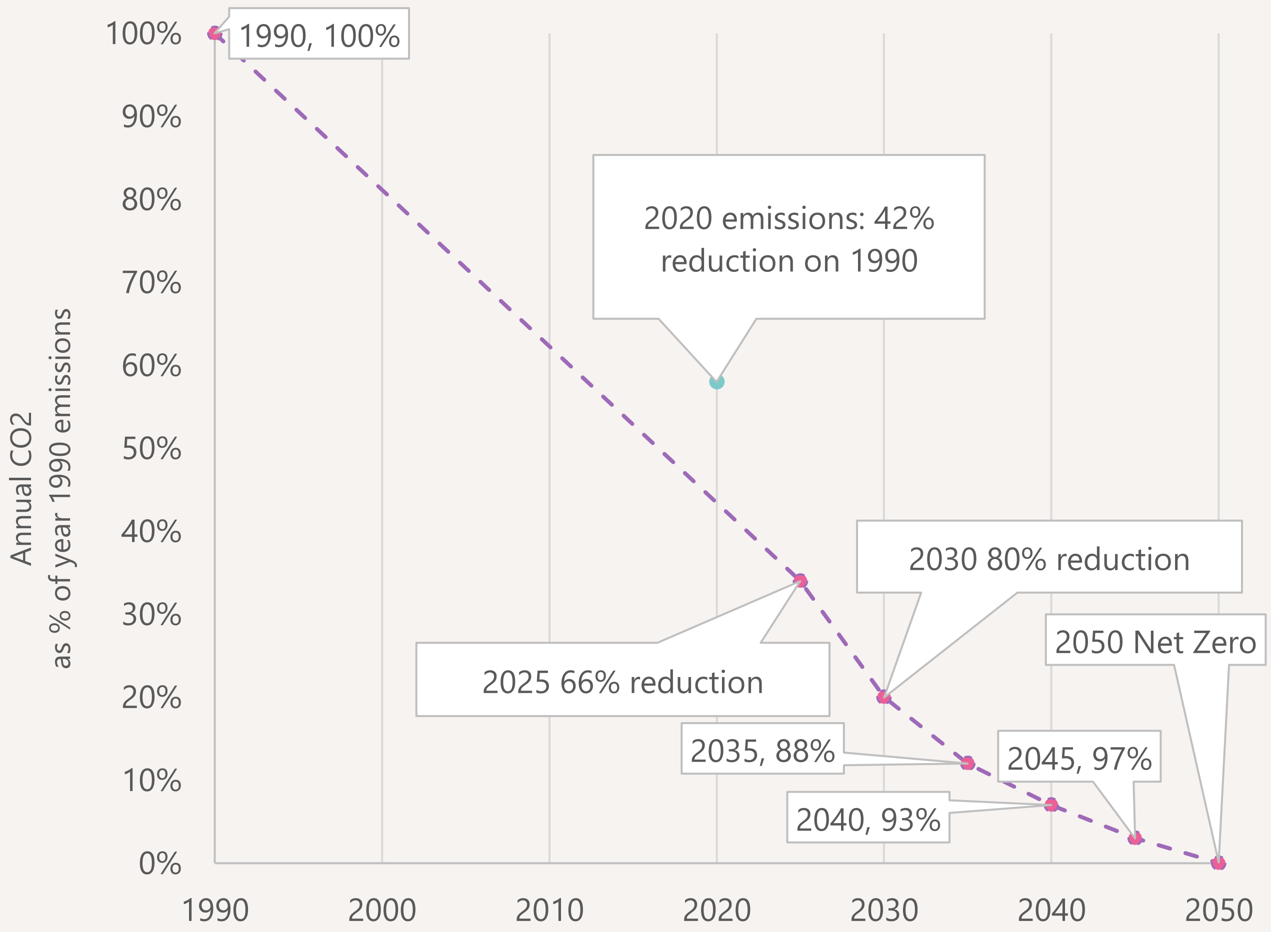
[2] https://yoursay.belfastcity.gov.uk/25730/widgets/75246/documents/45371

Emissions and Net Zero Targets

To help form a strategy to deliver Belfast's ambitious emission targets work has been done to divide the IPCC global carbon budget by the population in Belfast [1]. This gives Belfast a **total carbon budget of 48.4 MTCo2e from 2023**. Belfast **currently emits c.8.9 MTCo2e per year for scope 1 and 2 emissions within its boundaries**. So, on current trajectory, it would use up its carbon budget by the end of 2028[1]. A modified trajectory is shown below to account for the carbon targets and overall budget whilst achieving Net Zero by 2050. These figures help tailor the configuration of the LAEP modelling towards the local area carbon budget and targets.

Belfast's adopted emissions targets [reduction in scope one and two CO2 emissions compared to 1990 levels]:

- *66% by 2025.*
- *80% by 2030.*
- *100% by 2050.*



[1] An Analysis of Net-Zero Carbon Options for the Belfast Region, By Prof. Andy Gouldson, Andrew Sudmant and Ruaidhri Higgins-Lavery

Geographic Scope

The geographic area applicable to the Belfast LAEP is shown in the figure on the right. The area was broken into 11 'zones' to allow for a better understanding and assessment of options for decarbonisation. Zones help to highlight where hotspots of decarbonisation activity might occur and where investment opportunity lies. Zones also make the changes more tangible for local communities and break the pathway into more manageable pieces.

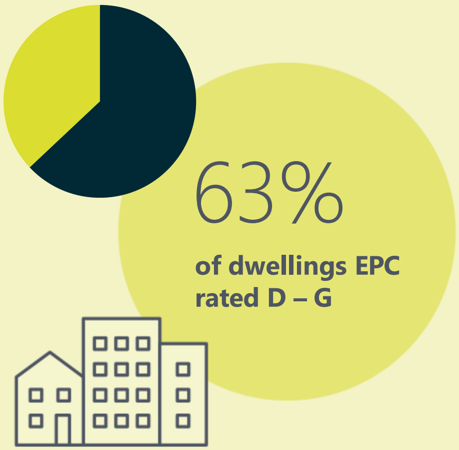
Zones were identified using the High Voltage (HV) electricity network. Low Voltage (LV) substations fed by same HV substation should be within the same zone.

These zones are used to aggregate results shown on visual maps, and to identify similar results related to certain building types within each zone.

Belfast's Energy System Today

See Annex A for detail

Setting the Scene: Belfast Today

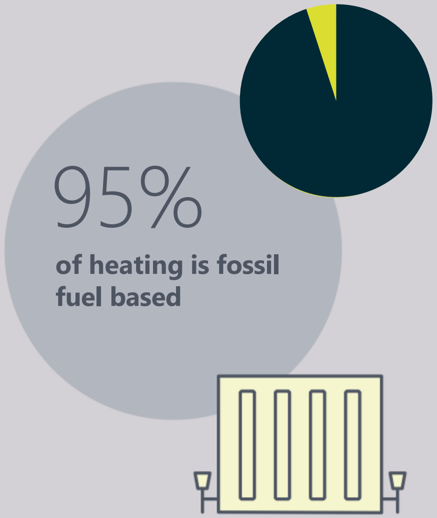


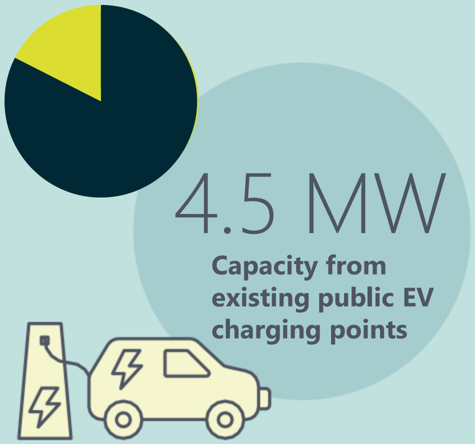
BUILDINGS

Currently 35% of of Belfast's existing domestic buildings are EPC rated D with 18% rated E, 8% rated F, and 2% rated G. These require energy efficiency improvements. Belfast must also ensure that 12 million square metres of public, commercial, and industrial floorspace is decarbonised by 2050.

HEATING

66% of buildings currently use gas for heating with 29% using oil. There are small quantities (<5%) of buildings electric heating, solid fuel or biomass heating.



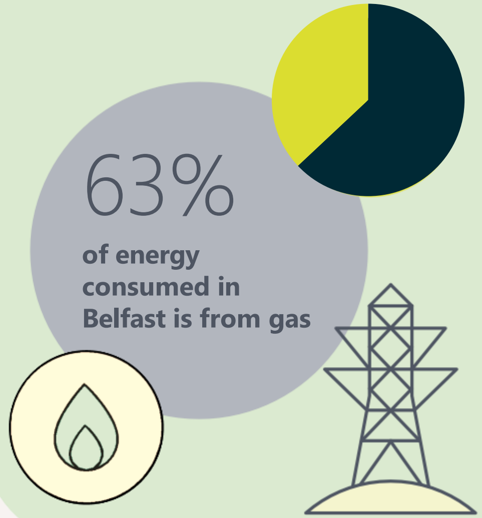


VEHICLES

Belfast currently has 170 Electric Vehicle charging points around the city delivering a total charging capacity of nearly 4.5 MW. Belfast's ambition is to deliver 800 charging points by 2027.

ENERGY

Belfast's metered energy consumption is 63% from gas and 37% from electricity. There are currently 1,311 domestic solar PV installations across Belfast contributing a total of 8.6 MW of renewable electricity to the local supply.



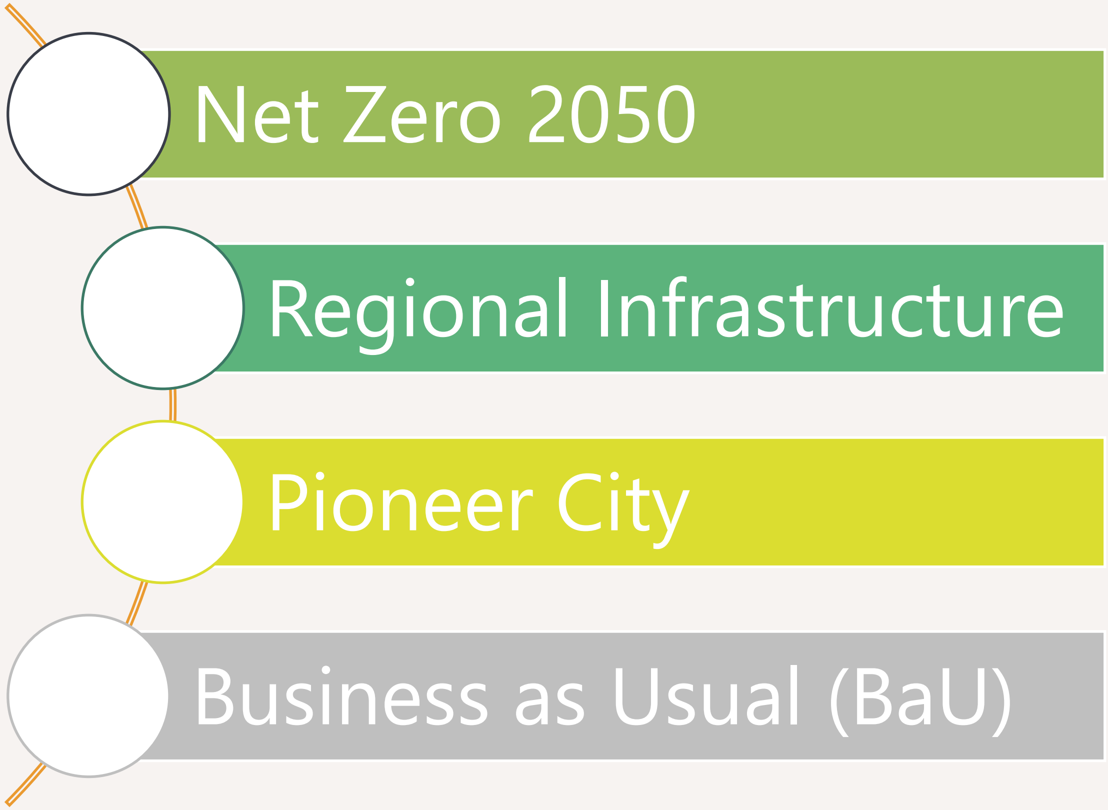
Assessing Options for the Future

See Annex B & C for detail

Scenarios for Belfast

Scenario Overview

Scenarios provide a vision of the future energy system and are a common modelling approach to establish the optimal Pathway for the local area. Scenarios should be based upon aspirations, desires, hopes for the future Net Zero energy system. Scenarios should focus on areas of specific interest or uncertainty (including stakeholder views that are polarising) and are modelled through fixing and varying of parameters and assumptions.



Note: Some technologies such as thermal storage, wave, hydro and offshore wind have not been included in the LAEP modelling. It is likely that these technologies will play an important part of the future energy mix with local, regional, and national contexts.

Net Zero 2050 Scenario aims to find the cost optimal path in line with the carbon targets set by the Northern Ireland Assembly; 56% reduction by 2025, 78% reduction by 2030, Net Zero by 2050 (against 1990 baseline). **This Scenario does not impose any constraints that would prioritise or accelerate any Belfast or Northern Ireland specific technologies.**

Regional Infrastructure Scenario aims to meet the same carbon targets, with the **assumption that there is significant regional investment in low carbon infrastructure to unlock the potential of large-scale technologies related to hydrogen and biomethane.** The hydrogen narrative is supported by regional developments such as Ballylumford power-to-X where a high regional capacity of wind generation leads to curtailment and enables the production of hydrogen in parallel with 24/7 operation of wind turbines in a co-benefit solution. Biomethane is made available from agricultural waste and feedstocks through anaerobic digestors located across rural Northern Ireland. Salt caverns in Larne Lough provide the opportunity for storage of both clean gases in large volumes.

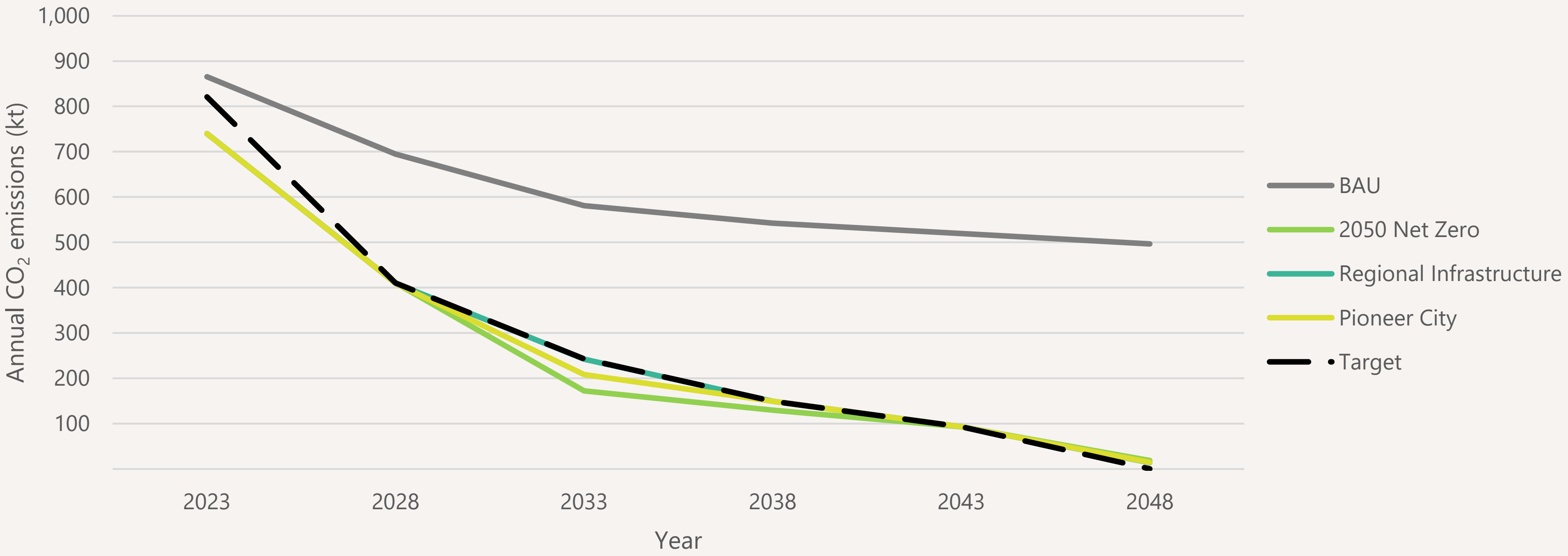
Pioneer City Scenario also aims to meet the same carbon targets, with the assumption that Belfast looks inward to take control of its journey to Net Zero irrespective of wider regional developments. Priority is given to local measures which maximise unique opportunities and accelerate decarbonisation. **This Scenario allows for investment in an aquifer-based ambient loop district heat system, accelerated smart meter roll out, higher uptake of solar PV and a higher transport modal shift resulting in fewer EVs.** The hydrogen narrative is supported by local developments such as Belfast power-to-X and small quantities of biomethane are also made available.

A '**Business-as-usual**' ('do nothing') **Scenario** is also modelled where no decarbonisation actions take place beyond already committed investments and peripheral decarbonisation progress (e.g. electricity grid). **This Scenario provides a counterfactual for cost and carbon impacts and other comparison purposes.** This is not required to meet the same local carbon targets and is not a Net Zero Scenario.

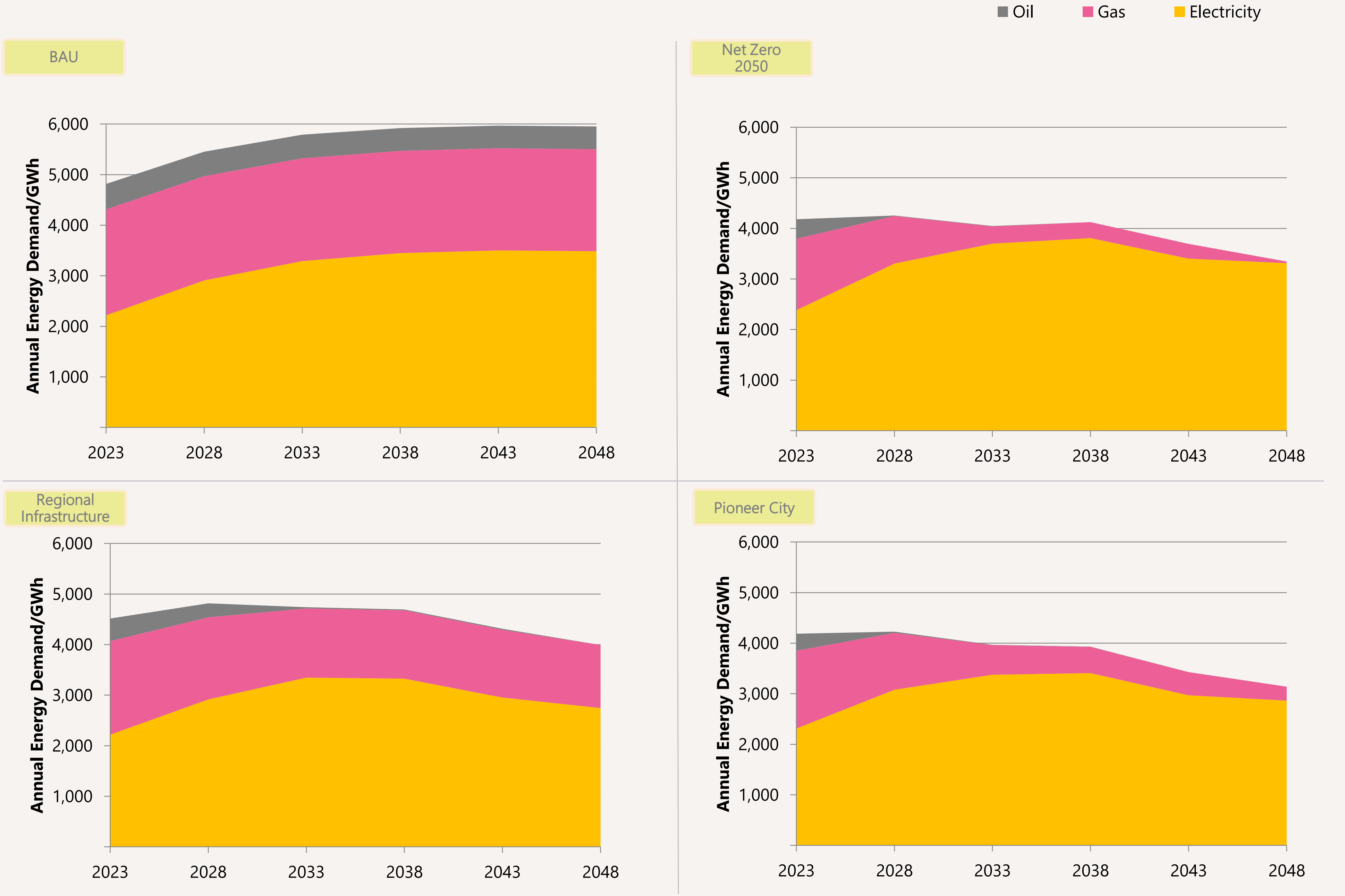
Scenarios: High-Level Overview

	BAU	Net Zero 2050	Regional Infrastructure	Pioneer City
Carbon Reduction Target	None Specified	56% reduction by 2025, 78% reduction by 2030 (against 1990 baseline), Net Zero by 2050		
Smart Meter Roll-Out	Not modelled	Decreased domestic demand over rollout (2.5% reduction per install) but assumed to not include gas or oil meters based on national stance that this is not cost effective.		Decreased domestic demand over rollout (2.5% reduction per install), assumed to include oil and gas meters. Implementation may rely upon local action.
Availability of Green Hydrogen	Not available	Not available (Hydrogen is available with carbon content as advised in Green Book)	Available from Ballylumford Power-to-X (100GWh/year by 2050) - for injection into gas grid up to 20% by volume or repurposing of grid	Available from Belfast Power-to-X (50 GWh/year by 2050) for injection into gas grid up to 20% by volume. Project also makes waste heat available to city centre areas
Transport Modal Shift	Not modelled		25% reduction reduction in demand from domestic EV chargers	50% reduction reduction in demand from domestic EV chargers
Availability of biomethane	Not available		Available – 2511 GWh/year by 2033 (equivalent to current day Belfast gas demand)	Available – 238 GWh/year by 2033 (From sources local to Belfast)
Aquifer ambient loop	Not available			Available (see Technical Annex for details such as cost)
Solar PV	Only current installations (based on MCS data)	Domestic deployment capped at 12.7 MW per year (averaged between 2025 and 2035)		Domestic deployment capped at 34.1 MW per year (averaged between 2025 and 2035)
Heating system Change	Limited	Fully optimised		

Emissions Reduction



All Scenarios see a decrease in emissions, with the BAU reduction reflecting the predicted decrease in carbon intensity of grid electricity. The three non-BAU Scenarios see a significant decrease on these BAU emissions, converging negligible residual emissions by 2050. The path that each non-BAU Scenario takes to get to Net Zero is influenced by the timing of installation of low carbon technologies. In practice the rate of deployment may be limited by supply chain capacity which cannot be accurately predicted in the techno-economic modelling. A key difference between the Scenarios is the availability of Green Gas (predominantly biomethane). This non-local resource is made available to the Belfast area with market costs and emissions embedded in the unit cost of energy (i.e. it is treated as an energy "import" to the local area; just as natural gas and electricity are). Regional Infrastructure has the highest availability of Green Gas, with Pioneer City having a smaller amount, and Net Zero 2050 having none. The volume of Green Gas purchased can be adjusted by the model (scaled up or down) to meet carbon targets whilst minimising overall energy system costs. Conversely, when no Green Gas is available, there are fewer decarbonisation options available so larger initial investments are required to meet carbon targets. For example, the Net Zero 2050 Scenario invests early and heavily in new heating systems for buildings to meet the interim carbon reduction targets, and as a result it needs to remove less carbon in the following years since emissions are lower than the target in the mid-2030s. This apparent "overshoot" on the interim emissions target is largely due to roll out of large-scale measures, such as district heating, rather than measures that would result in smaller incremental reductions in emissions over time. Delay of such large-scale measures would prohibit meeting those interim carbon targets and deployment of other solutions would not be cost optimal. The Pioneer City emissions also show some of this overshoot of targeted emissions, but to a lesser extent since it has more decarbonisation options available including a relatively small quantity of Green Gas. The key conclusion is that all Scenarios significantly reduce emissions by 2050 approximately in-line with the carbon targets set. This outcome is expected since Belfast has set challenging interim carbon targets, and all Scenarios (except BAU) are given those same targets including the year of achieving Net Zero. The true 'optimal' pathway to Net Zero relies upon many factors which cannot all be captured in a purely cost optimal model. These aspects are discussed more fully throughout this report. Although emissions from the energy system are reduced over time, energy demand does not significantly decrease until the 2040s despite improvements to energy efficiency such as building fabric and low carbon heating systems. This is largely due to electric vehicles causing an increased demand on the energy system which previously would have been allocated to the transport system when fossil fuelled vehicles were dominant.



Note: 'Gas' contains biomethane and hydrogen, as well as existing methane natural gas. For a detailed breakdown of these, please refer to Annex C.

Scenario Costs

Total Cost

- Business as Usual (BaU): **£15,630m**
- Net Zero 2050: **£17,900m**
- Regional Infrastructure: **£16,600m**
- Pioneer City: **£17,560m**

Total Cost Increase vs Business as Usual

- Net Zero 2050: **£2,270m**
- Regional Infrastructure: **£970m**
- Pioneer City: **£1,930m**

Business-as-usual

- Costs reflect the considerable spend on maintaining the local energy system; this Scenario puts cost increases of decarbonisation into context.
- Costs include replacing assets at end-of-life with like-for-like replacements (e.g. gas boilers, oil boilers, and other existing heating systems), upkeep of networks for existing demands, the emergence of EVs, and the cost of the fuels supplied to assets.

Net Zero 2050

- Costs – relative to BAU – primarily reflect the shift away from gas and towards electrification of heating.
- Relative to the other decarbonisation Scenarios, the cost of electricity import is higher, with money saved on not importing any Green Gas.

Regional Infrastructure

- Lowest cost Net Zero Scenario.
- Major cost is the import of biomethane. High biomethane availability enables continuation of gas boilers or introduction of hybrid heating which avoid the magnitude of costs associated with electrification of heat prominent in Pioneer City and Net Zero 2050. This also enables more savings on electricity import.

Pioneer city

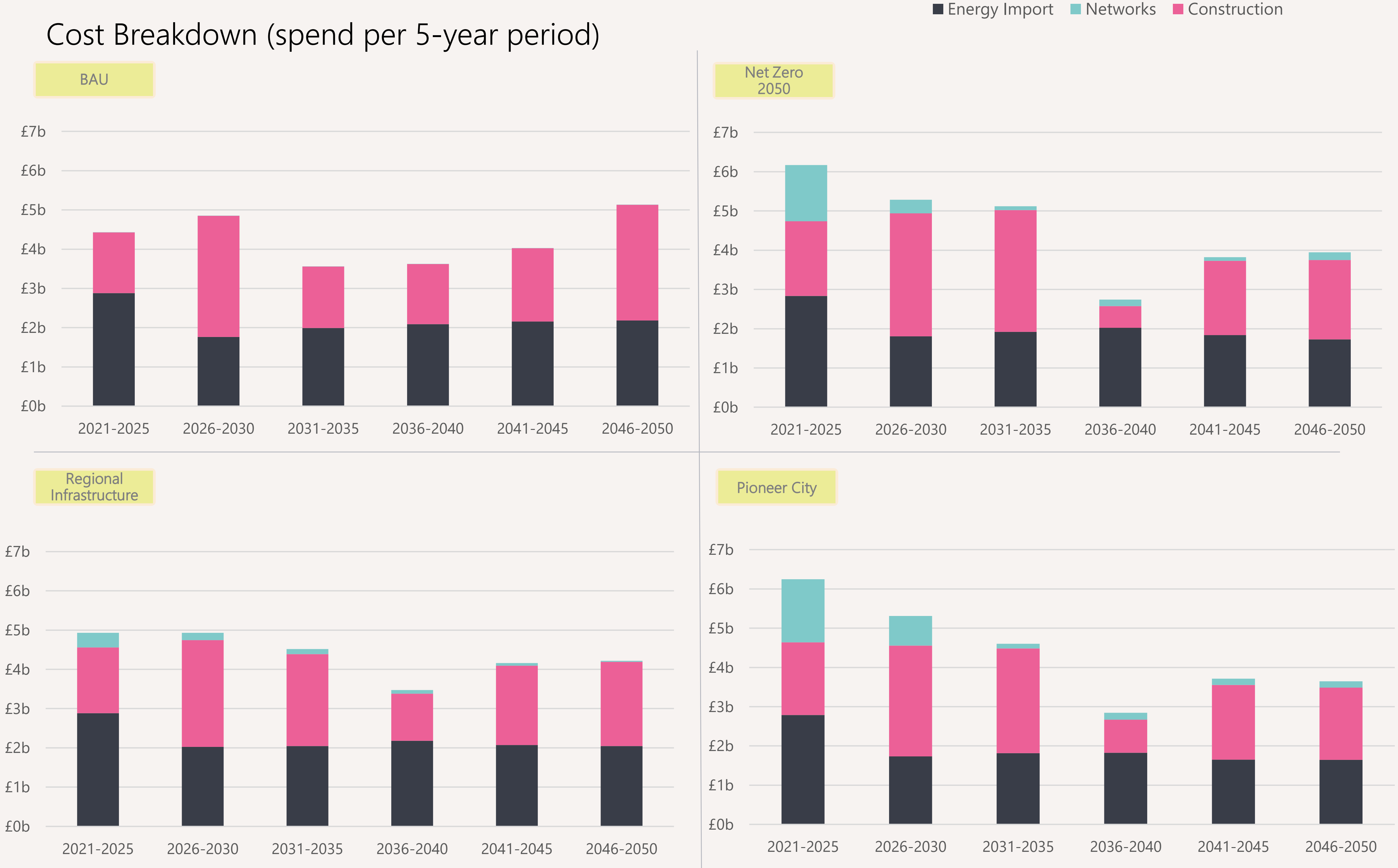
- Lower cost than Net Zero 2050 primarily by using biomethane.
- Ambient loop district heating made available, however not chosen on a cost-optimal basis.

These costs include Capital Expenditure (CapEx) and Operational Expenditure (OpEx) related to the establishment and operation of a Net Zero energy system in Belfast – except for BAU which does not achieve Net Zero. CapEx and OpEx include: fuel costs, network upgrades, heating system installations, insulation, and renewable energy generation.

In accordance with HM Treasury Green Book [1] costing, these costs are discounted by a rate of 3.5% per year between now and 2050. Discounting is a financial process which aims to determine the "present value of future cash flows", or in other words: calculating what monies spent or earned in the future would be worth today. Discounting reflects the "time value of money" i.e. one pound is worth more today than a pound in say one year's time as money is subject to inflation and has the ability to earn interest. A Discount Rate is applied to financial inflows or outflows – this generally reflects what it costs a company to borrow money or is a defined rate such as the 3.5% discount rate suggested in the UK Treasury's "Green Book" (used in the financial evaluation of UK Government projects).

[1] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent/the-green-book-2020

Cost Breakdown (spend per 5-year period)



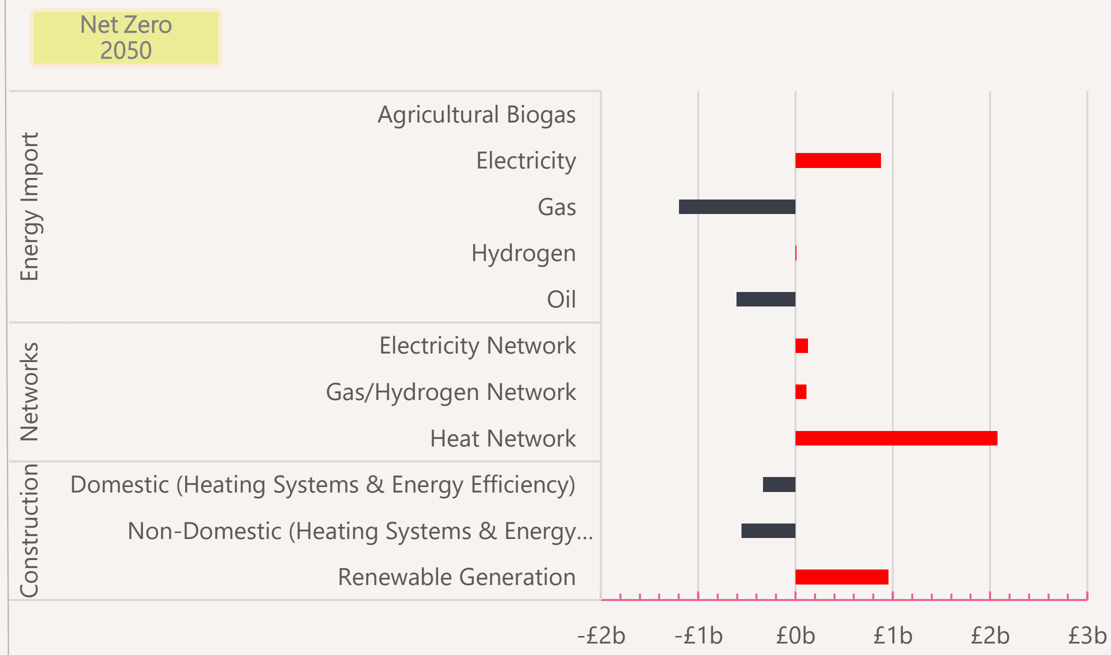
Cost Breakdown

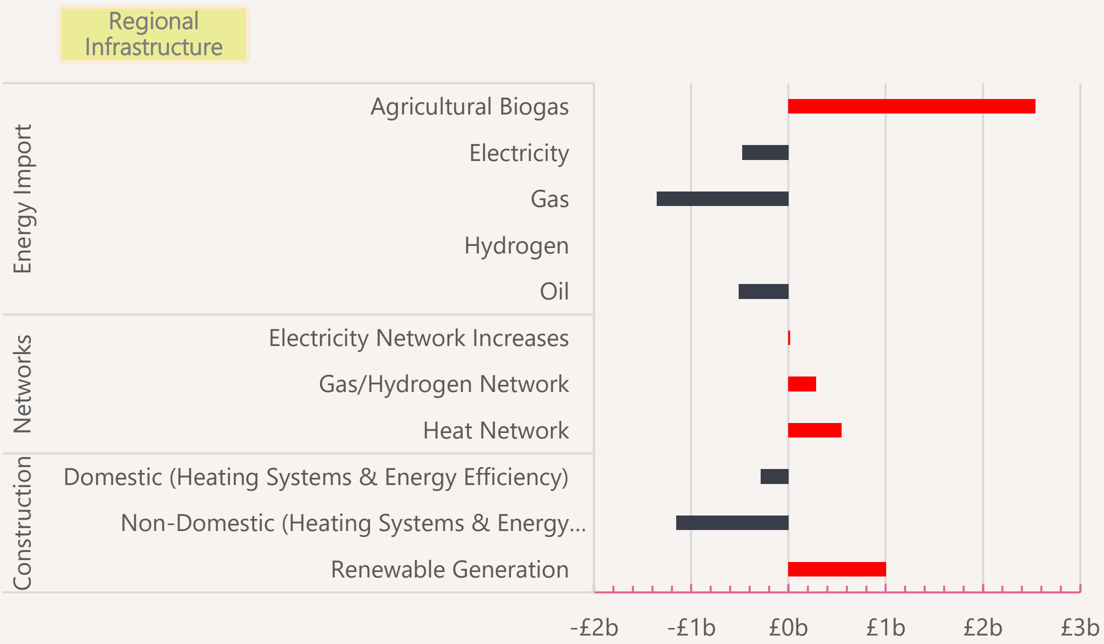
Cost Breakdown (vs Business as Usual)

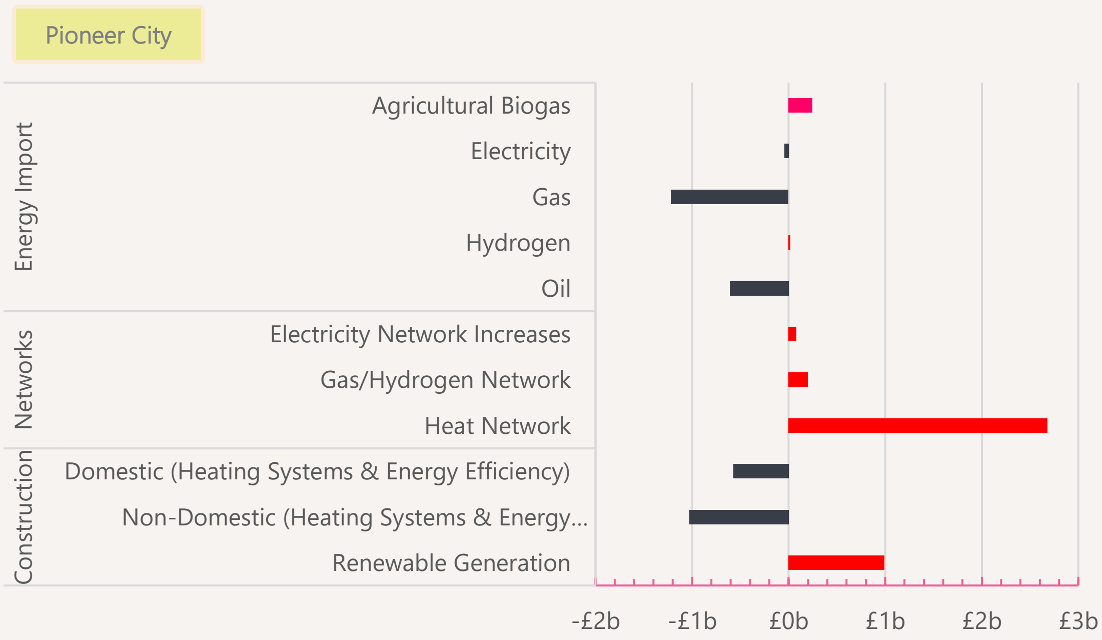
These charts show the cost of each category as additional spending or saving vs the Business-as-Usual Scenario.

Cost increase vs Business as Usual

Cost saving vs Business as Usual

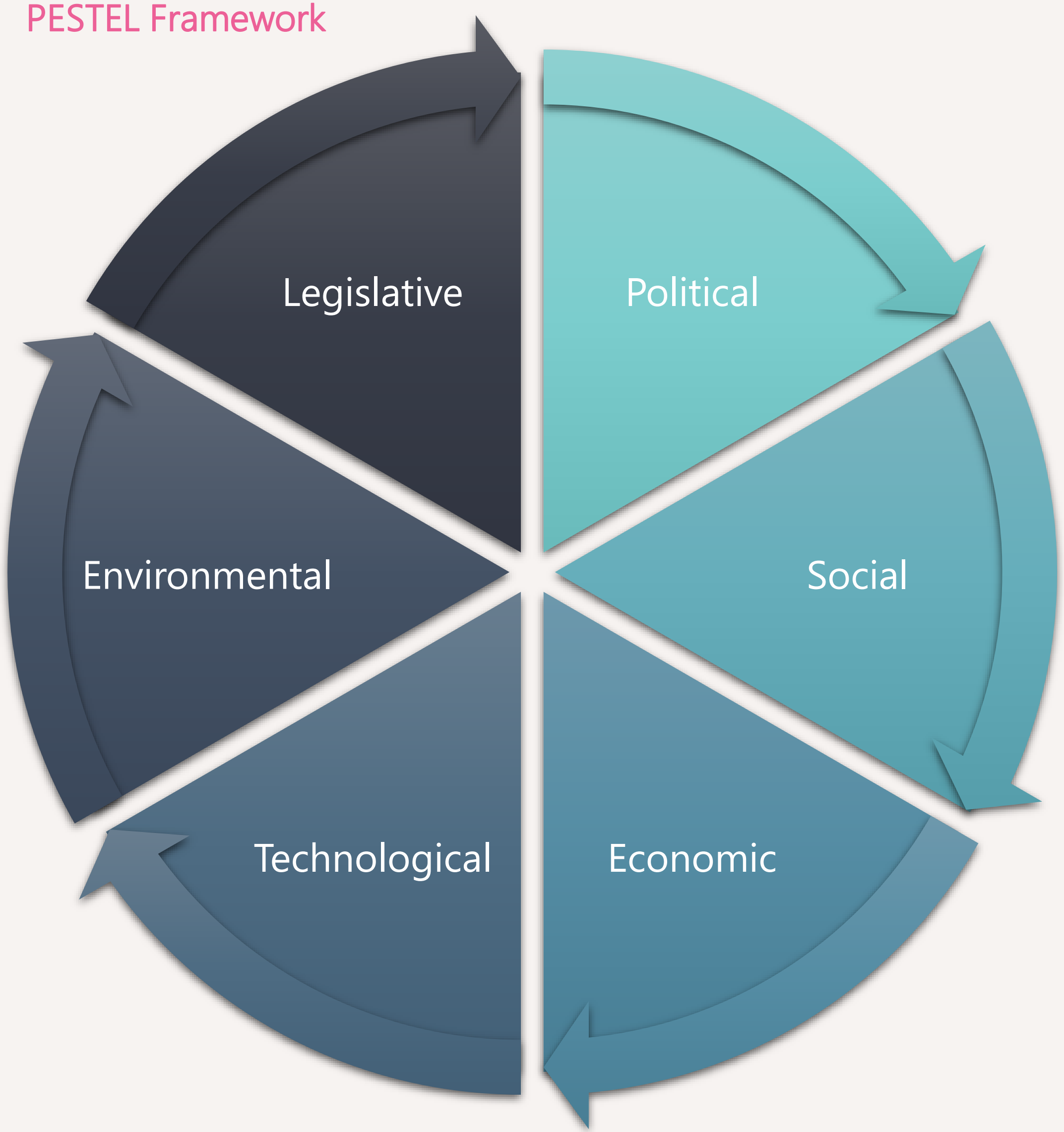






Wider Factors Evaluation

PESTEL Framework



Evaluation factors are derived from the PESTEL framework to ensure factors cover a sufficient and holistic range of viewpoints. Examples of a typical wider factors analysis included in the LAEP process are:

- Energy and Carbon Savings
- Distribution of Costs & Benefits
- Impact on Bills
- Investment per Household
- Employment
- Health
- Comfort Taking
- Disruption
- Resilience of Supply
- Strategic Influences and Compatibility
- Public Attitudes and Preferences
- Deliverability

Factors may be qualitative or quantitative and some quantitative factors may include monetisation. Qualitative factors are generally analysed with the support of stakeholders who have a better understanding of local context.

A summary of wider factors analysis in Belfast is presented in the table opposite. The factors included here are those that produce **quantitative** results only. **Qualitative** factors, such as deliverability, public attitudes and preferences, and Strategic Influences and Compatibility are not rated. However, these are discussed in **annex C** where more detail can be found including methodology and interpretation of results.

Indicative ratings of wider factors evaluation per Scenario (quantitative measures only)

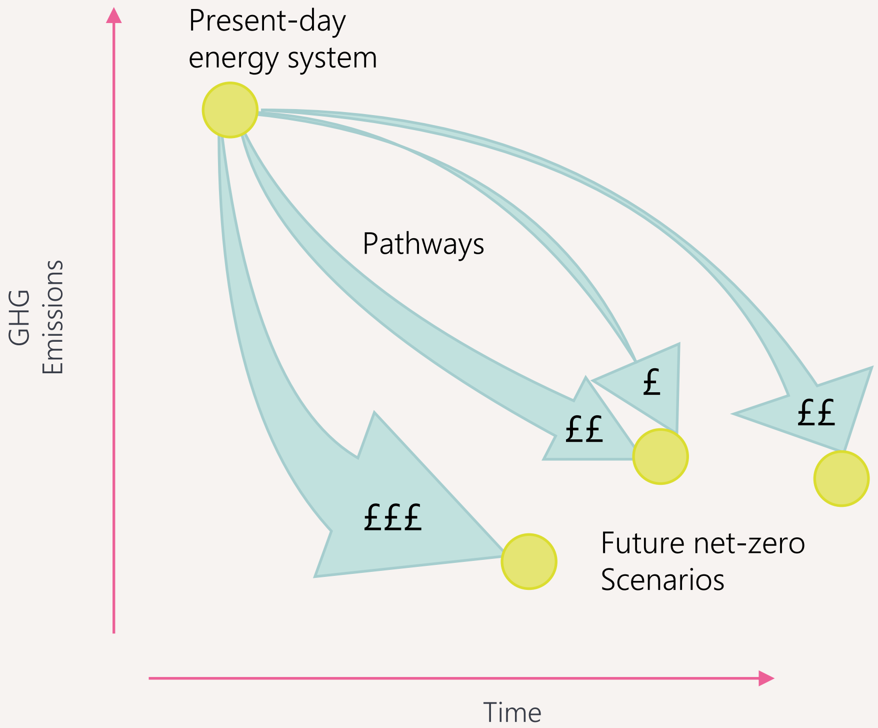
	BAU	Net Zero 2050	Pioneer City	Regional Infrastructure
Carbon Savings Valuation	Red	Amber	Amber	Green
Changes to Household Expenditure	Amber	Green	Green	Red
Local Jobs	Amber	Green	Green	Red
Health	Red	Green	Green	Amber

Belfast's Pathway to Net Zero

LAEP Pathways

It is essential for long-terms plans to make allowances for uncertainty about the future, as no projection can ever be completely certain. There is uncertainty about how the world will change over the period covered in this LAEP, and there are different choices which can be made within the local area; hence there is no single "right answer" to the question of what the transition should look like. The LAEP Pathway represents the most cost-effective and co-beneficial way for the area to achieve a Net Zero energy system.

By modelling multiple plausible Scenarios for how Belfast and the wider world will look by 2050, the Pathway can remain flexible to changes and unknowns (hence, the term Pathways may be used instead of Pathway). The various Pathways to progress from the present day to 2050 allow freedom for local decision makers to make choices which best fit their circumstances, concerns and ambitions whist allowing new developments, priorities and information to emerge.



Pathway Components

A pathway has near-term and long-term components to enable and scale up energy system decarbonisation in a cost-effective way, along with Key Decision Points to stay on track and navigate future uncertainty. In the near-term, the LAEPs illustrate the proposed activities for the region to progress towards Net Zero by identifying 'Quick Wins', and specific 'Outline Priority Projects' which could be taken forward into a feasibility stage.

Quick Wins – Near-term actions/projects of short duration and with high confidence that the intervention is the correct choice. A Quick Win requires fertile market conditions and has relatively few barriers to implementation.

Low Regrets – Actions/projects which are common under various Scenarios but may require further Enabling Action before they can be progressed. These could occur in the near-term but may require longer-term resolution of uncertainties or market conditions to evolve naturally.

Scale Up – Long duration major decarbonisation activities not expected to happen naturally in today's market conditions. Typically preceded by a Key Decision Point in situations of low certainty or an Enabling Action in situations of high certainty.

Enabling Actions – Mostly occur in the near-term to develop market conditions which enable scale up activities in the long-term. Often these are not under Local Government control.

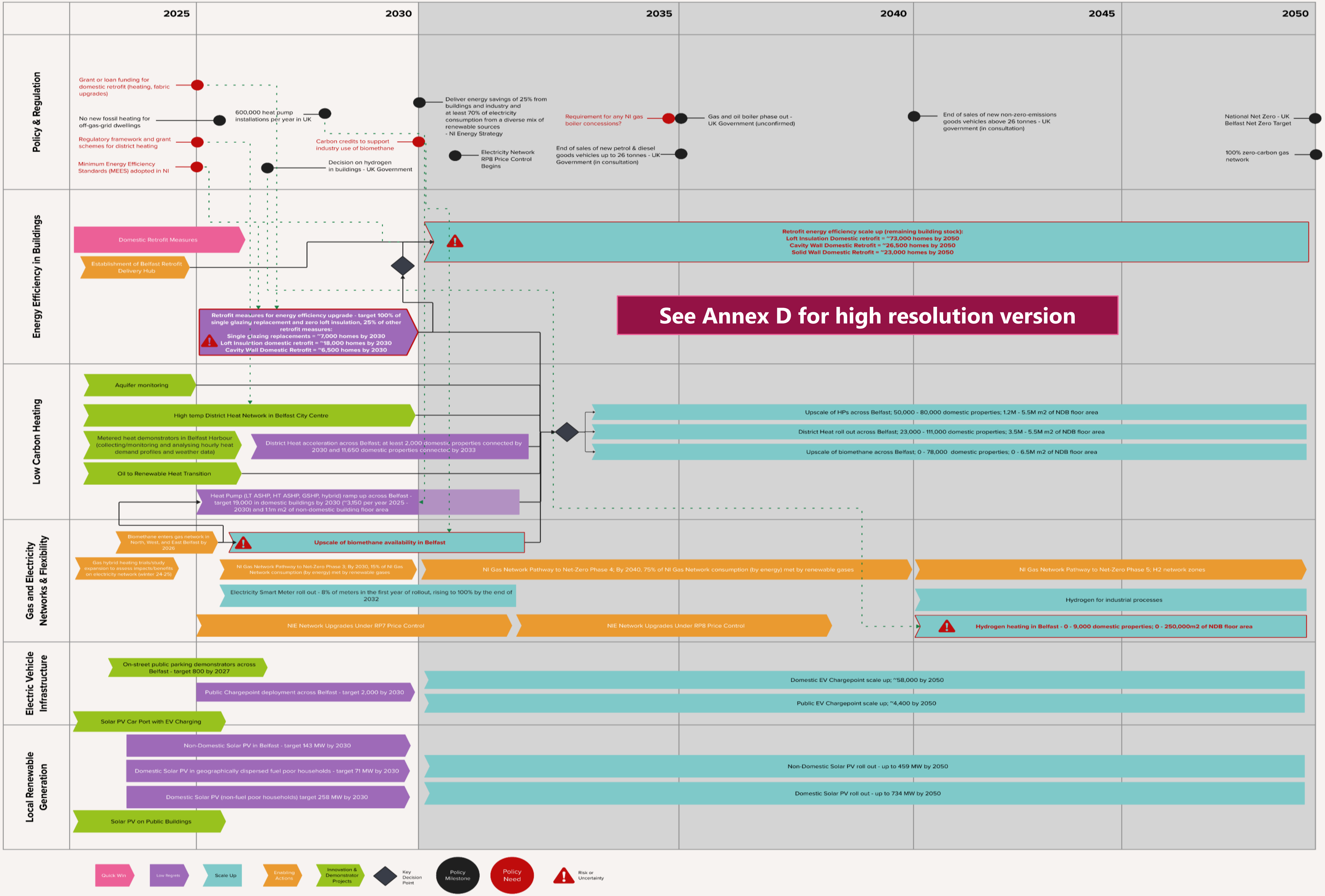
Innovation & Demonstrator Projects – These projects help navigate aspects of uncertainty or bring longer-term solutions into the near-term. Often these feed into Key Decision Points on the Pathway.

Key Decision Points – A milestone marker that indicate a fork in the pathway between decarbonisation options. These are typically preceded by Enabling Actions or Innovation & Demonstrator Projects and typically feed into Scale Up activities.

Policy Milestone

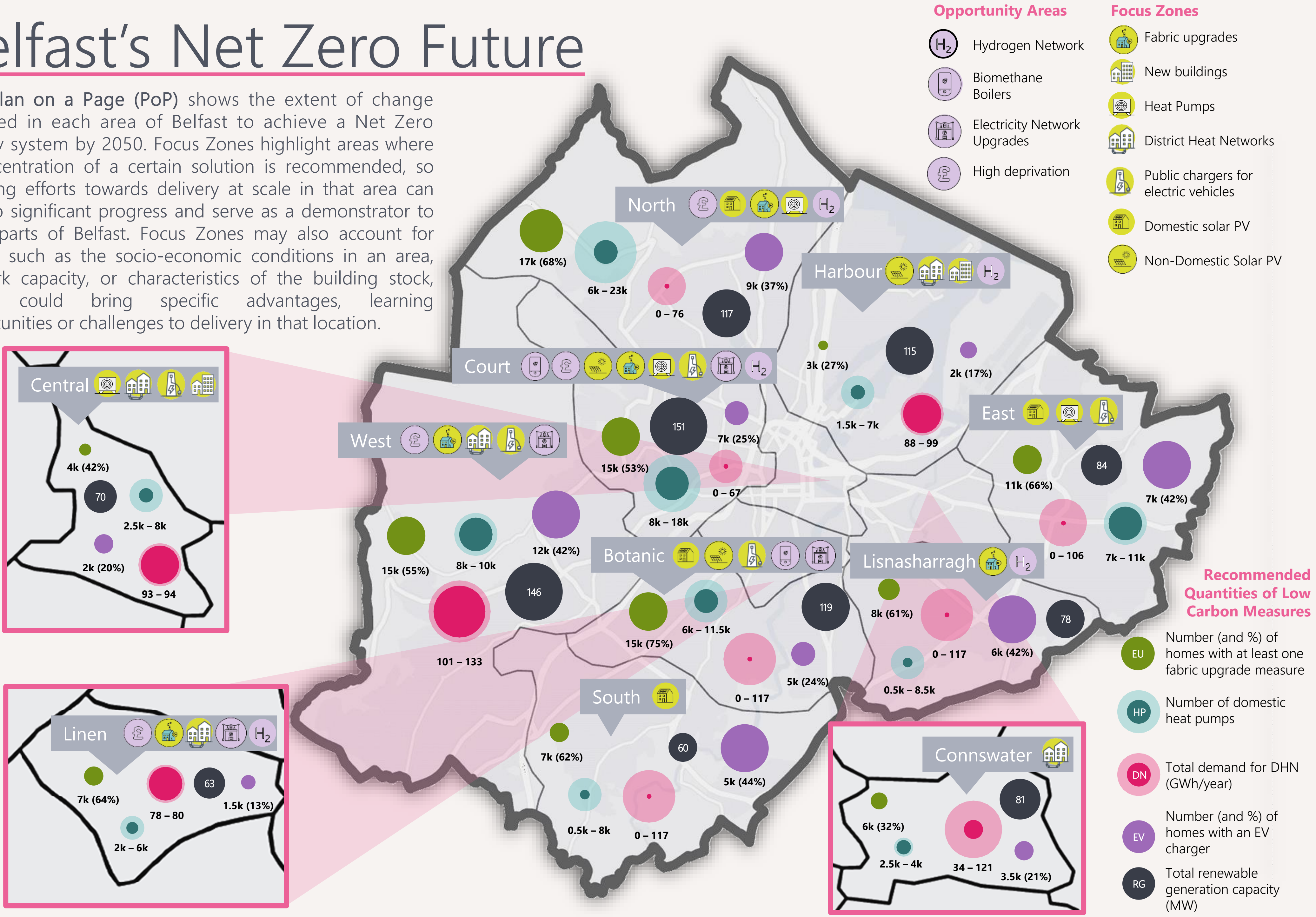
Policy Need

Risk or Uncertainty


2025
2030
2035
2040
2045
2050
Policy & Regulation
Grant or loan funding for domestic retrofit (heating, fabric upgrades)
No new fossil heating for off-gas-grid dwellings
600,000 heat pump installations per year in UK
Regulatory framework and grant schemes for district heating
Minimum Energy Efficiency Standards (MEES) adopted in NI
Decision on hydrogen in buildings - UK Government
Carbon credits to support industry use of biomethane
Deliver energy savings of 25% from buildings and industry and at least 70% of electricity consumption from a diverse mix of renewable sources - NI Energy Strategy
Electricity Network RP8 Price Control Begins
Requirement for any NI gas boiler concessions?
Gas and oil boiler phase out - UK Government (unconfirmed)
End of sales of new petrol & diesel goods vehicles up to 26 tonnes - UK Government (in consultation)
End of sales of new non-zero-emissions goods vehicles above 26 tonnes - UK government (in consultation)
National Net Zero - UK Belfast Net Zero Target
100% zero-carbon gas network
Energy Efficiency in Buildings
Domestic Retrofit Measures
Establishment of Belfast Retrofit Delivery Hub
Retrofit measures for energy efficiency upgrade - target 100% of single glazing replacement and zero loft insulation, 25% of other retrofit measures:
Single glazing replacements = ~7,000 homes by 2030
Loft insulation domestic retrofit = ~18,000 homes by 2030
Cavity Wall Domestic Retrofit = ~6,500 homes by 2030
Retrofit energy efficiency scale up (remaining building stock):
Loft Insulation Domestic retrofit = ~73,000 homes by 2050
Cavity Wall Domestic Retrofit = ~26,500 homes by 2050
Solid Wall Domestic Retrofit = ~23,000 homes by 2050
See Annex D for high resolution version
Low Carbon Heating
Aquifer monitoring
High temp District Heat Network in Belfast City Centre
Metered heat demonstrators in Belfast Harbour (collecting/monitoring and analysing hourly heat demand profiles and weather data)
District Heat acceleration across Belfast; at least 2,000 domestic properties connected by 2030 and 11,650 domestic properties connected by 2033
Oil to Renewable Heat Transition
Heat Pump (LT ASHP, HT ASHP, GSHP, hybrid) ramp up across Belfast - target 19,000 in domestic buildings by 2030 (~3,150 per year 2025 - 2030) and 1.1m m2 of non-domestic building floor area
Upscale of HPs across Belfast; 50,000 - 80,000 domestic properties; 1.2M - 5.5M m2 of NDB floor area
District Heat roll out across Belfast; 23,000 - 111,000 domestic properties; 3.5M - 5.5M m2 of NDB floor area
Upscale of biomethane across Belfast; 0 - 78,000 domestic properties; 0 - 6.5M m2 of NDB floor area
Gas and Electricity Networks & Flexibility
Biomethane enters gas network in North, West, and East Belfast by 2026
Upscale of biomethane availability in Belfast
Gas hybrid heating trials/study expansion to assess impacts/benefits on electricity network (winter 24-25)
NI Gas Network Pathway to Net-Zero Phase 3; By 2030, 15% of NI Gas Network consumption (by energy) met by renewable gases
NI Gas Network Pathway to Net-Zero Phase 4; By 2040, 75% of NI Gas Network consumption (by energy) met by renewable gases
NI Gas Network Pathway to Net-Zero Phase 5; H2 network zones
Electricity Smart Meter roll out - 8% of meters in the first year of rollout, rising to 100% by the end of 2032
Hydrogen for industrial processes
NIE Network Upgrades Under RP7 Price Control
NIE Network Upgrades Under RP8 Price Control
Hydrogen heating in Belfast - 0 - 9,000 domestic properties; 0 - 250,000m2 of NDB floor area
Electric Vehicle Infrastructure
On-street public parking demonstrators across Belfast - target 800 by 2027
Public Chargepoint deployment across Belfast - target 2,000 by 2030
Domestic EV Chargepoint scale up; ~58,000 by 2050
Public EV Chargepoint scale up; ~4,400 by 2050
Solar PV Car Port with EV Charging
Local Renewable Generation
Non-Domestic Solar PV in Belfast - target 143 MW by 2030
Domestic Solar PV in geographically dispersed fuel poor households - target 71 MW by 2030
Domestic Solar PV (non-fuel poor households) target 258 MW by 2030
Non-Domestic Solar PV roll out - up to 459 MW by 2050
Domestic Solar PV roll out - up to 734 MW by 2050
Solar PV on Public Buildings
Quick Win
Low Regrets
Scale Up
Enabling Actions
Innovation & Demonstrator Projects
Key Decision Point
Policy Milestone
Policy Need
Risk or Uncertainty

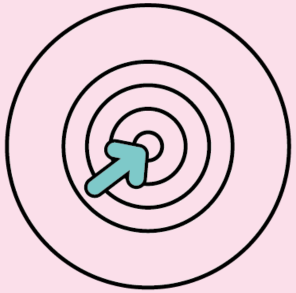
Belfast's Net Zero Future

This **Plan on a Page (PoP)** shows the extent of change required in each area of Belfast to achieve a Net Zero energy system by 2050. Focus Zones highlight areas where a concentration of a certain solution is recommended, so directing efforts towards delivery at scale in that area can lead to significant progress and serve as a demonstrator to other parts of Belfast. Focus Zones may also account for factors such as the socio-economic conditions in an area, network capacity, or characteristics of the building stock, which could bring specific advantages, learning opportunities or challenges to delivery in that location.



Opportunity Areas & Focus Zones

Opportunity Areas & Focus Zones



An **Opportunity Area** describes an area of Belfast where an intervention is recommended in high numbers but **may have uncertainties or barriers associated with delivery.** Opportunity Areas help Belfast City Council and stakeholders see the bigger picture in terms of **medium to long-term delivery**.

A **Focus Zone** describes an area of Belfast where an intervention is recommended in high numbers and with **high certainty (low-regrets) and enablers for near-term delivery**. Focus Zones help to identify key locations which Belfast City Council and stakeholders may use to **prioritise and specify a pipeline of projects for implementation**.

This section of the LAEP uses Opportunity Areas and Focus Zones to summarise the key details for each intervention area within the scope of the LAEP. These help to highlight areas for priority action and are intended to support the post-LAEP implementation to build a pipeline of energy decarbonisation projects and recommended actions for the local area.

The identified Opportunity Areas and Focus Zones have emerged from the techno-economic Scenarios modelled in this LAEP. Depending on the intervention, a ‘minimum' number may be specified indicating a low-regrets approach. Or, if it is not possible to declare a low-regrets approach then the key aspects of Scenario variation is explained. The aim is to identify the right priorities for stakeholders to progress their decarbonisation actions whilst simultaneously having a view to where future opportunities may emerge.

Domestic Fabric Upgrades

Fabric upgrades help to improve the thermal performance and energy efficiency of buildings. The measures proposed in this LAEP apply to the existing building stock and are therefore considered to be "retrofit measures". The primary incentive of retrofit measures is energy demand reduction which induces several co-benefits such as:

- Lowering energy bills
- Reducing carbon emissions (if energy demand is not yet from a carbon neutral supply chain)
- Reduced loading on the electricity grid and/or avoiding the need for network reinforcement
- Improving comfort level (warmth of home) which drives improved health and well-being.

63%
Of Belfast's existing domestic buildings are EPC rated D – G

108,000
Properties out of 193,000 require at least one retrofit measure by 2050

This LAEP contains four main retrofit measures each with different potential to reduce carbon and return on investment periods:

- Single glazing window replacement
- Loft insulation
- Cavity wall insulation
- Solid wall insulation

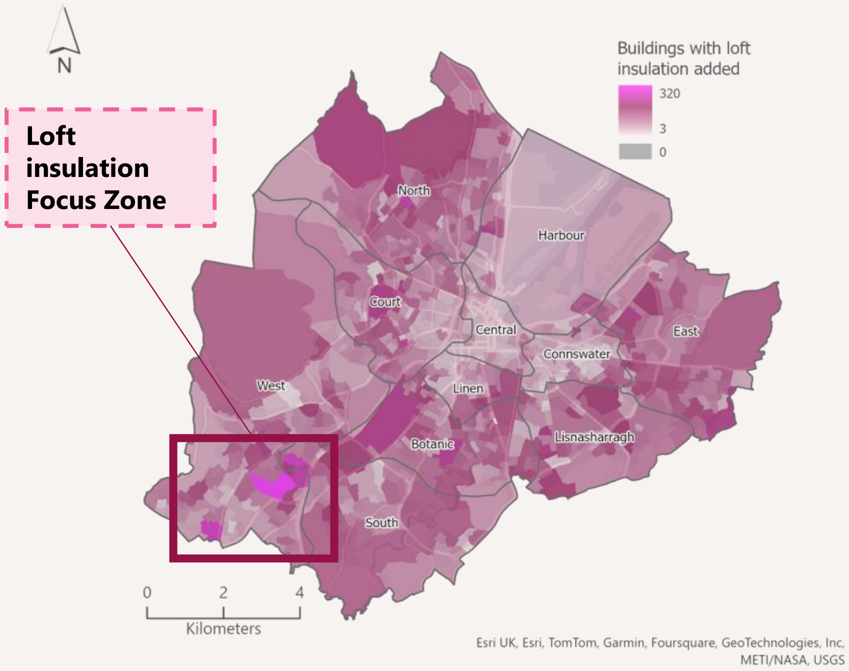
Cavity wall and loft insulation are considered the preferrable options as levels of disruption and up-front investment are relatively low. However, single glazing window replacement can bring co-benefits such as reduction in condensation and damp – which drives health benefits – reduced external noise and draughts which help improve comfort.

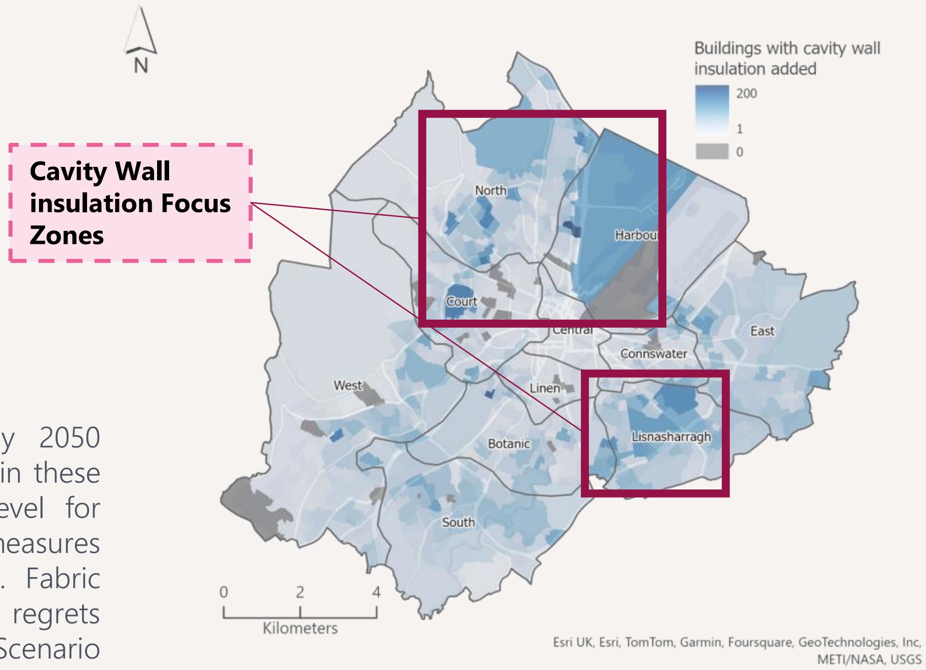
Indicative ratings of LAEP retrofit measures

Qualitative indicators taken from Energy Savings Trust [1]	Up front investment	Return on investment	Carbon Savings	Co-benefits (damp reduction, draughts, external noise, comfort level, fuel bills)
Loft Insulation	Green	Green	Amber	Green
Cavity Wall Insulation	Green	Green	Amber	Amber
Single Glazing Window Replacement	Red	Amber	Amber	Green
Solid Wall Insulation	Red	Amber	Green	Amber

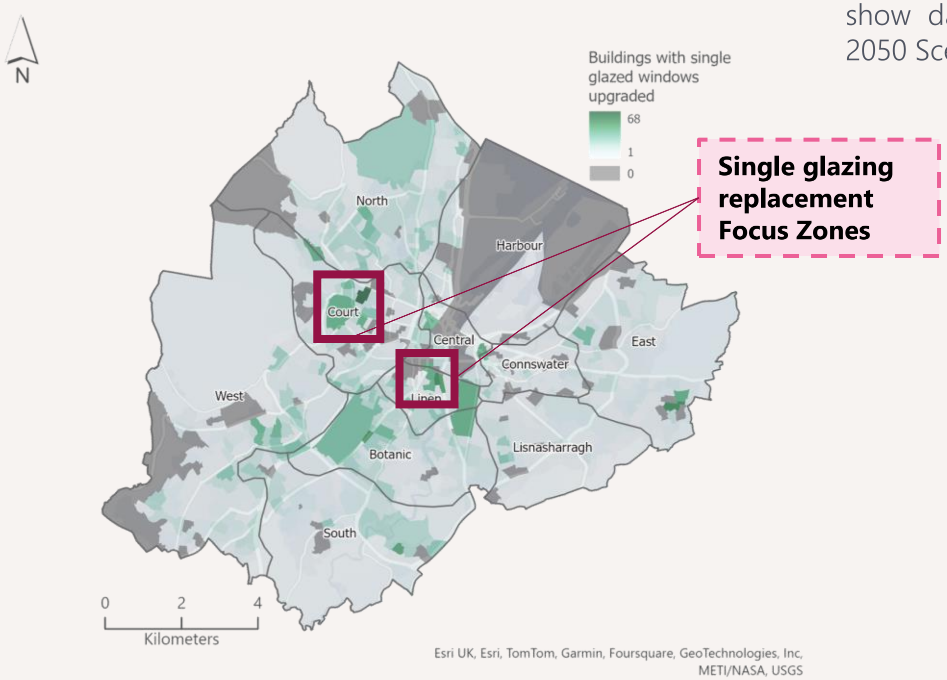
Enablers	Barriers	Actions
• Technologies and supply chains are well established. • Funding mechanisms have been provided in the past and may be re-opened. • Fabric first approach is widely recognized as a low-regrets decarbonisation action. • Likely to receive policy backing as a near-term enabler to achieving reduction in energy demand.	• Lack of 'off-the shelf' funding mechanisms for domestic fabric upgrades in Northern Ireland. • Desire to avoid pushing responsibilities for decarbonisation measures onto local citizens and businesses. • Skills and capacity in the supply chain may be inadequate to cope with the same and pace of action recommended by the LAEP.	• Explore opportunities, costs, and benefits for high temperature heating solutions (e.g. HT HPs, gas hybrid HPs, or HT DHN) that may avoid the need for widespread domestic retrofit. • Plug any skills gap or capacity requirements in the supply chain. • Build the case for grant or loan funding for domestic retrofit (heating, fabric upgrades) to be adopted in NI • Ensure citizens and businesses are provided with support services in their decarbonisation journey.

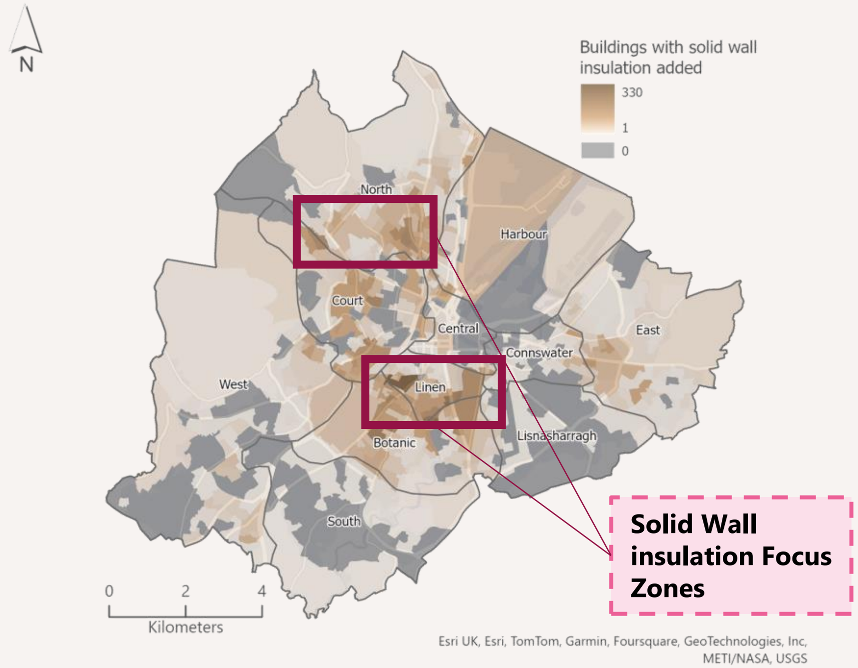
[4] https://energysavingtrust.org.uk/energy-at-home/reducing-home-heat-loss/



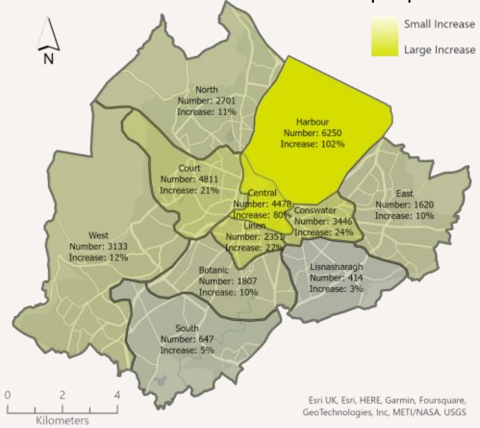


Retrofit deployment by 2050 across Belfast is shown in these maps at Data Zone level for each of the 4 retrofit measures modelled in this LAEP. Fabric upgrades are a low regrets measure (minimal Scenario variation), but the images here show data from the Net Zero 2050 Scenario.

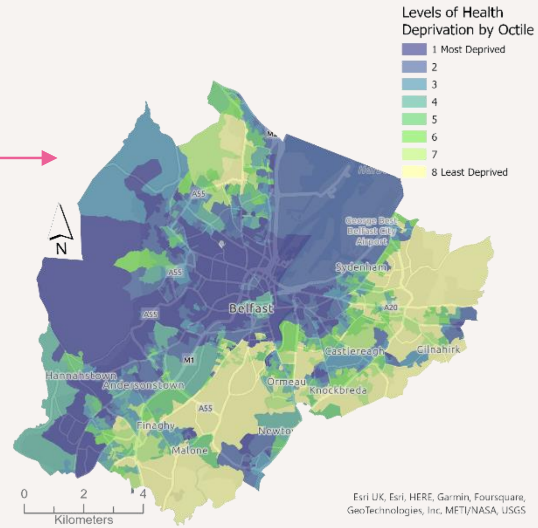


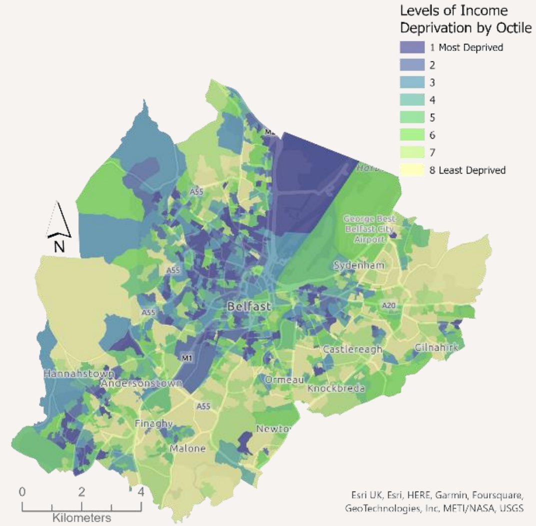


Planned new build domestic properties



Biasing retrofit towards areas of deprivation can have significant socio-economic benefits such as reduction in consumer energy bills, alleviation of fuel poverty, and warmer homes.





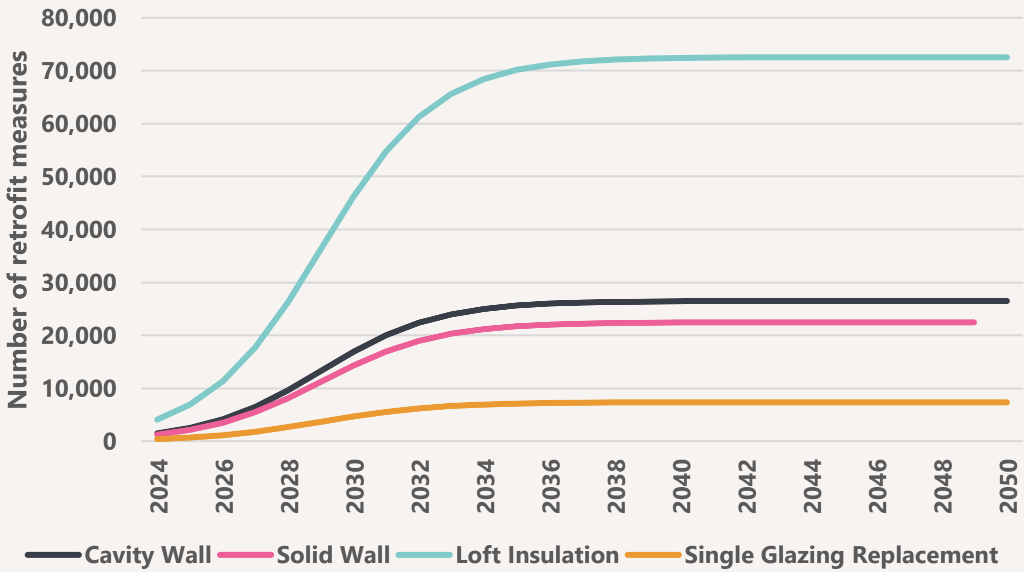
Fabric upgrades may be less prevalent in areas where new build properties due to improvements in energy efficiency enforced through building standards

Belfast's domestic retrofit pathway in numbers:

	2030 (total properties)	2050 (total properties)
Loft Insulation	47,000	73,000
Cavity Wall Insulation	17,000	26,500
Single Glazing Window Replacement	5,000	7,500
Solid Wall Insulation	15,000	23,000

Moving towards high temperature heating solutions will reduce the scale of fabric upgrades required and/or relieve the pressure to progress all fabric upgrades imminently. Increasing domestic connections to DHN by 20% and doubling the number of high temperature HPs will potentially eliminate the need for retrofit although this approach is not as cost-effective from a system perspective.

Retrofit Deployment Rates*



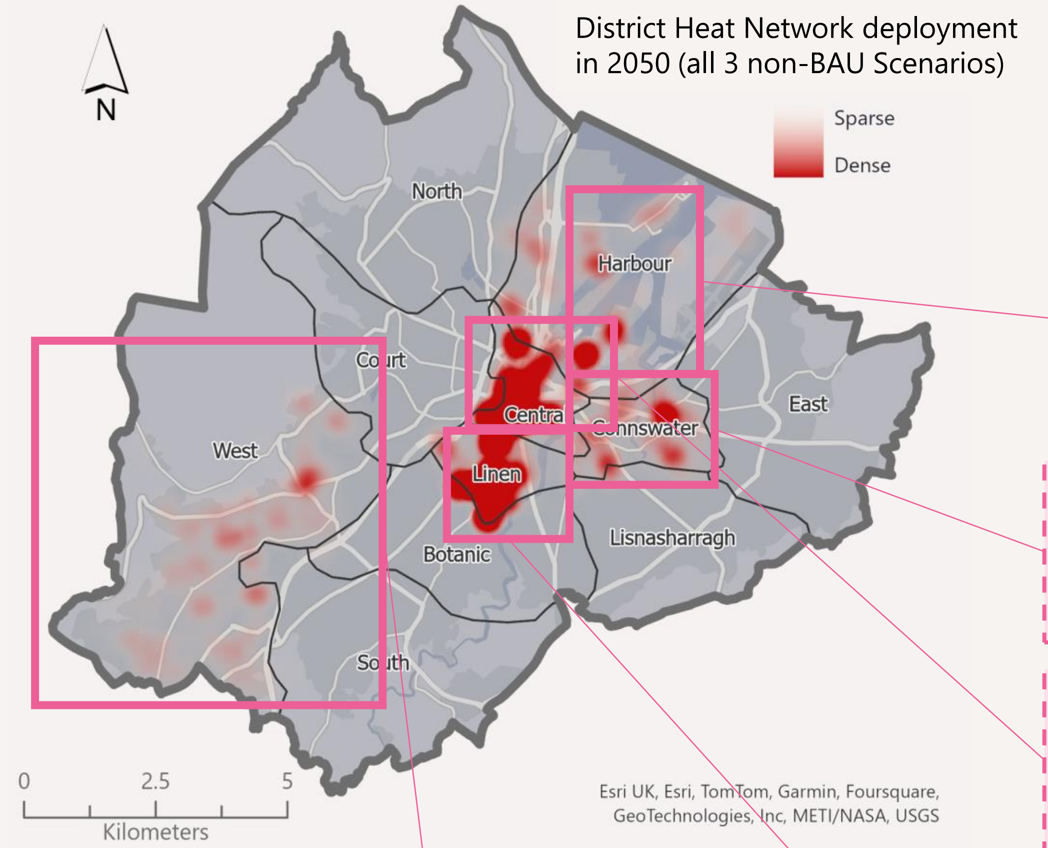
***Numbers obtained from Net Zero 2050 Scenario**

District Heat Networks

At least 30%
of Belfast's non-domestic heat demand is from District Heat Networks by 2050

Up to 58%
of Belfast's domestic buildings could be connected to District Heat Networks by 2050

District Heat Network deployment in 2050 (all 3 non-BAU Scenarios)



The 'heat map' opposite shows Opportunity Areas across Belfast for DHN. The map contains data for both domestic and non-domestic buildings from all 3 non-BAU Scenarios modelled in this LAEP. This visual therefore represents a low regrets viewpoint. Specific Focus Zones are highlighted where DHN should be prioritised for near-term action. More detailed feasibility studies will be required in these areas to verify the scale and potential. This should include consideration for deployment of a fully electrified heat network or a biomethane hybrid heat network; the latter preserves compatibility with the medium to long-term emergence of biomethane which remains an uncertainty. Harbour, Central, Connswater, and Linen represent Focus Zones for non-domestic buildings primarily but may offer opportunities to expand the network towards nearby domestic buildings. West represents a Focus Zone driven mainly by domestic connections. Phasing of this deployment will be crucial since typically a heat network requires anchor loads from public, commercial, or industrial buildings to establish viability before connecting domestic properties in subsequent phases.

DHN In Harbour Area

- 12,346 homes in Harbour area in total
  - At least 1,100 connected to district heating (8.9%)
  - Potential to connect to the 6,250 emerging new build properties
- 1.95 million m^2 of non-domestic building floor area
  - At least 730,000 m^2 connected to district heating (37.4%)

DHN In Connswater

- 17,652 homes in Connswater in total
  - At least 4,900 connected to district heating (27.8%)
- 456,000 m^2 of non-domestic building floor area
  - At least 184,000 m^2 connected to district heating (40.4%)

DHN In Central

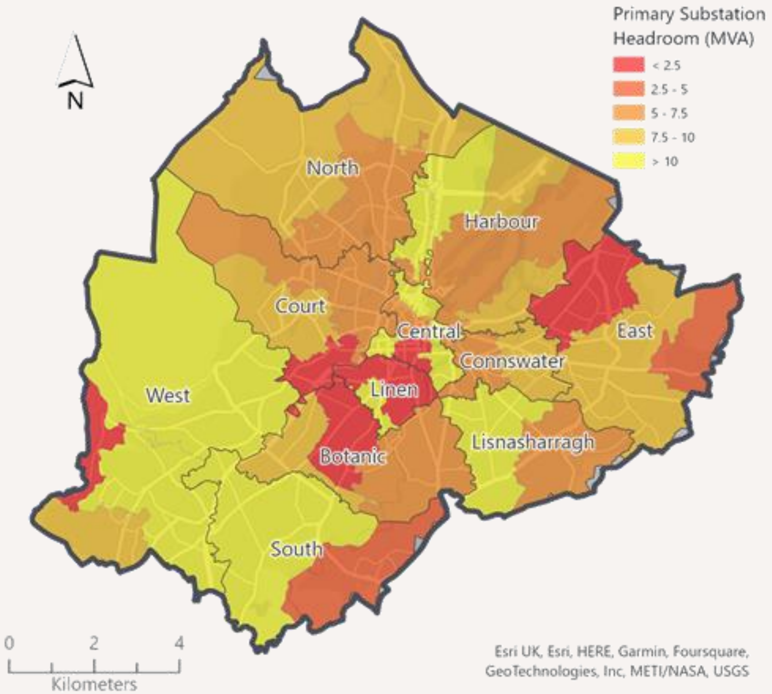
- 10,047 homes in Central Belfast in total
  - At least 1,700 connected to district heating (16.9%)
- 2.56 million m^2 of non-domestic building floor area
  - At least 1.61 million m^2 connected to district heating (62.9%)

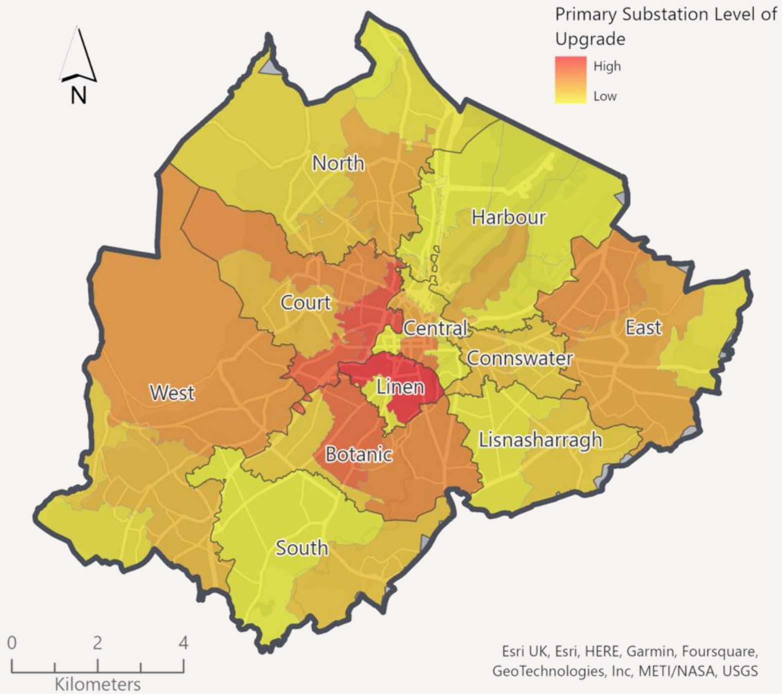
DHN in West

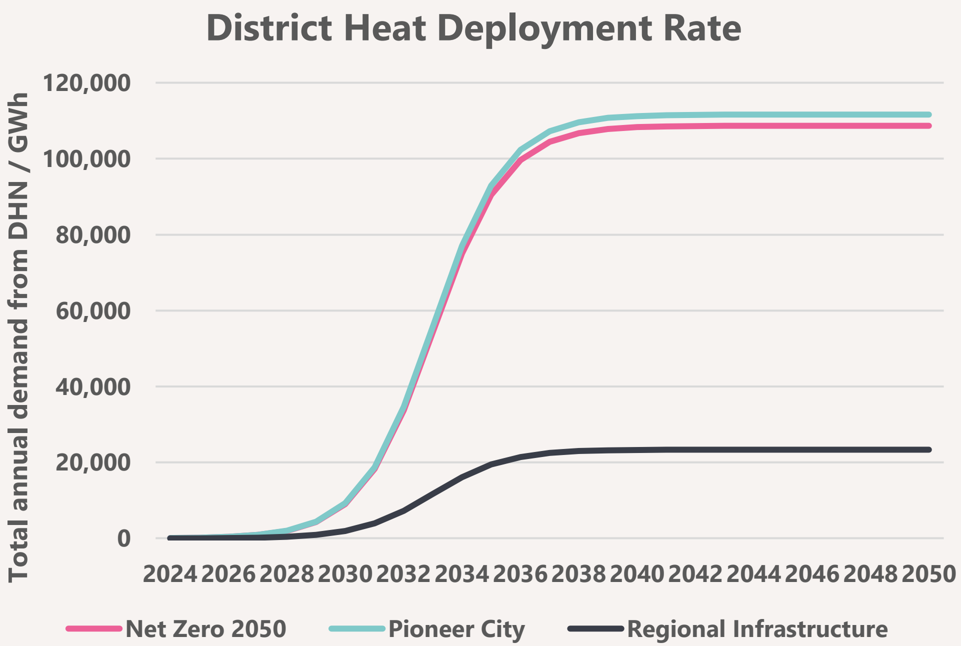
- 28,000 homes in West Belfast in total
  - At least 16,000 connected to district heating (57.1%)
- 870,000 m^2 of non-domestic building floor area
  - At least 334,00 m^2 connected to district heating (38.4%)
- What does the HV network look like? Is upgrade required?

DHN In Linen

- 10,959 homes in Linen in total
  - At least 4,100 connected to district heating (37.4%)
- 1.28 million m^2 of non-domestic building floor area
  - At least 640,000 m^2 connected to district heating (50.0%)







Existing HV network capacity and levels of upgrade required by 2050 are shown top-left and top-right respectively for the Net Zero 2050 Scenario. High temperature DHN on the scale recommended by this LAEP are anticipated to connect to the HV rather than LV network hence these are shown in context here. The deployment rate of district heat networks at the time of writing this LAEP is shown on the left. The relative shape of the curves are identical for all modelled Scenarios but the magnitude of deployment results in different gradients. Steeper gradients indicate more expectations and ramp up on the local supply chain.

Enablers	Barriers	Actions
• Policies and incentives are likely to drive continued HP uptake in the market. • DHN developers are appearing on the market providing end-to-end services from feasibility to commissioning and operation.	• Lack of regulatory framework. • Small profit margin prevents developer investment. • Disruption to roads and buildings. • Co-ordination of consumer switch over from existing heating systems	• Engage the market to offer heat supply agreements to potential off-takers and attract investment from heat network developers. • Build the case for a regulatory framework and grant schemes for district heating to be adopted in NI • Consult citizens to ascertain views on switch to DHN.

Heat Pumps

66k – 86k

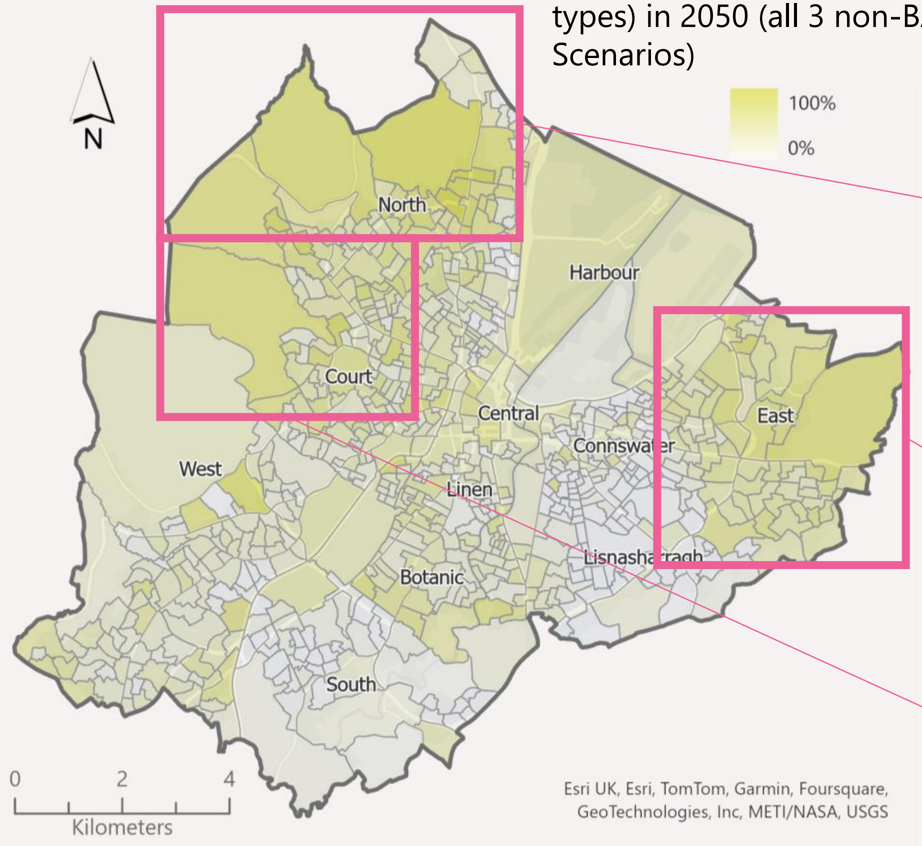
Heat Pumps Deployed across Belfast by 2050

Hybrid HPs or HT HPs may avoid the need for retrofit measures and therefore act as an enabler for low carbon heating uptake

Heat pumps are widely deployed in Belfast's Net Zero future, but their deployment across Belfast is relatively sensitive to Scenario variation and/or domestic-to-non-domestic buildings. However, North, Court, and East are areas with relatively high and stable quantities of heat pump deployment for both domestic and non-domestic buildings making them ideal Focus Zones for near-term action.

The specific form of heat pump technology deployed will depend upon many interdependent factors that require more detailed evaluation during the LAEP implementation phase (see subsequent 'Implementation – Critical Decision-Making Factors' section for example). Heat pump deployment for domestic buildings are shown on the left for all types (LT ASHP, HT ASHP, gas hybrid HP) and presented for all 3 non-BAU Scenarios indicating the scale of low regrets approach to deployment.

% Heat Pump deployment (all types) in 2050 (all 3 non-BAU Scenarios)



Heat Pumps In North Belfast

- 25,325 homes in North Belfast in total
    - At least 6,000 supplied by heat pumps in 2050 (42.9%)
- 500,000 m^2 of non-domestic building floor area
    - Potentially no supply of heat pumps to non-domestic buildings if biomethane is widely available. Otherwise at least 206,000 m^2 supplied by heat pumps in 2050 (41.2%)

Heat Pumps In East Belfast

- 17,034 homes in East Belfast in total
    - At least 7,300 supplied by heat pumps in 2050 (42.9%)
- 560,000 m^2 of non-domestic building floor area
    - At least 49,000 m^2 supplied by heat pumps in 2050 (8.7%)

Heat Pumps In Court

- 27,549 homes in Court in total
    - At least 8,000 supplied by heat pumps in 2050 (29.0%)
- 1.5 million m^2 of non-domestic building floor area
    - At least 370,000 m^2 supplied by heat pumps in 2050 (24.7%)

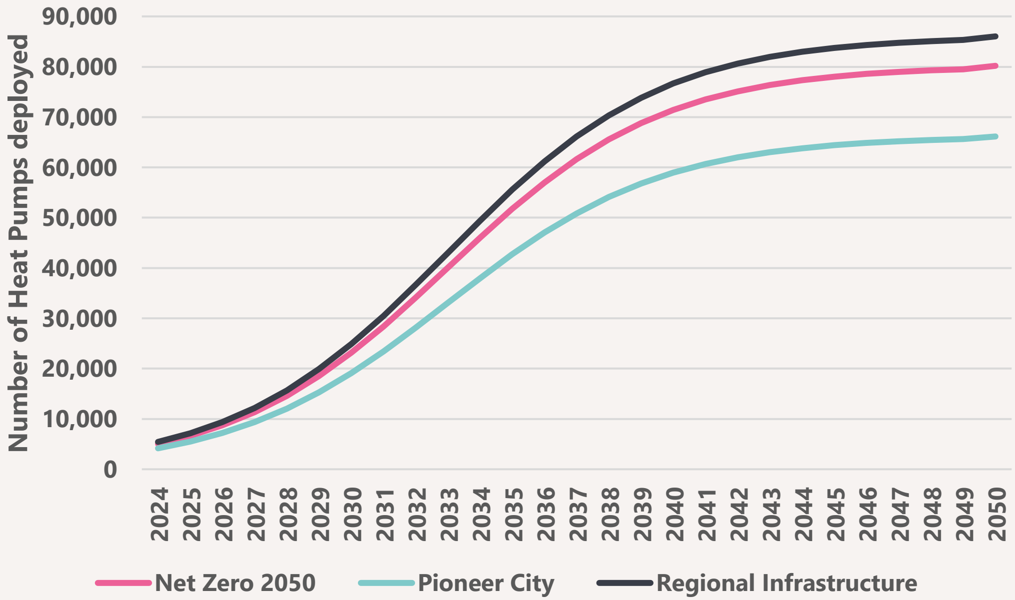
The Scenario variation for heat pump deployment and variation between domestic and non-domestic buildings can be visualised in the 3 maps opposite. Heat Pumps account for between 10% and 47% of total heat demand from Non-Domestic Buildings in 2050. Current estimates of heat pump deployment are shown in the chart below. Using Regional Infrastructure Scenario as the example, HP deployment rate will average at just over 3,000 per year between 2028 and 2030. By comparison, the UK government is committed to 600,000 HP installations annually by 2028. If this commitment is allocated pro-rata to population, then Belfast's rate of deployment over this 3-year period is aligned within 1%.

1.2 – 5.5 million m²

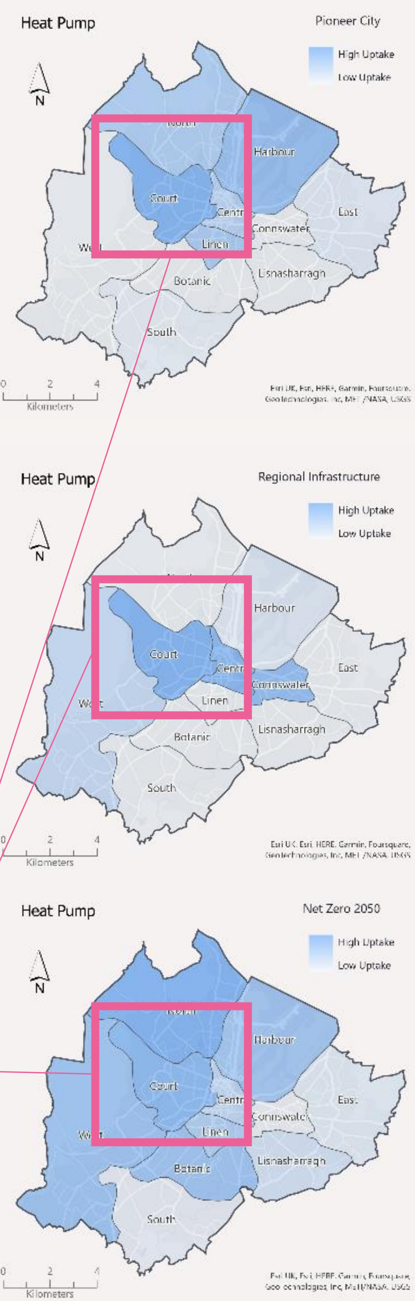
of Non-Domestic Building floor area (public, commercial, or industrial buildings) across Belfast will be heated by Heat Pumps by 2050

Enablers	Barriers	Actions
• Technologies and supply chains are becoming increasingly mature. • Policies and incentives are likely to drive continued HP uptake in the market.	• There are no dedicated funding schemes for heat pumps in NI. • Some installations may require concurrent or prior building fabric upgrades. • Desire to avoid pushing responsibilities for decarbonisation measures onto local citizens and businesses. • Skills and capacity in the supply chain may be inadequate to cope with the same and pace of action recommended by the LAEP.	• Explore opportunities, costs, and benefits for high temperature heating solutions (e.g. HT HPs, gas hybrid HPs, or HT DHN) that may avoid the need for widespread domestic retrofit. • Plug any skills gap or capacity requirements in the supply chain. • Build the case for grant or loan funding for domestic retrofit (heating, fabric upgrades) to be adopted in NI • Ensure citizens and businesses are provided with support services in their decarbonisation journey.

Heat Pump Deployment Rates



Non-Domestic Heat Pump deployment in 2050 for all 3 non-BAU scenarios



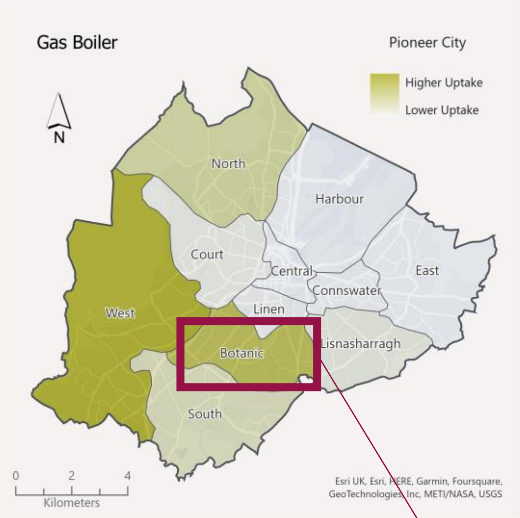
Court and Central represent the primary Focus Zones for Heat Pumps in Non-Domestic Buildings with 960,000 m² – 2.1 million m² of floor area heated by Heat Pumps in 2050. The upper estimate accounts for up to 35% of Central's and 75.0% of Court's total non-Domestic floor area heat demand and up to 17.5% of Belfast's total non-Domestic floor area heat demand.

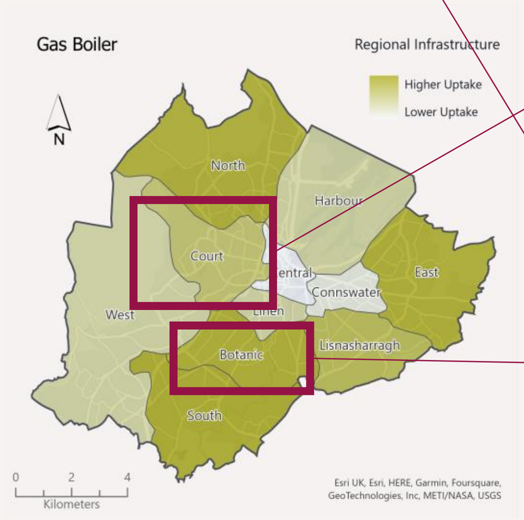
Biomethane Boilers

Enablers	Barriers	Actions
• Gas network already established – level of upgrades not anticipated to differ from BAU.	• Lack of carbon credits to support industry use of biomethane. • Uncertainty on biomethane production – much wider than an energy system consideration • Boiler concessions will be required in the medium to long term assuming UK ban on gas boilers is enforced mid-2030s.	• Build the case for introducing carbon credits to support industry use of biomethane. • Explore the need for NI gas boiler concessions in anticipation of biomethane availability supporting extended use of gas boilers.

Uptake of biomethane boilers is highly Scenario dependent and relatively disparate across areas of Belfast and when comparing domestic and non-domestic buildings. This is not conducive to near-term action through biomethane Focus Zones. However, Botanic and Court stand out as future Opportunity Areas for uptake of biomethane boilers in both domestic and non-domestic buildings. This may correlate with building type and age for domestic uptake and the operational nature of non-domestic (public, commercial, or industrial) buildings. For example, a large quantity of Belfast's listed buildings and oldest housing stock can be found in the Botanic area which may present a barrier to lower temperature electrified heating.

Non-Domestic Buildings

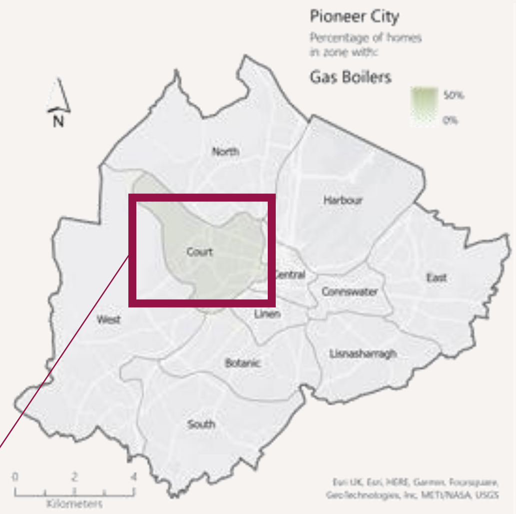


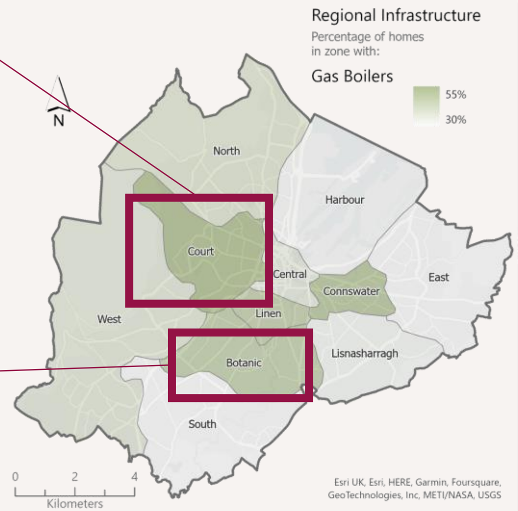


Uptake of Biomethane Boilers in Court
- 27,549 homes in Botanic area in total
  - A maximum uptake of 14,132 biomethane boilers (51.3%)
- 1.54 million m² of non-domestic building floor area
  - A maximum uptake of 1.09 million m² floor area heated by biomethane boilers (71.1%)

Uptake of Biomethane Boilers in Botanic
- 19,675 homes in Botanic area in total
  - A maximum uptake of 9,000 biomethane boilers (46.0%)
- 1.23 million m² of non-domestic building floor area
  - A maximum uptake of 1.18 million m² floor area heated by biomethane boilers (95.9%)

Domestic Buildings



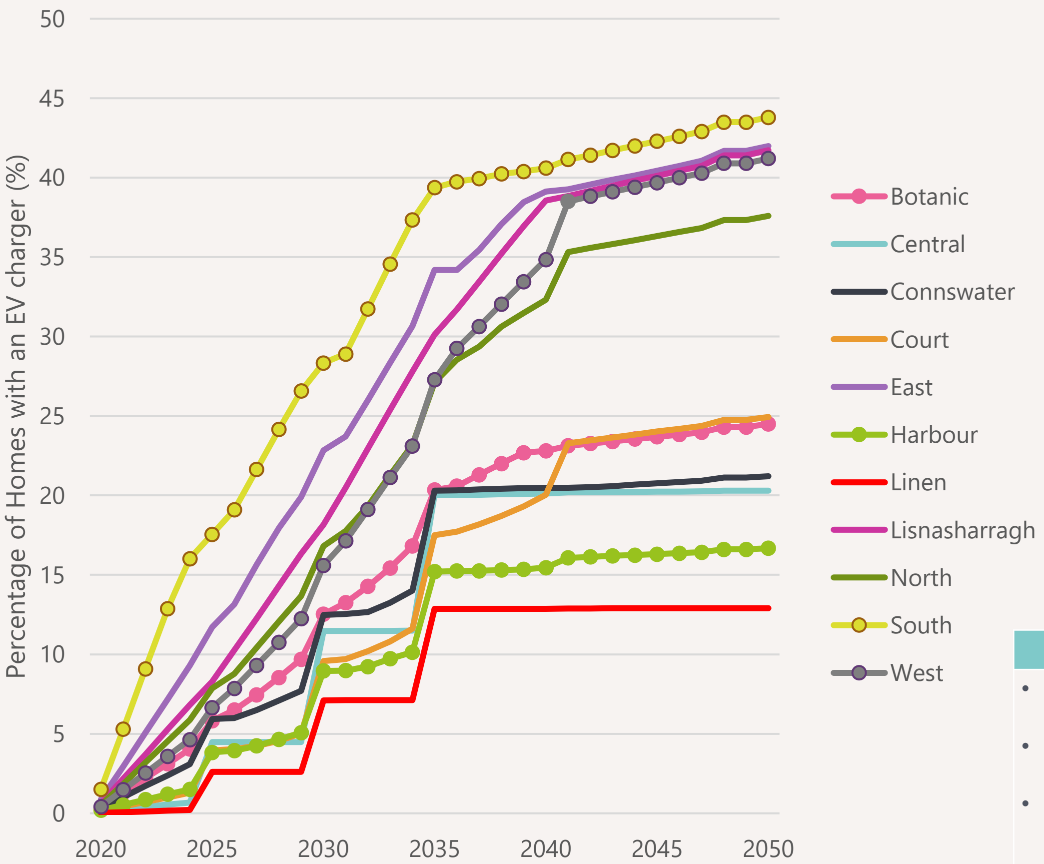


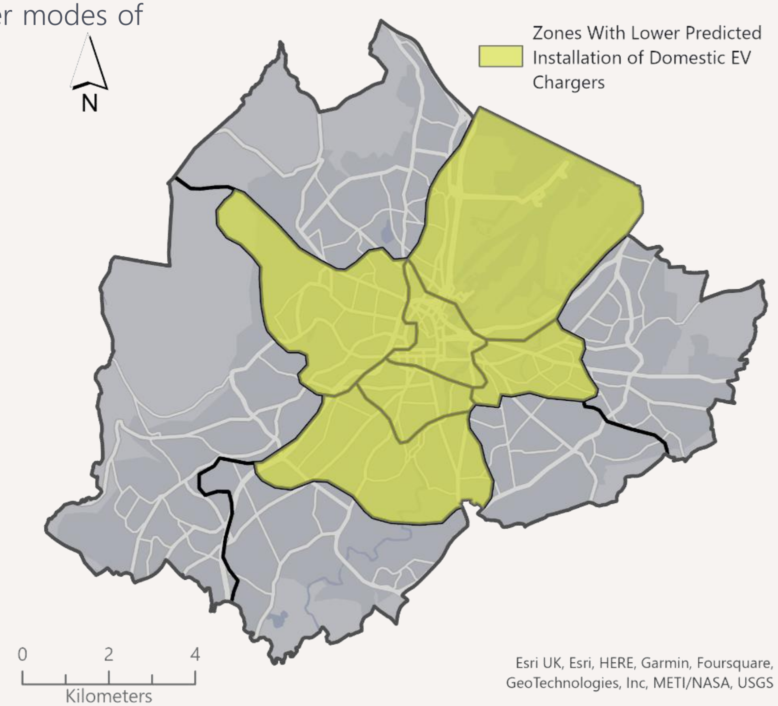
EV Infrastructure

The modelling approach in this LAEP aligns with Belfast's draft EV Strategy which estimates 158,000 electric vehicles (cars and vans) and 59,000 domestic EV charge points will be operational in Belfast by 2050. Spatial deployment of domestic charge points is determined by the potential for off-street parking – including an estimate of available space at each home – plus the allocation of the charge point to the HV electricity network. The resultant distribution of domestic EV charge points across Belfast is shown below as a % of total homes in the area. New build properties are assumed to be more likely to have a charge point installed than existing buildings which accounts for the sharp increase in domestic chargers in some areas – particularly central areas of Belfast – in the mid-2030s. Despite this, these central areas of Belfast fall significantly behind the outer areas of the city where properties typically have more space for off-street EV charging. This also highlights the importance of providing innovative and alternative EV charging provisions and other modes of transport if everyone is to be brought along on the transition to low carbon transport.

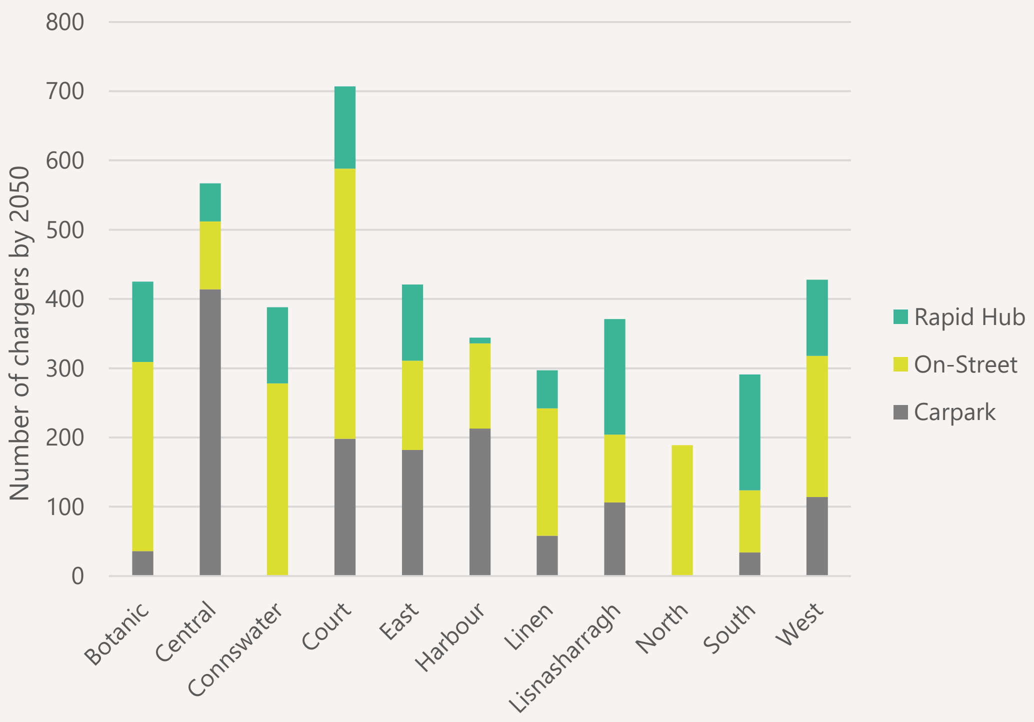
30%

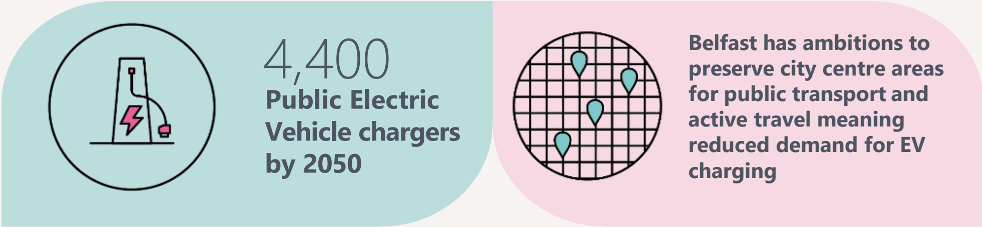
of domestic properties (on average across Belfast) will have an EV charge point by 2050



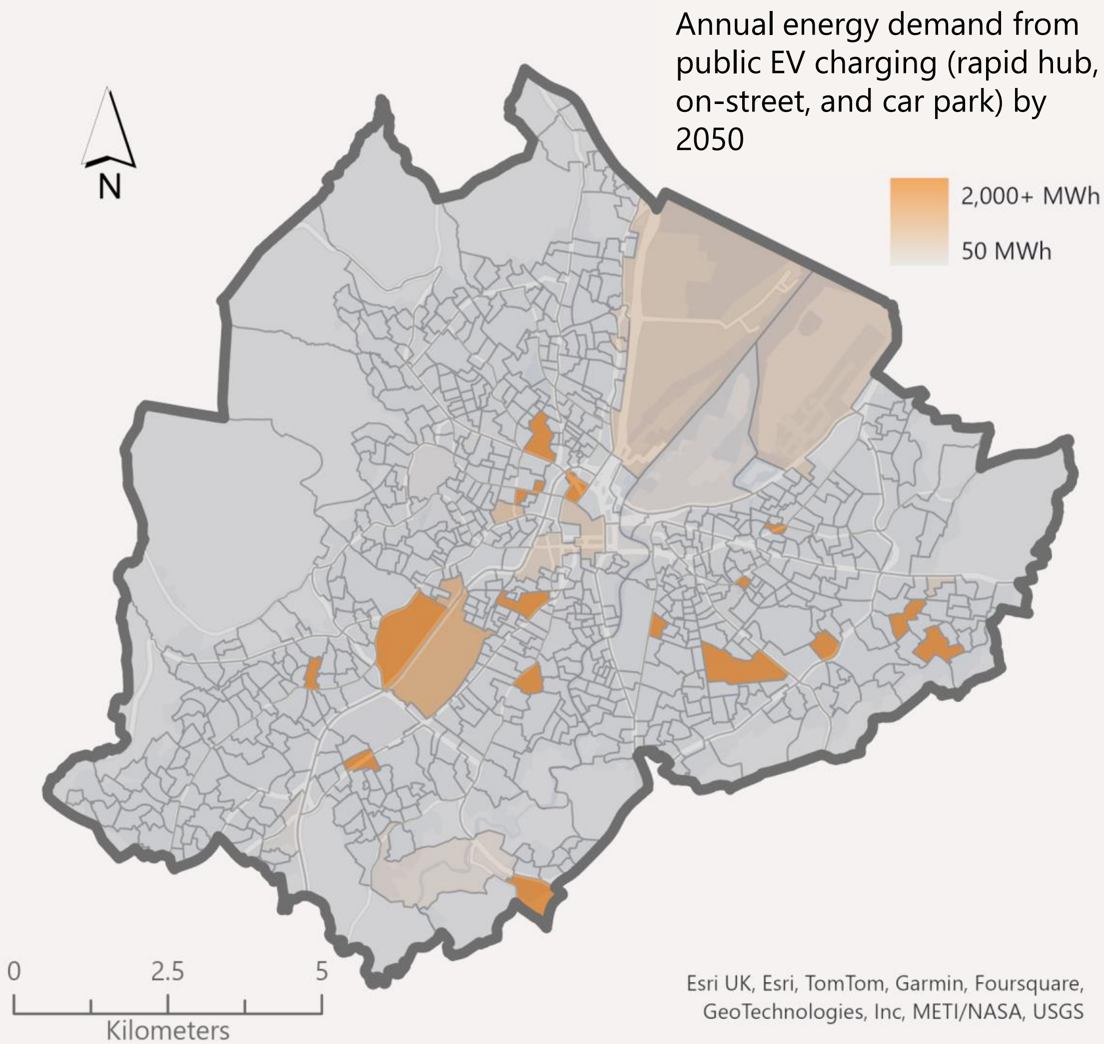


Enablers	Barriers	Actions
• Technologies are well established. • Market conditions well understood. • Demand almost certain to increase over time.	• The scale and pace of network upgrades could limit deployment in some areas. • Consumer cost to install charge points. • Limitations in ability to deploy domestic and public charge points (e.g. space, competing infrastructure or social perspectives).	• Explore demonstrator projects that might help accelerate public EV charge point deployment.



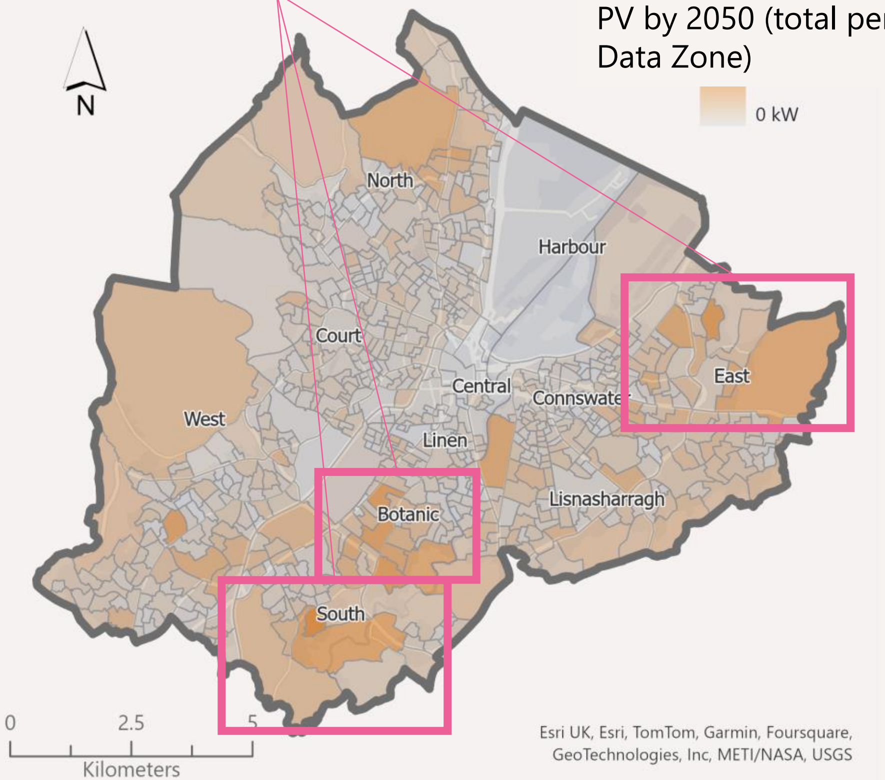


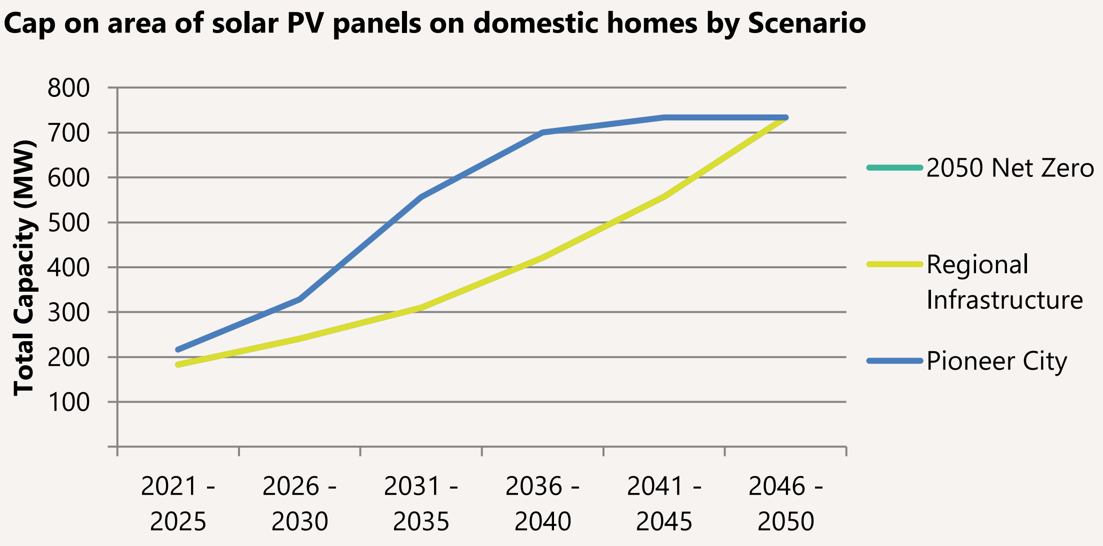
The spatial deployment of public EV infrastructure by 2050 is shown opposite at Data Zone level. The coloured areas highlight annual energy demand from all charge points (types and power outputs) in these areas so each acts as an Opportunity Area for deployment. This deployment is not Scenario sensitive so building towards this is a low regrets option for Belfast. Note the distribution of demand away from Belfast city centre where modal shift towards public transport and active travel are the preferred ambitions for Belfast to help build the status as a "15-minute city centre". Thus, demand from EV charging is lower in these areas. The modelling approach to this deployment varies by type (rapid hub, on-street or carpark). On-street chargers were assumed to be required near homes without sufficient space for off-street home charging. Rapid hubs were placed at the location of petrol stations in the area, and in existing car parks.

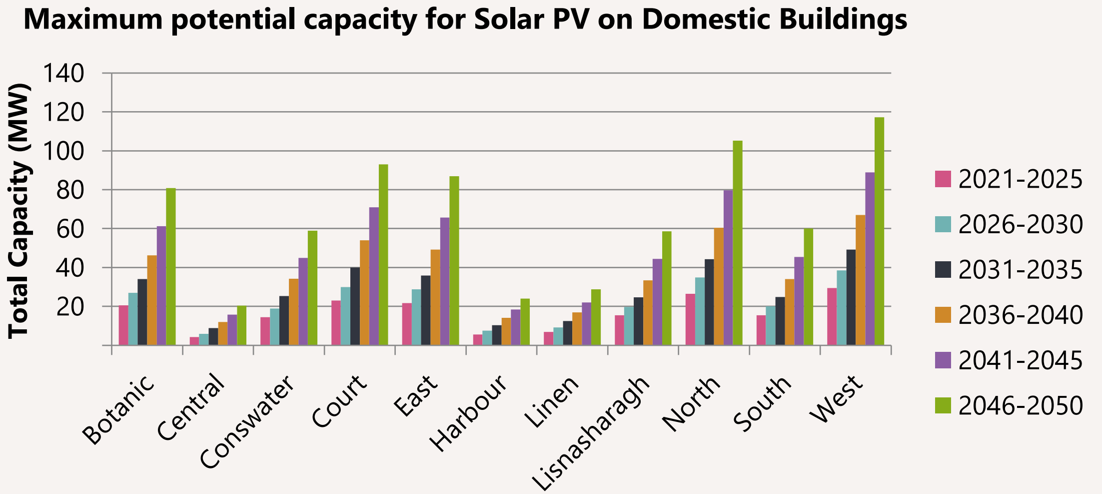


Solar PV

Botanic, South, and East areas of Belfast present Focus Zones for accelerated solar PV deployment







The criteria for determining rooftop solar PV suitability in the LAEP modelling includes building categorisation, orientation, slope, and area of roof. From this, domestic Solar PV is widely deployed in the LAEP modelling with a total of 734 MW deployed in Belfast's Net Zero future of 2050. This total deployment is not sensitive to Scenario variation although the rate of deployment is modelled differently in the Scenarios of this LAEP (see chart top right). Data from the Microgeneration Certification Scheme (MCS) suggests that there is currently approximately 8.5 MW of domestic Solar PV generation from over 1,300 homes in Belfast therefore the recommended deployment in this LAEP represent an 8,600% increase in domestic solar PV capacity between now and 2050. The spatial distribution of deployment suggests that Belfast has several Opportunity Areas but three predominant Focus Zones of South, Botanic, and East are identified for potential accelerated roll out across relatively geographically dispersed areas (see map above) – which helps mitigate the risk that weather conditions may adversely impact the electricity grid if multiple PV arrays are simultaneously affected.

734 MW

Domestic Rooftop Solar PV potential by 2050

The determination for rooftop solar PV suitability uses similar datasets and methods as for domestic buildings but the pitch and orientation of NDB roofs are determined by Light Detection and Ranging (LIDAR) data. The outcomes are similar to domestic buildings too, with many NDBs subject to a relatively large deployment of solar PV resulting in 459 MW of NDB Rooftop Solar PV potential by 2050.

The Harbour offers the biggest opportunity for non-domestic solar PV deployment in Belfast

459 MW

Total Non-Domestic Building Rooftop Solar PV potential by 2050

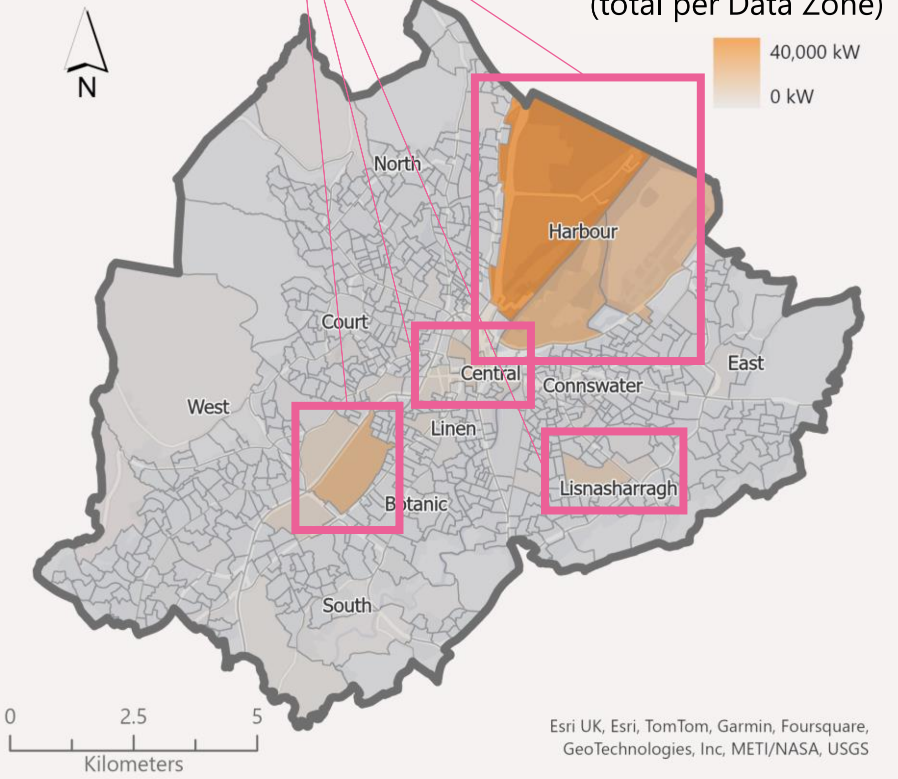
kWh

solar PV may contribute up to 107 GWh **of renewable energy in 2030 which is 5% of Belfast's total energy demand in 2030 (2.13 TWh)**

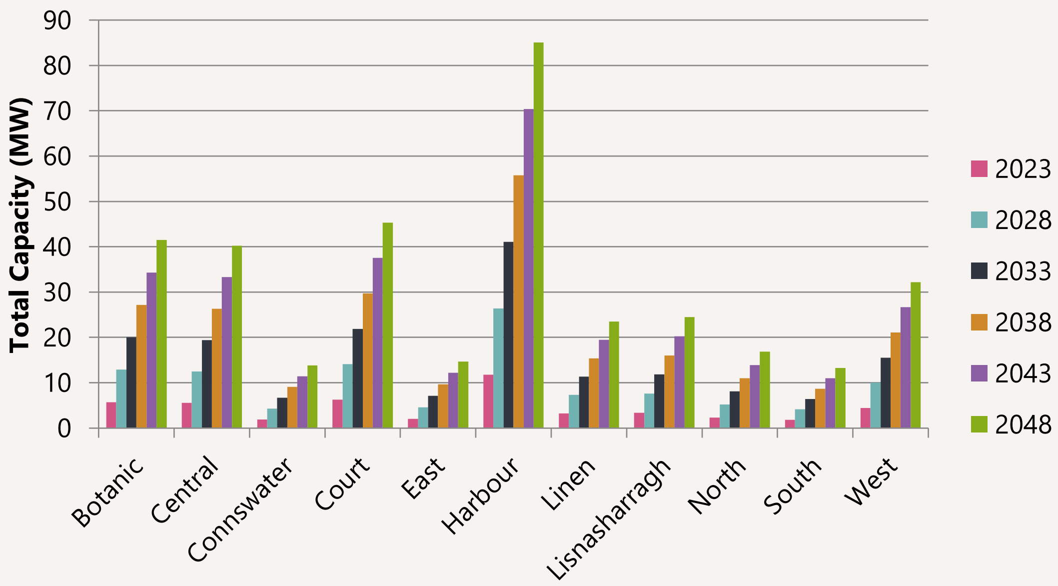
Enablers	Barriers	Actions
• Technologies and supply chains are well established. • Funding mechanisms have been provided in the past and may be re-opened. • Likely to receive policy backing as an enabler to achieving near-term carbon reduction ahead of grid decarbonisation.	• Scale of solar PV recommended by LAEP may impose negative impacts on electricity network (e.g. intermittent weather effects).	• Explore solar PV deployment on council owned buildings. • Support community energy organisations to develop rooftop solar PV installations.

Harbour presents the primary Focus Zone for accelerated NDB solar PV deployment but large public, commercial or industrial areas in Botanic, Central, or Lisnasharragh may provide excellent opportunities for coordinated roll out.

Capacity of Non-Domestic building rooftop solar PV by 2050 (total per Data Zone)



Maximum potential capacity for Solar PV on Non-Domestic Buildings



Electricity Networks

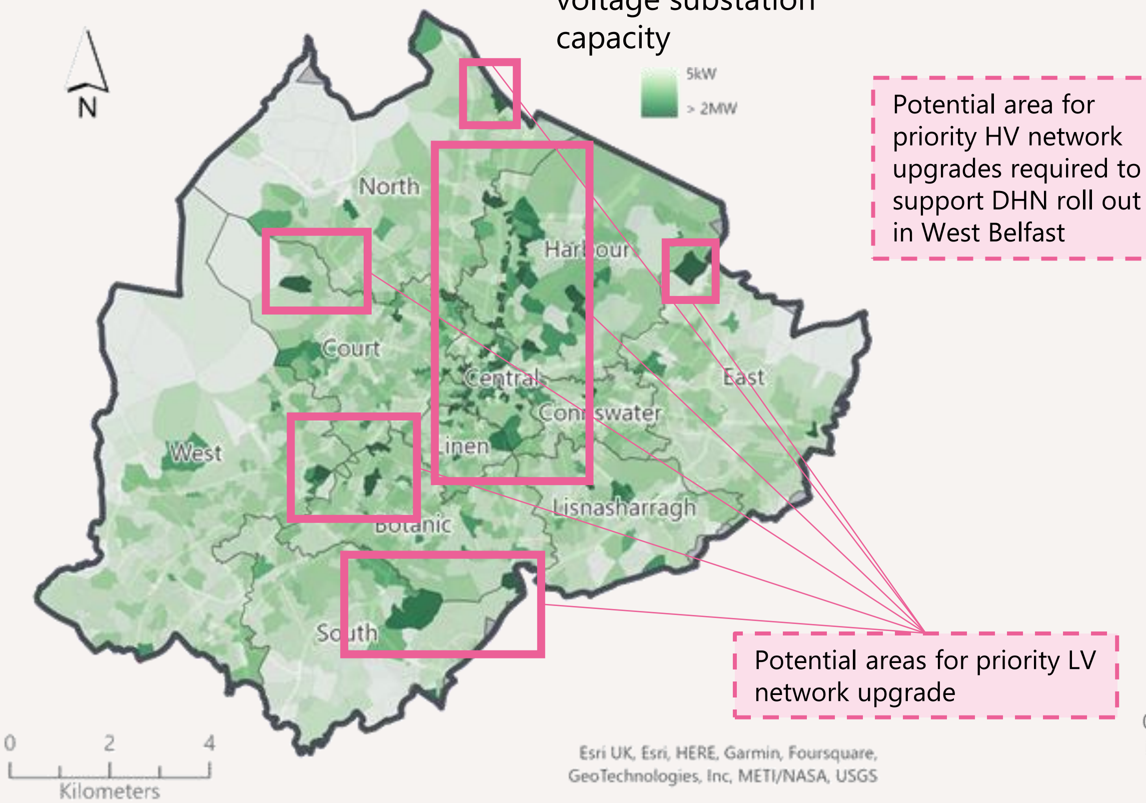
Electricity Networks across Northern Ireland are already subject to £3bn of investment by 2031 through the RP7 price control mechanism. The LAEP helps to highlight areas where network upgrades in Belfast could be prioritised to support key Interventions. In areas requiring lower levels of network upgrade, or if Belfast's future tends towards Scenarios with lower electricity demand (Pioneer City or Regional Infrastructure), then flexibility solutions could play a significant role in deferring or avoiding the level of upgrades required.

£kWh
£117m
Potential cost to upgrade electricity distribution network around Belfast

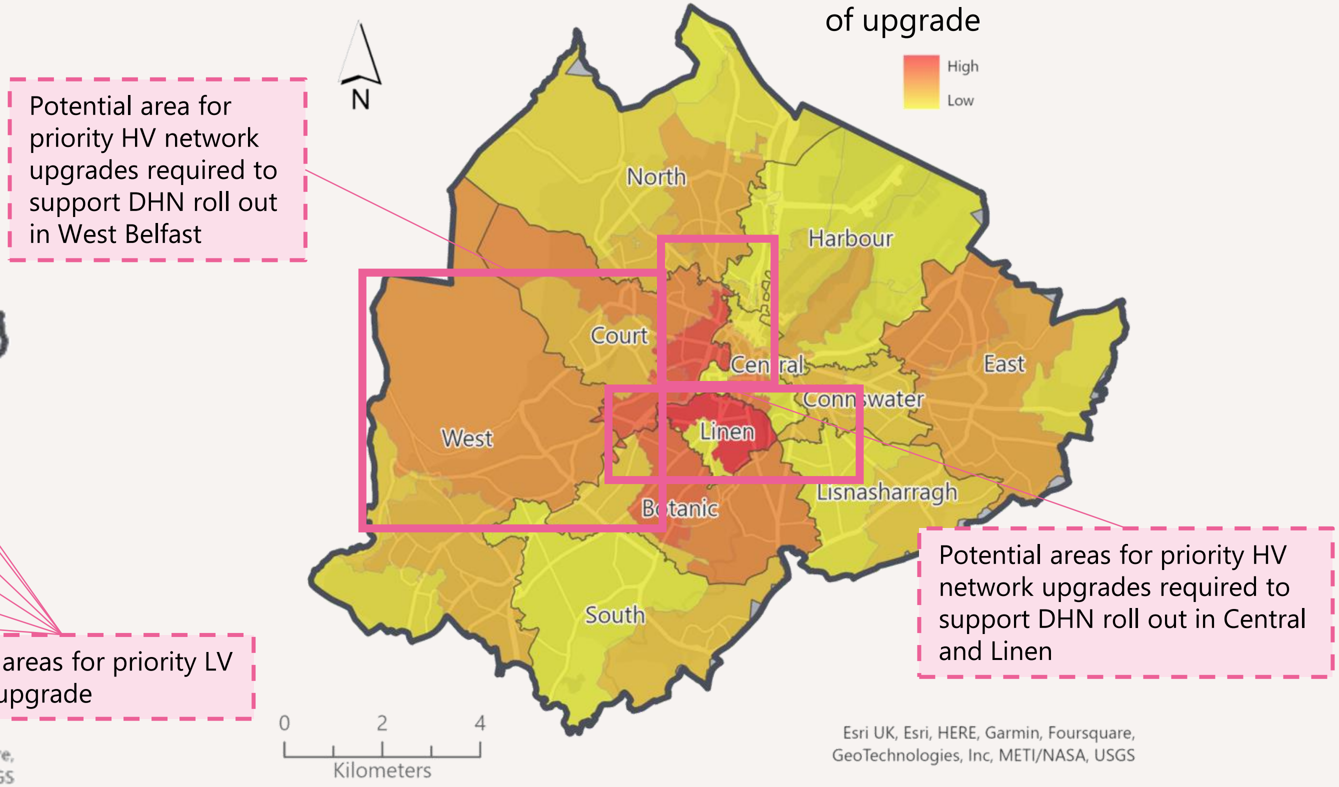
57% - 166%
increase in peak electricity demand at night (due mainly to EV charging)

Enablers	Barriers	Actions
• Investment already planned for upgrades. • Network operator engaged and aligned with local authority over decarbonisation action. • Emerging flexibility markets may provide near-term low-cost mechanism to reduce or avoid level of required network upgrades	• Uncertainty over gas network re-purposing for biomethane may constrain near-term network upgrades. • Flexibility options not fully modelled in LAEP; uncertain impact and compatibility.	

Estimated existing low voltage substation capacity



Primary substation level of upgrade



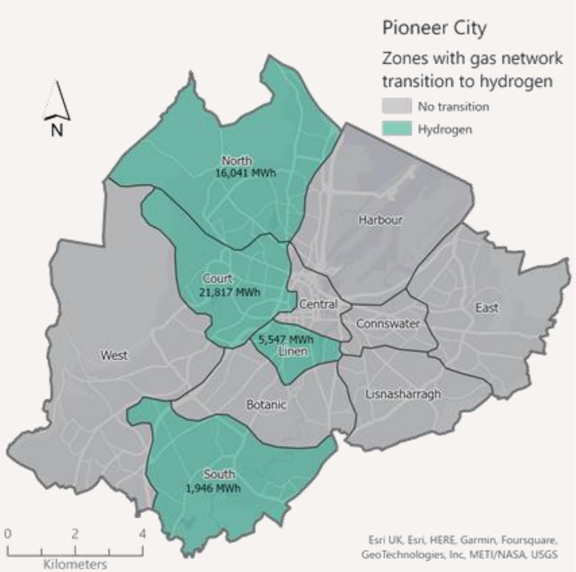
Hydrogen

Two modelled Scenarios – Pioneer City and Net Zero 2050 – provide a methane to green hydrogen conversion of the gas grid in the late 2040s (there is no hydrogen conversion in the 3rd non-BAU Scenario of Regional Infrastructure where biomethane dominates).

The maps below identify the Opportunity Areas where hydrogen may be used in 2050 and the annual demand for hydrogen in MWh/year for each zone and each Scenario respectively. Hydrogen demand is driven by industrial buildings requiring high-temperature processes although some domestic, commercial, or public buildings were forced to switch to hydrogen boilers or hydrogen hybrid heat pumps for heating.

Areas shown in grey for Pioneer City indicate where biomethane is the dominant renewable gas; whereas in Net Zero 2050, areas in grey indicate a decommissioning of the gas network.

Enablers	Barriers	Actions
• Gas network is already composed of plastic pipework and considered "hydrogen ready". • Hydrogen is widely accepted as the preferred decarbonisation option for industrial high temperature processes found in parts of Belfast.	• The level of uncertainty regarding the use-cases, costs, and availability of hydrogen prevents any immediate action recommended by this LAEP. • Modelling proves that both biomethane and hydrogen may coexist in Belfast's Net Zero future, but they are likely to compete for dominance.	• None identified for short term action.



	Pioneer City	Net Zero 2050
Annual demand for green hydrogen by 2050 (GWh/year)	45.4	29.6
As a proportion of the cap applied to the LAEP modelling	98.8%	64.5%

Implementation

Project Implementation Framework

A conceptual framework, consisting of 4 main steps, describes how projects can be taken forward from the LAEP pathway. This framework operates on the assumption that projects are led by Belfast City Council. Delivery of Net Zero will require progression of hundreds and possibly thousands of projects and therefore other frameworks may be necessary to consider in parallel. As part of this framework, Belfast City Council will need to determine their organisational role in Net Zero delivery, and how to work with partners and other stakeholders to deliver effective outcomes. The framework is shown alongside the key stages of Innovate UK's 'Financing Local Net Zero Projects: A Guide for Local Authorities' [1]. Crucially, the steps are not taken in a linear sequence and may require an iterative approach especially when considering the phasing of stakeholder engagement.

Prioritise

The first stage recommends stakeholders work to prioritise the projects identified within the LAEP – seeking Quick Wins or Low Regrets – and commission desktop feasibility studies to understand the low carbon Interventions and renewable technologies required in further detail. Feasibility assessment could include sizing commercial renewable technologies, assessing co-located storage options, consideration of network connection requirements and an initial outline business case. Prioritisation of the LAEP projects should be influenced by areas currently within stakeholders' direct control, for example social housing or land assets and public buildings owned by the council. Projects should be assessed in line with both local and regional targets which may include carbon reduction, cost breakdown, energy reduction, and impact on aspects such as fuel poverty, air quality, and economic growth plans. These activities may be supported by resources such as Net Zero Go [2]. Prioritisation should also include understanding the role each tier of local and regional government wishes to play as decarbonisation projects are further developed. For example, they could work with partner organisations to assess their risk profiles, and desired roles in any future energy system before matching outcomes against different types of local energy business models. Projects may be arranged and managed using a portfolio approach if desired.

Assess

In the next phase of energy project development, various options can be assessed with the aim of exploring investible delivery mechanisms. Dependent on project type, a partner organisation with experience of innovative business modelling can assess how technologies can be connected and delivered to residents in a way that matches the risk profile of each stakeholder and the role they wish to play. This could include assessing different types of smart energy tariffs that incorporate costs for retrofit for social housing, exploring ways for councils to invest into infrastructure projects while ensuring commercial revenues are secured or assessing business models where the councils are off-takers or customers.

Connect

Further consideration should be given to how technologies and other measures – such as market arrangements – can be integrated through Smart Local Energy Systems (SLES), which can aggregate to unlock private investment and create numerous co-benefits. When an initial capital investment plan has been formed and initial sources of investment and funding have been identified, the detailed design phase needs to firm up assumptions made during desktop feasibility. This involves working with partner organisations with engineering expertise to assess spatial, planning and structural considerations. Connection costs to the electricity and gas networks should be fully understood, and a finalised capital investment plan produced.

Engage

Key stakeholders need to be identified and consideration should be given to how residents and businesses are consulted and bought into the potential benefits of decarbonising the built environment. A partner organisation with strong digital engagement experience and relationships with key stakeholders such as network operators or community energy groups can support this process. During this phase the local authority should seek to negotiate commercial contracts with other stakeholders.

[1] https://iuk.ktn-uk.org/wp-content/uploads/2023/12/Financing-Local-Net-Zero-Projects-A-Guide-for-Local-Authorities.pdf
[2] https://www.netzerogo.org.uk/

Project Pipeline Development [1] → Commercialisation [1] → Build... [1]

PRIORITISE

- Prioritise projects from the LAEP Pathway using Recommended Project Prioritisation Assessment Criteria
- Commission feasibility studies
- Assess risk profile and role of the council (e.g. as investors, facilitators, off-takers etc).
- Develop outline business case
- Develop portfolio management plan/strategy.

ASSESS

- Complete feasibility studies
- Explore investible delivery mechanisms
- Explore business model delivery routes

CONNECT

- Explore integration of measures through Smart Local Energy Systems (SLES).
- Introduce engineering expertise to assess spatial, planning and structural considerations during detailed design.
- Identify sources of investment and funding.
- Develop capital investment plan.

ENGAGE

- Identify critical stakeholders needed to deliver priority projects
- Consult citizens, community groups, and local businesses.
- Engage investors
- Negotiate commercial contracts.
- Complete full business case

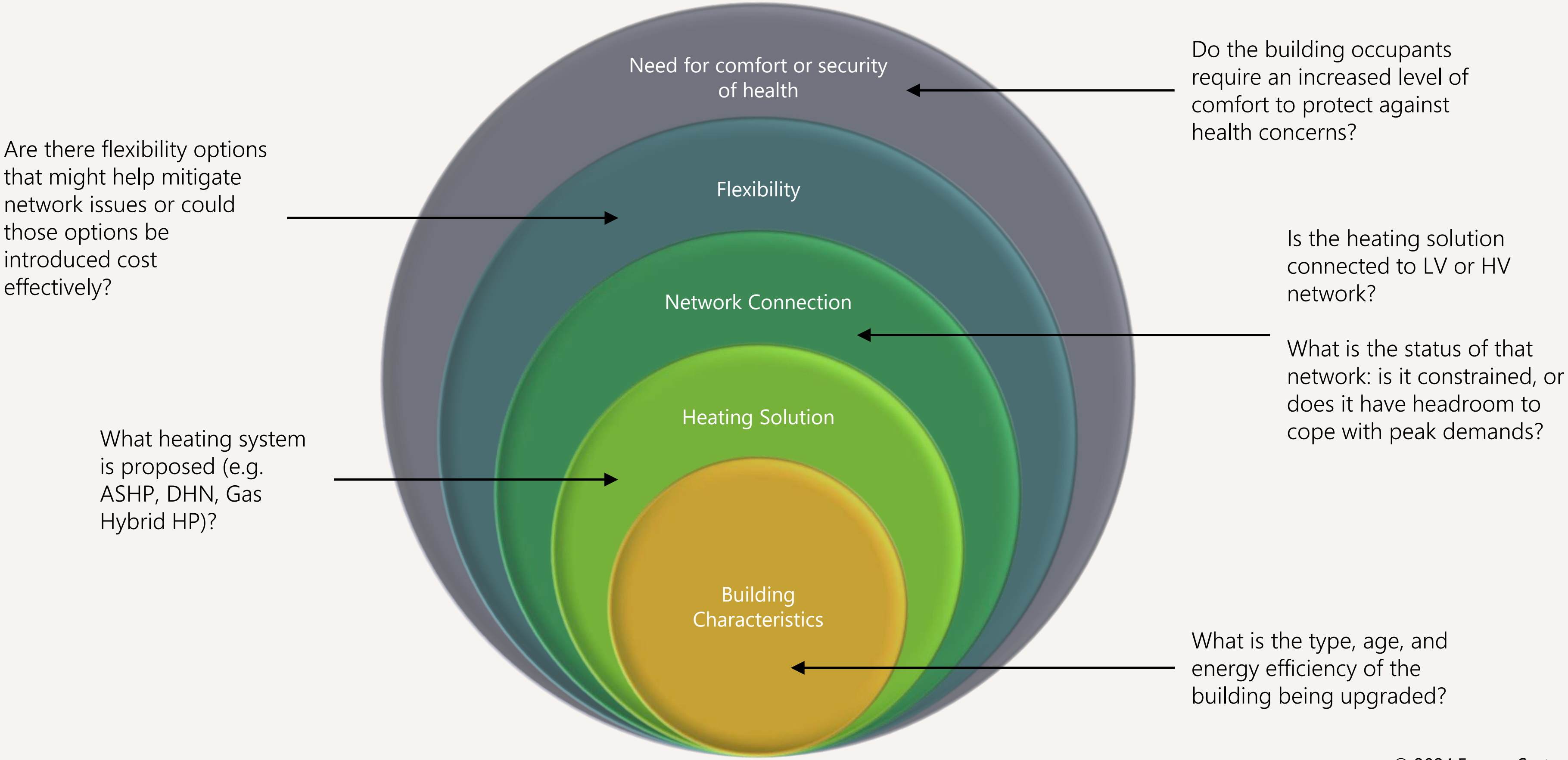
Recommended Project Prioritisation Assessment Criteria

- Level of stakeholders' direct control (e.g. targeting projects related to social housing or land assets and public buildings owned by the council) [1].
- GHG emissions reduction
- Alignment with regional targets (e.g. assess impact on fuel poverty, air quality, local economic growth plans etc).
- Market Conditions including:
  - Technology Readiness Level (TRL),
  - Strength of economic rationale,
  - Maturity/readiness of supply chain,
  - Anticipated access to funding/investment.

[1] https://iuk.ktn-uk.org/wp-content/uploads/2023/12/Financing-Local-Net-Zero-Projects-A-Guide-for-Local-Authorities.pdf

Critical Decision-Making Factors

Many of the implementation decisions about technology deployment involve a range of interdependent factors. For example, a recommendation from this LAEP is to pursue building energy efficiency improvements (mainly through fabric retrofit measures) as a low-regrets decarbonisation action. Such recommendations require a level of detail for implementation beyond the scope of the LAEP (i.e. the need to assess deployment at a building-by-building level or sub-local area level if building characteristics are similar). The factors to consider when making retrofit decisions at this level are shown below. For example, the installation of heat pumps on properties with solid uninsulated walls would increase peak demand on the electricity network. If the network is constrained or would be unable to cope with the additional peak load, then it is often cheaper – at a system level – to deploy measures that would avoid the cost of network upgrade. These may include fabric retrofit measures, such as solid wall insulation, to improve energy efficiency or flexibility measures to balance peak loads on the network. There are other retrofit options such as installation of bigger radiators within the property to achieve a desired level of comfort or to for those who require warmer homes to protect against health concerns, but this type of action would not avoid the higher overall energy system cost for network upgrades. The right incentives in the right places at the right times for the right people need to be considered to ensure the balance is addressed across these factors.



Complexity & Risk

There are risks and benefits associated with each of the technologies and options presented in this LAEP with each option bringing its own range of complexity considerations. Due to these factors, Belfast's actual energy transition will reflect some challenges and opportunities that have not been accounted for, or those that could arise in coming years. Therefore, before making any widescale and significant commitment to one option or technology over another, evaluation of multiple factors will be needed.

Risks

The key risks associated with this LAEP are summarised in Annex E. Consideration of these aspects during implementation must be reflected, as outcomes may necessitate an update to the LAEP. In addition, there may be additional market, policy and regulatory changes that could also result in a need to reconsider aspects of the pathways. Many of the actions identified in the Next Steps section of this document should also assist in mitigating some of these risks.

Complexity Considerations

Aspects of the LAEP for which there are technological, economic, spatial, or temporal limitations in scope, may present unforeseen issues which could impact delivery with respect to time, budget, or unintended consequences. For example, as the proportion of renewable electricity on the system increases, consumers are likely to see bigger variations in effective electricity prices (generation plus supply costs plus flexibility incentives), making heat storage, batteries, heat networks, and hybrid ASHPs potentially more economically viable and desirable. Variations in CO_2 emissions in time would also affect the viability of different technical combinations. Modelling of these future variations is recommended during post-LAEP implementation to ensure appropriate energy system choices are deployed.

For more details on Risk, see Annex E – Risk Register

Pathway Metrics

Through stakeholder engagement, a range of potential 'Pathway Metrics', were proposed. These act as a system of measurements to track status of delivery and progress of Belfast's Pathway to Net Zero. These represent thematic areas of importance to the Pathway and of interest to stakeholders. Proposed metrics are shown opposite.

Units of measure (where applicable), frequency of reporting, and scale of reporting are not specified to allow the necessary level of post-LAEP definition in the governance and assurance processes required to execute data gathering, monitoring, and reporting. For example, the metric on 'cumulative energy loss' may be an annual report on the average energy efficiency rating obtained from EPCs over the whole of Belfast. Or it may be desirable to report more frequently or using a different indicator or be broken down by areas of the city.

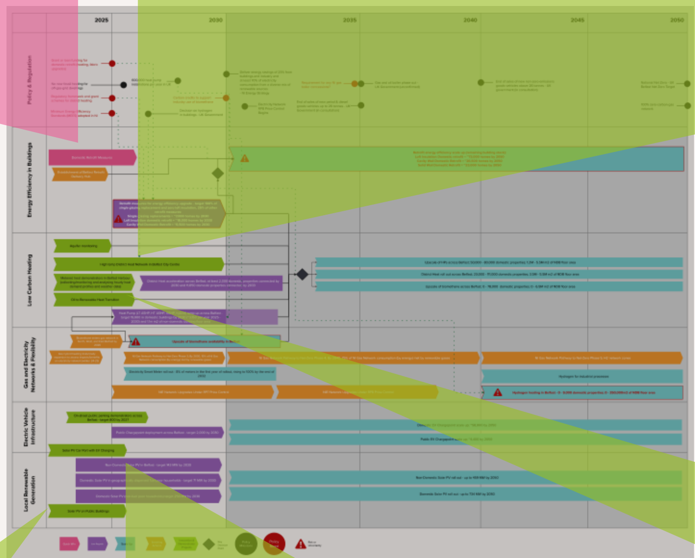
The Next 5 Years:
Outline Priority Projects

Outline Priority Projects

Using the Project Implementation Framework supported by the Project Prioritisation Assessment Criteria (see section Implementation), five projects, which are identified for near term implementation and provide substantial impact against Belfast decarbonisation ambitions, are selected from the LAEP Pathway and declared as Outline Priority Projects (OPPs). The graphic below provides a temporal view of the chosen OPPs and how they relate to the LAEP Pathway. The following page provide a spatial view of where the project may be implemented. Not all OPPs have a spatial allocation at this point and each that is allocated may be subject to change as implementation is progressed.

Domestic Retrofit Measures

High Temperature District Heat Network in City Centre



Each of these 5 OPPs will be described as a high-level concept in terms of:

- What the project looks like
- Rationale for choosing the project
- Estimated costs (where possible)
- Estimated carbon savings (where possible)
- Desired outcomes

Oil to Low Carbon Heating Transition

Solar Car Port with EV Charging

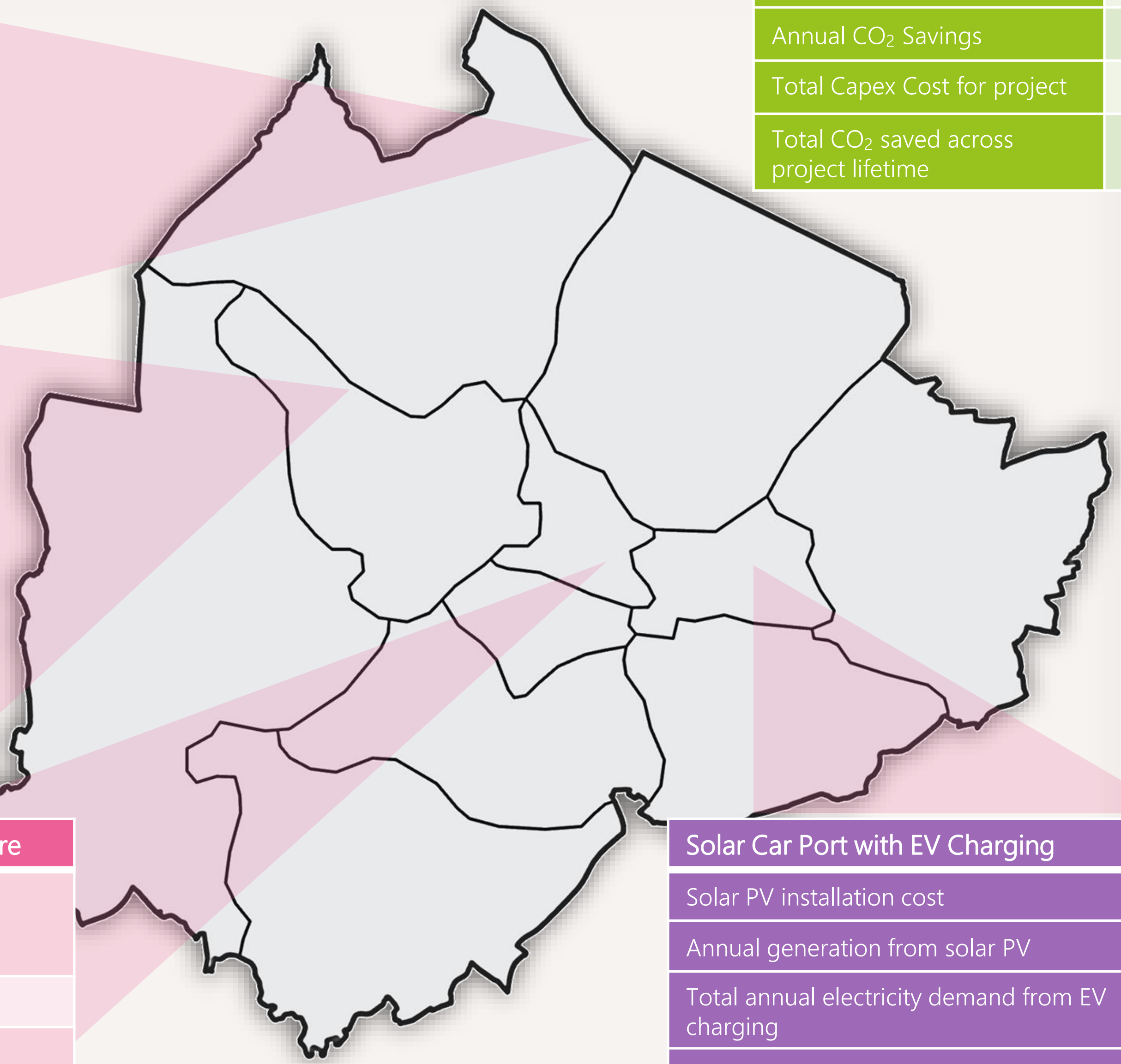
Solar PV on Public Buildings

Oil to Low Carbon Heating Transition

Number of homes transitioning	500
Annual CO2 Savings (per household)	4,400 $kgCO_2e$
Total Capex Cost for project	£7.0m
Total CO2 saved from project	2.2 $ktCO_2e$

Domestic Retrofit Measures

Number of Dwellings	Up to 2,000
Capital Investment	£2.7m – £5.6m
Annual bill savings per dwelling	£123 – £520
Annual carbon savings per dwelling	420 – 1,500 $kgCO_2e$
Additional benefit	Fuel poverty reduction



High Temperature District Heat Network in City Centre

Potential annual energy demand (phase 1: Non-Domestic Buildings only)	2.8 GWh
Capital Investment	£4.2m
Additional benefit	Expansion to domestic properties in phase 2

Solar PV on Public Buildings

Number of buildings	20
Annual energy generated	903 MWh
Annual CO_2 Savings	40 tCO2e
Total Capex Cost for project	£1.0m
Total CO_2 saved across project lifetime	606 tCO_2e

Solar Car Port with EV Charging

Solar PV installation cost	£21,100
Annual generation from solar PV	47,800 kWh
Total annual electricity demand from EV charging	3,432 MWh
Demand coverage from installed solar PV	1.4%
Annual CO_2 Savings	2,140 $kgCO_2e$

Domestic Retrofit Measures

This "quick win" pilot project is expected to target mixed tenure properties in lower income areas with EPC ratings D-G. Funding is anticipated to be provisioned for 500 properties for replacement of single glazing windows, 1,000 properties for loft insulation, and 500 properties for cavity wall insulation. Funding is proposed to be acquired through existing streams such as Northern Ireland's Housing Executive (NIHE) 'Affordable Warmth Scheme [1] or the Northern Ireland Sustainable Energy Programme (NISEP) [2]. Measures may be carried out together as a retrofit package or separately on individual properties. This project should act as a pathfinder which builds on learnings from existing pilot projects of a similar nature (circa 20 homes) helping to inform a city-wide approach to retrofit in Belfast. Ultimately, the goal is to accelerate the supply chain capability to deploy retrofit measures to help contribute to the achievement of 2030 carbon targets.

This project is expected to include:

- Developing a methodology for identifying and prioritising potential areas, properties, measures, project development, management, and delivery.
- Developing the business case to apply for adequate funding.
- Targeted support with applications for households that may be unaware of the scheme or having difficulty with the application process.
- Marketing of the scheme to relevant households.

Estimated required funding for **pilot project** (number of households x cost of retrofit):

Windows:
500 * (£3,300-£6,500) [3] = £1.65m – £3.25m
Loft insulation
1,000 * (£740-£1,700) [4] = £740k – £1.7m
Cavity wall:
500 * (£530-£1,300) [4] = £265k - £650k

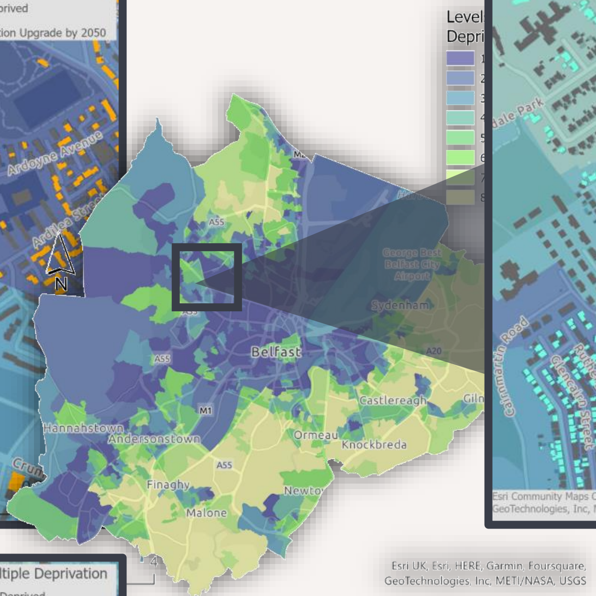
Belfast has approximately **19,000 properties** with inadequate **loft insulation**, approximately **7,000 properties** with **inadequate cavity wall insulation**, and approximately **7,500** with **single glazing windows**.

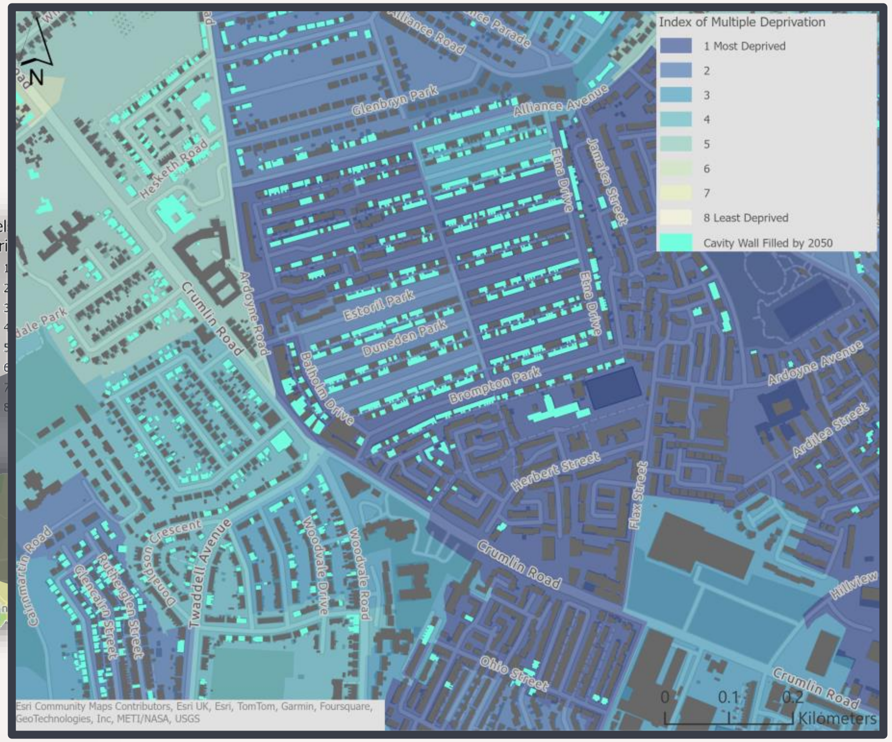
Breakdown of potential benefits from fabric upgrade measures

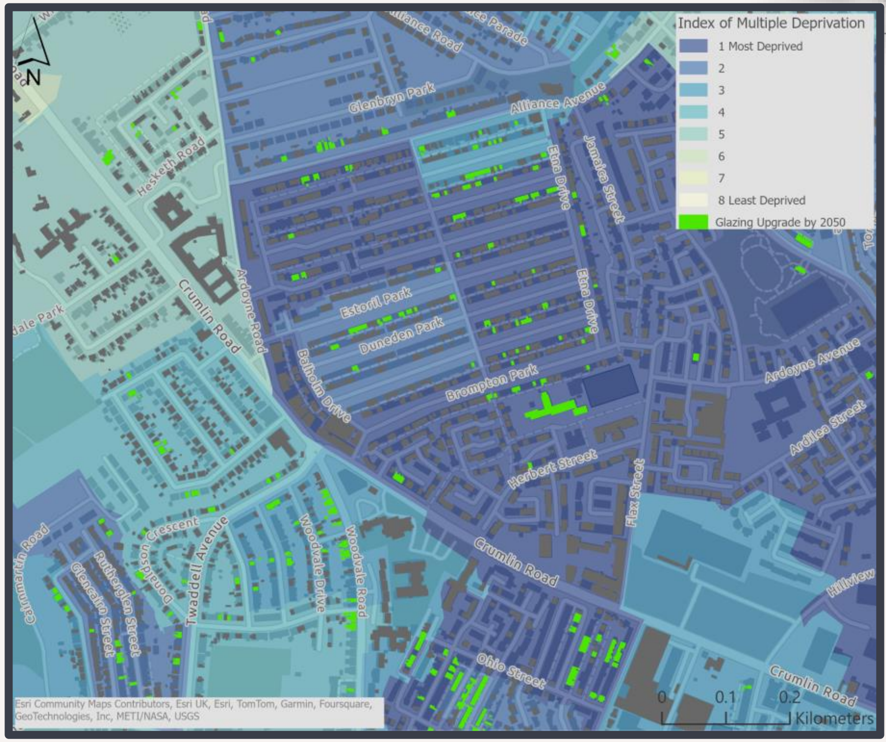
Retrofit Measure	Assumed details on building and fabric [5]	Nominal U-value pre measure [5]	Nominal u-value post measure [5]	Annual energy bills savings	Annual carbon savings (kgCO_2e)
Replacement of Single Glazing Windows	Metal single glazing *Changed to:* Wood/PVC low-e double glazing	5.70	2.30	£123 [3]	Not available
Loft insulation	Pitched roof – slates or tiles, ventilated air space, 9.5 mm plasterboard, **no insulation** *Changed to:* Pitched roof – slates or tiles, sarking felt, ventilated air space, 9.5 mm plasterboard, **300 mm** insulation between joists	3.13	0.12	£255 - £475 [4] *figures provided for 270 mm insulation not 300 mm	760 – 1,400 [4] *figures provided for 270 mm insulation not 300 mm
Cavity wall insulation	19 mm render, 102 mm brick, **open cavity**, standard aerated block (100 mm inner leaf), 13 mm plaster *Changed to:* 19 mm render, 102 mm brick, **mineral wool slab in cavity 50 mm**, standard aerated block (100 mm inner leaf), 13 mm plaster	0.82	0.44	£140 - £520 [4]	420 – 1,500 [4]

[1] https://www.nihe.gov.uk/housing-help/affordable-warmth-boiler-replacement/affordable-warmth-scheme
[2] https://energysavingtrust.org.uk/programme/nisep/
[3] https://www.gov.uk/guidance/domestic-private-rented-property-minimum-energy-efficiency-standard-landlord-guidance
[4] https://energysavingtrust.org.uk/energy-at-home/reducing-home-heat-loss/

[5] Energy Systems Catapult Analysis of Microgeneration Installation Standard: MIS 3005 ('The Heat Pump Standard')







These maps show an area of Belfast where a high proportion of fabric upgrades for improved energy efficiency (requiring retrofit action) are spread across areas with differing levels of deprivation (using Index of Multiple Deprivation as the measure). This suggests action may be required across a variety of social circumstances, property types, and property tenures.

Number of retrofit measures applied to properties in the area shown

	Loft Insulation	Cavity Wall Insulation	Single Glazing Window Replacement
Number of homes in area shown (% of all homes in Belfast)	6,615 (3.4%)		
Number of homes in area requiring retrofit measure	2,517	1,419	456
As a % of required measures across Belfast	3.4%	5.4%	6.1%

High-Temperature DHN in City Centre

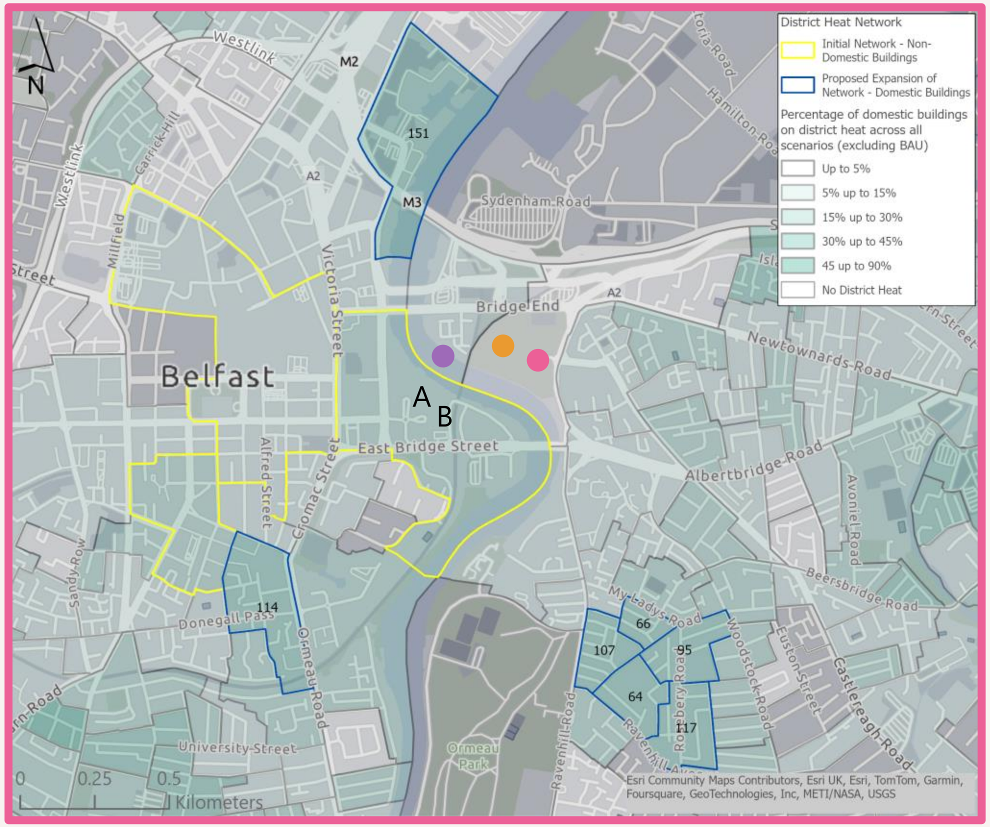
This project seeks to deploy a high temperature heat network in Belfast city centre where there is high heat density (a large amount of heat required in a small area).

Phase 1 (Pilot Phase)

The first phase of the project aims to connect multiple anchor loads from non-domestic buildings – ideally public buildings – each with a minimum annual heat demand of 100 MWh (examples of potential anchor loads are shown on the map). This first phase seeks to establish a viable heat network and create an attractive value proposition to the market in order to attract strong bidders and create competition.

Phase 2

With a viable heat network established it should become convenient and cost-effective for nearby homes to connect in a second phase thus, avoiding the upfront costs and disruption of installing dedicated low carbon heating systems on a per property basis. These connections are anticipated from areas with a high density of domestic buildings, such as terraced dwellings and low-rise flats, where district heat has been selected as a cost-effective low regrets approach in the LAEP modelling (i.e. where a high percentage of domestic buildings are connected in all 3 non-BAU Scenarios). This additional phase and any further phases would seek to extend the heat network to supply hundreds of domestic buildings (as shown by the numbers in the Data Zones outlined in blue). The mixture of domestic and non-domestic buildings allows for a more balanced load across the network at any given time. Although the anchor loads are in Central Belfast, the LAEP modelling suggests that the dominant opportunity for expansion of the heat network lies to the east penetrating into the Connswater zone (with two main exceptions highlighted in blue to the north and south of the phase 1 heat network boundary).



A. Waterfront Hall (annual heat demand 8 GWh)

B. Hilton Hotel, 4 Lanyon Place (annual heat demand 9 GWh)

● Potential river-sourced energy centre

● Potential land-based energy centre

● Potential geothermal boreholes for thermal underground storage

Split of domestic and non-domestic properties connected and annual energy demand. (Note: peak power demands on the network are not considered here)

	Minimum number of domestic dwellings connected (selected by LAEP modelling)	Potential domestic energy demand (GWh/year)	Potential non-domestic energy demand in area (GWh/year)	Assumed % of non-domestic demand connected	Potential total energy demand on network (GWh/year)
Phase 1	-	-	142	2%	2.8
Phase 2_South Connection	114	0.6	142	5%	7.7
Phase 2_North Connection	151	0.7	142	5%	7.8
Phase 2_East Connection	449	2.5	142	5%	9.6

Energy Centre

The potential areas for the energy centre are shown on the image on the previous page. Provision of land required for the energy centre would be a necessary and currently uncertain step in the process but if successful this may serve to attract early investment from heat network developers. With the river Lagan nearby, a water-source heat pump could be considered as an energy centre contributor which may be evaluated as part of the necessary heat network feasibility study following this LAEP. The project aims to allow the opportunity for energy from waste heat to be added to the heat network therefore large commercial or industrial waste heat sources in proximity should also be identified in the feasibility study.

The district heat network will connect to the electricity distribution network in order to draw power for the energy centre. This area of Belfast shows relatively high levels of high voltage and low voltage substation capacity which may allow this project to progress without the network capacity as a barrier.

The project and its associated feasibility study should include provision for thermal underground storage by ensuring:

1. The heat network area sits on top of the geothermal aquifer "high probability" zone.
2. The energy centre is in a suitable open space where it may be feasible to deploy geothermal boreholes.

Estimated CAPEX costs for High-Temperature DHN in City Centre Phase 1

Section of DHN	Parameter	Value
Spine	Length (m)	1,600
	CAPEX rate (£/m)*	1,500
	CAPEX (£)	2.4m
Branch**	Length (m)	500
	CAPEX rate (£/m)*	1,500
	CAPEX (£)	0.75m
Energy Centre (ASHP on land)	Gross internal floor area (m^2)	400
	CAPEX rate (£/m^2)*	2,650
	CAPEX (£)	1.06m
Thermal Underground Storage		Not Costed
Total CAPEX		£4.2m

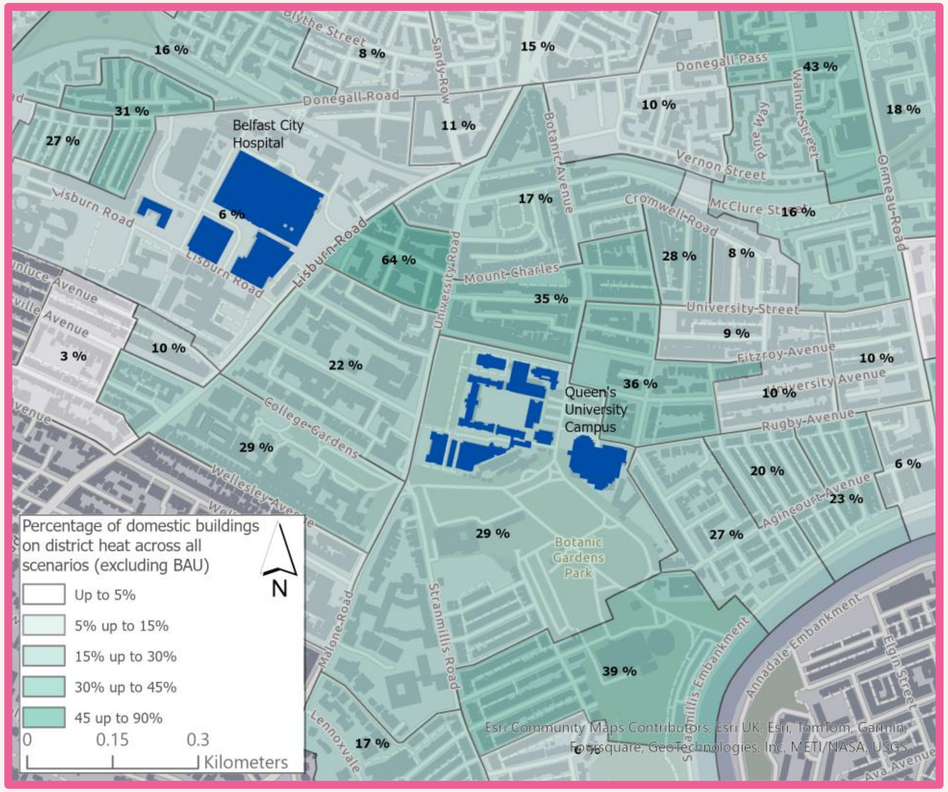
**CAPEX rates aligned with Queens Island Decarbonisation Plan produced by Energy Systems Catapult*

***Assumes 10 off-takers each at a distance of 50m from main spine*

The initial indicators are that both criteria are satisfied in the scoping of this project although this requires verification during the feasibility study.

Other Heat Network Opportunities

Further Opportunity Areas for deployment of a heat network exist in the city centre of Belfast (see below). In this area, key anchor loads from Queens University Belfast (QUB) and Belfast City Hospital are shown in blue. The nearby botanic gardens or indeed grounds within QUB or Belfast City Hospital may also present opportunities for geothermal boreholes and underground thermal storage. Should a heat network be made viable in this area with public, commercial or industrial anchor loads then the potential for expansion into non-domestic buildings is substantial. The numbers shown in % for each Data Zone are taken as the minimum number of domestic connections across all 3 non-BAU Scenarios in this LAEP. This suggests a low regrets approach to domestic district heat deployment in this area.



Oil to Low Carbon Heating Transition

This project seeks to replace existing oil heating in domestic and non-domestic buildings with low carbon heating technologies such as heat pumps. The following page shows an area of North Belfast which may act as a suitable and high impact area for this pilot project. At present, this area is predominantly domestic buildings on oil heating (>50%) with the presence of some public and commercial buildings which may also be oil heated. The 5 Data Zones highlighted are in the 67th – 92nd percentile of deprivation across Northern Ireland (using multiple index of deprivation data calculated at Small Area level and cross-referenced to Data Zone level) making this area the most prominent in Belfast for the combination of oil heating prevalence and deprivation. The wider surrounding area of North Belfast scores much higher in the multiple index of deprivation data suggesting relatively isolated deprivation in the 5 Data Zones highlighted.

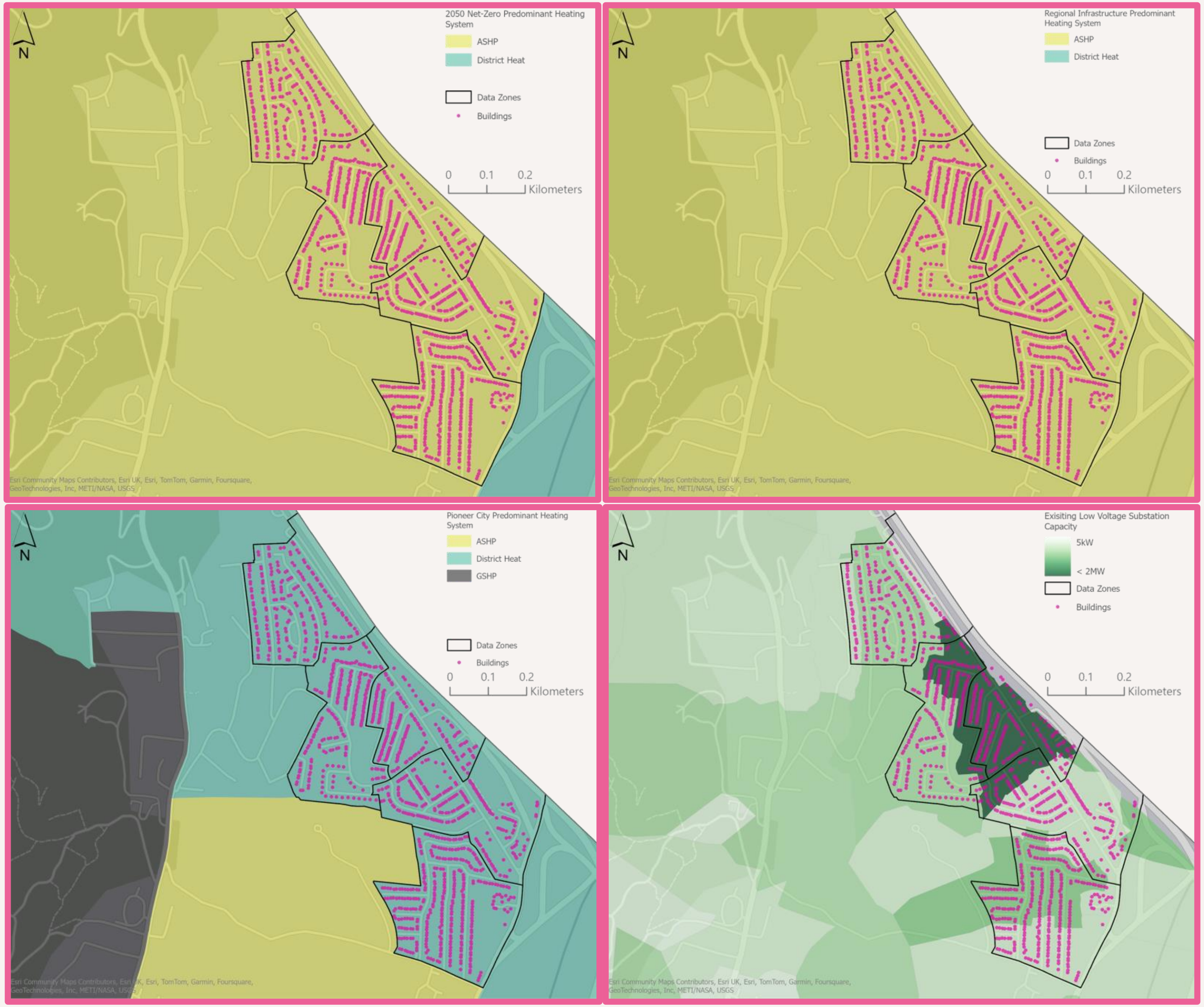
The 4 images on the next page represent the estimated existing low voltage substation capacity and the selected future heating solution from the 3 non-BAU Scenarios of the LAEP techno-economic modelling. The future heating solution is Scenario dependent but comparison between the Regional Infrastructure and Net Zero 2050 Scenarios suggest that the most cost-effective choice of heating is not sensitive to the presence of biomethane. The Pioneer City Scenario suggests that district heating may be a cost-effective option in this area, but this pilot project assumes that decarbonisation of oil heating will be tackled on a property-by-property level in this area and therefore heat pumps present a better demonstrator option. Both the Regional Infrastructure and Net Zero 2050 Scenarios opt for ASHPs but with 10% to 20% of these properties on the gas grid, a transition to hybrid heat pumps may be possible in these areas. The addition of the estimated existing low voltage substation capacity highlights specific areas where network constraints may act as a barrier to the electrification of heat using property level heat pumps. Note the imperfect alignment between substation boundaries and Data Zones and the uncertainty over which properties would connect to which substation areas. Nonetheless, this may support the rationale for prioritisation of network upgrades in support of this pilot project.

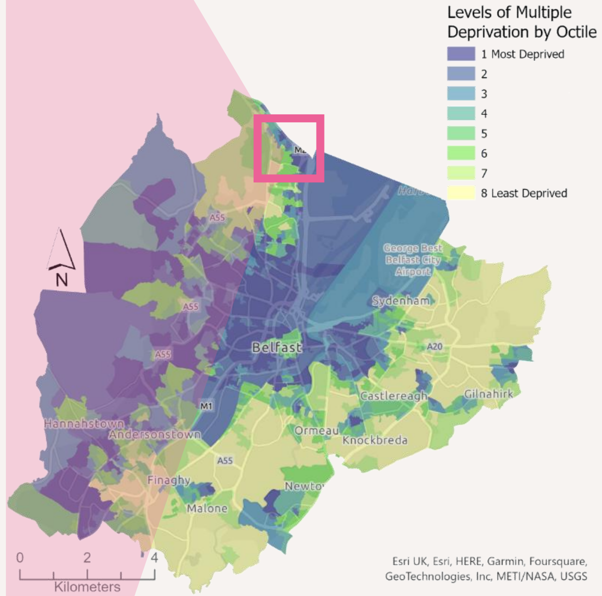
Costs in the table below suggest that annual fuel bills may increase by an average of £45 per year under this type of heating system transition. More detailed assessment at a building-by-building level will be required to verify or amend the assumptions built into this estimate. However, the premise is that this project is driven by the relatively high quantities of CO_2 reduction in the short-term and removal of a reliance on fossil fuel heating systems (and potential prices variations) in the medium to long term.

Estimated figures for Oil to Low Carbon Heating Transition Pilot Project

Parameter	Value	Notes
Number of homes transitioning	500	Assumption on number of properties being transitioned
HP installation cost per home [1]	£14,000	Assumes transition to low temperature ASHP (air-to-water)
Annual fuel bill savings (per household) [1]	-£45	Potential annual savings of installing a standard air source heat pump in an average three-bedroom semi-detached home, with radiator upgrades as required.
Annual CO_2 Savings [1] (per household)	4,400 $kgCO_2e$	Assumes transition from old (G rated) oil boiler
Total Capex Cost for project	£7.0m	
Total CO_2 saved from project	2.2 $ktCO_2e$	

[1] https://energysavingtrust.org.uk/advice/air-source-heat-pumps/





Top-left = Net Zero 2050 Scenario future heating system
Top-right = Regional Infrastructure Scenario future heating system
Bottom-left = Pioneer City Scenario future heating system
Bottom-right = Estimated existing low voltage substation capacity

Data Zones (2021 code) highlighted: N20000790, N20000792, N20000793, N20000794, N20000795

Solar PV on Public Buildings

This project targets public owned buildings providing a total of no less than 1MWp of renewable electricity for local consumption which may be either direct demand to the host buildings or to other buildings via Belfast's electricity distribution network.

Areas where the network has limited capacity may act as a barrier to electrification of heat or transport. This may be exacerbated in areas where the substation, or other network assets, serve a limited number of buildings meaning the upgrade cost per building is relatively high. Solar PV may prove useful in these areas to alleviate network constraints and provide a local source of renewable electricity which may contribute to increased demand from electrification of heat or transport if combined with localised short duration electricity storage.

Solar PV may also enable a cluster of buildings – which may be a mix of public buildings, commercial buildings and industry – to form a commercial arrangement for shared generation and consumption of renewable electricity.

Solar PV may also act as an enabler for the viability of a District Heat Network by providing a direct wire which reduces the electricity costs of heating the water through the energy centre.

Fig. Estimated figures for Solar PV on Public Buildings Pilot Project

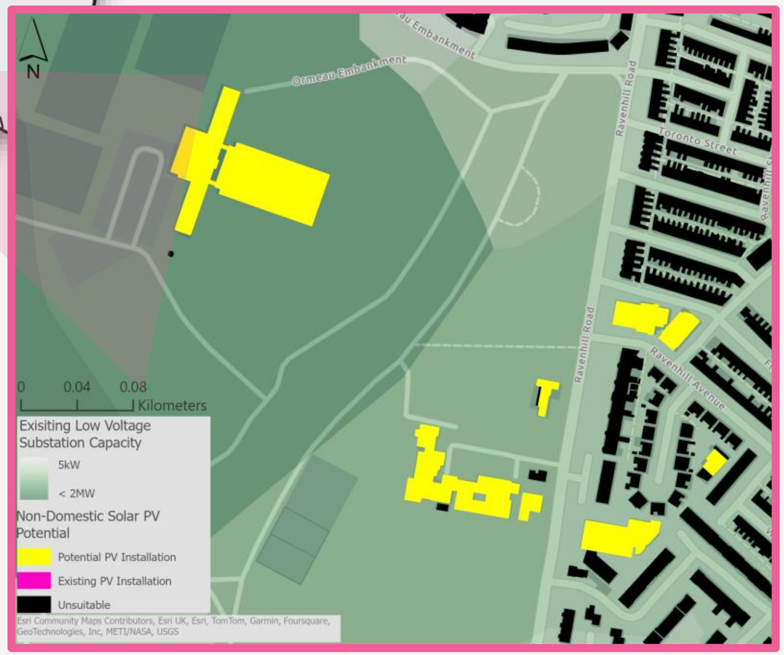
Parameter	Value	Notes
Number of buildings	20	Assumption to achieve target of 1MWp for this project
Peak power per building (averaged across all buildings)	50kWp	
Solar PV install cost per building [1]	£50,000	Uses the medium estimated construction cost for solar PV of 10-50kW at 2025 prices of 1000 £/kW. The install cost does not include costs for any storage assets or ancillary equipment that may be required as part of this project.
Annual energy savings (for all buildings across project) [2]	903 MWh	Total annual energy generated by all buildings installed with solar PV on this project is assumed to be a saving on energy previously consumed from the electricity grid. Calculation uses specific photovoltaic power output of 903 kWh/kWp (accurate for Donegall Square North, Belfast).
Annual CO_2 Savings [3] (for all buildings across project)	40,400 $kgCO_2e$	The energy generated as a saving from grid is converted to a carbon saving using the HM treasury Green Book grid average for commercial/public sector consumption-based data. This is averaged for 15 years between 2025 and 2039, inclusive, representing an assumed project lifetime of 15 years. The average figure over the 15-year project lifetime is 0.045 kgCO2e/kWh.
Total Capex Cost for project	£1 million	Installation cost per building multiplied by number of buildings
Total CO_2 saved across project lifetime	606,000 $kgCO_2e$	Assuming 15-year project lifetime as above

1 UK Government Department for Energy and Net Zero - Electricity Generation Costs (2023)
2 https://globalsolaratlas.info/map?c=54.597183,-5.930829,11&s=54.597183,-5.930829&m=site
3 HM Treasury Green Book Table 1: Electricity emissions factors to 2100, kgCO2e/kWh

Data Zone (2021 code): **N20000842** Solar PV capacity in area shown = 670 kW

Data Zone (2021 code): **N20000825** Solar PV capacity in area shown = 40 MW

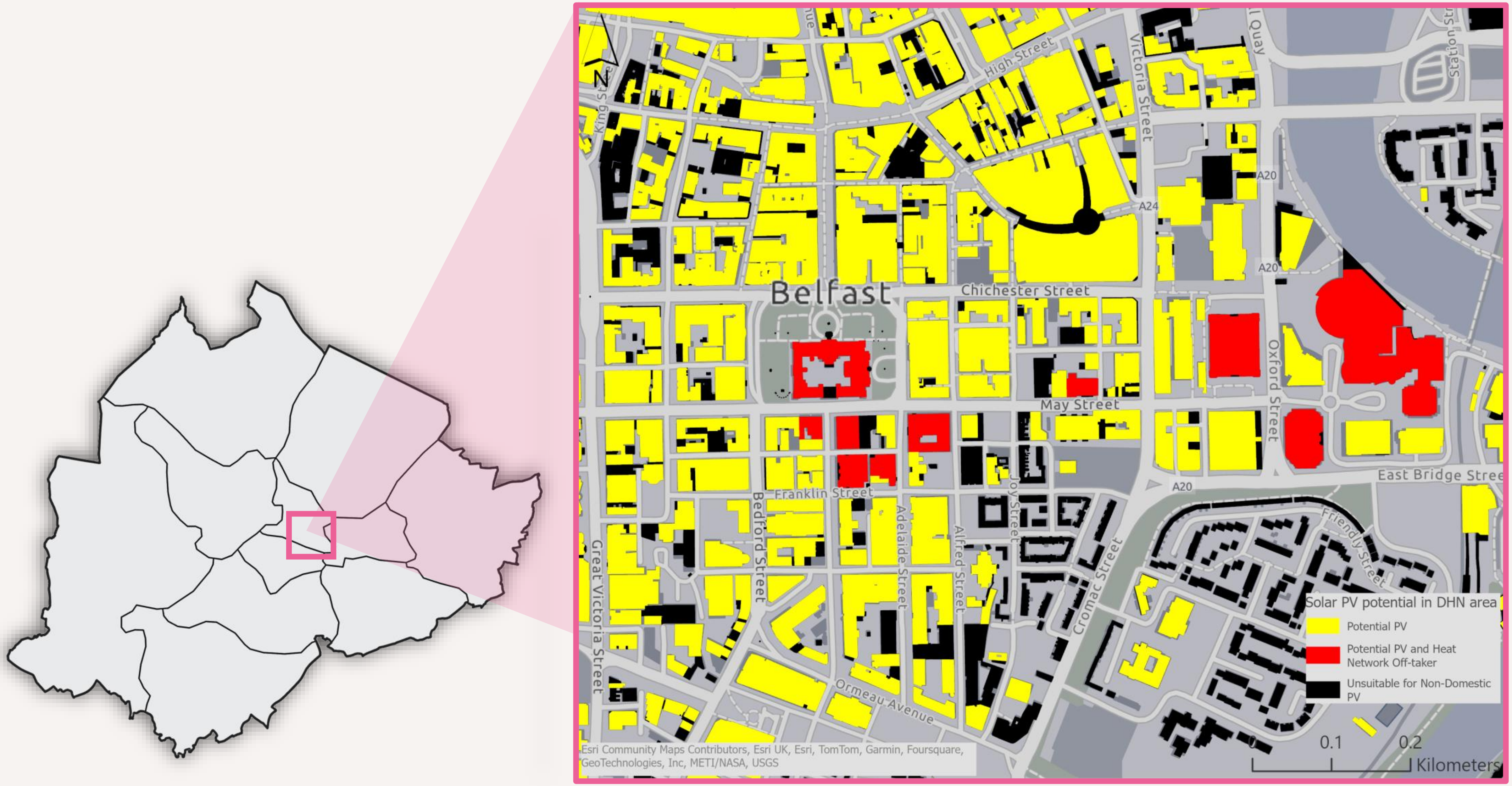
Data Zone (2021 code): N20001421 Solar PV capacity in area shown = 2 MW



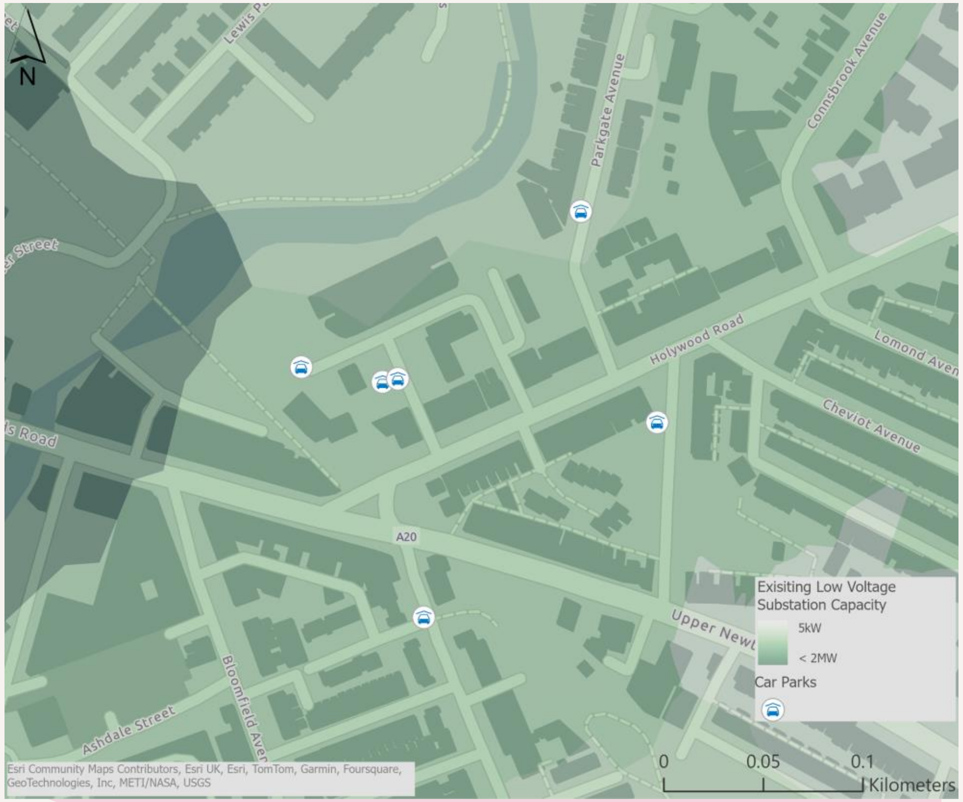
Data Zone (2021 code): **N20001121** Solar PV capacity in area shown = 774 kW

Solar PV may also prove to be a crucial enabler in establishing the viability of a district heat network since it presents the opportunity to provide a direct wire for supply of renewable electricity at minimal operational expenditure. The image below shows some of the non-domestic buildings within the proposed area for the 'High Temperature District Heat Network in Belfast City Centre' OPP. In yellow are the Non-Domestic Buildings with the potential for installation of rooftop solar PV. The buildings highlighted in red have both solar PV potential and are known public buildings which could be attractive as anchor loads for establishment of the heat network. Note that buildings unsuitable for non-domestic solar PV *may* include domestic buildings and, in those cases, will appear black in this image.

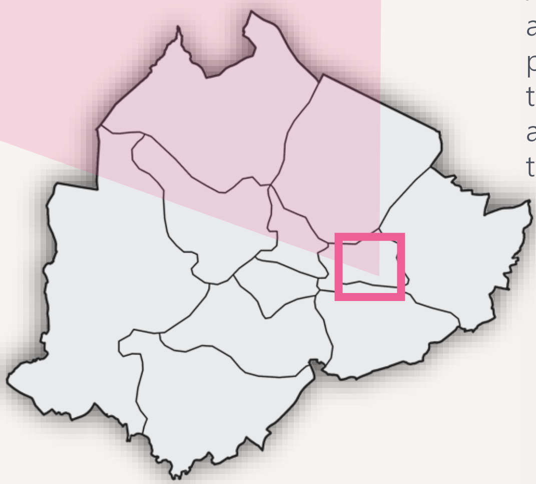
Solar PV potential on Non-Domestic Buildings in central Belfast potential DHN area



Solar Car Port with EV Charging



Car parks shown and respective capacities:
Westminster (north, east, and west) = 87
Parkgate = 36
Grampian Ave = 41
Ravenscroft = 53
Ashdale St (paid) = 85



The area in the image opposite (centred on Data Zone N20000891 within the Connswater area of Belfast) shows a collection of BCC owned car parks that currently do not offer EV charging. The colours of the base map indicate the estimated existing low voltage substation capacity.

This area is outside of Belfast city centre but on one of the main arterial roads into the centre from east to west. These roads are relatively congested with traffic, especially on weekdays [1]. Car parks in this area may therefore serve as attractive park and ride facilities when used in conjunction with public transport. This may inspire some innovative commercial and market incentives collaboratively between the energy and transport domains in the public sector. For example, the potential to offer a public transport incentive for users of EV charging facilities in the nearby car parks during times of peak traffic. An increase in the usage of these car parks, future improvements in public transport, and innovative business models available to the citizens of Belfast, would potentially enable both a reduction in road traffic congestion and the desire to reduce overall city centre traffic leaving Belfast one-step closer to being a 15-minute city with widespread modal shift towards public transport.

There is a need for public EV charge point deployment in this area although notable that this is generally in the form of on-street charging to serve residential areas without a driveway or where installation of a charge point is compromised.

Additional capacity required from the local electricity substation to service the additional demand from EV charging may not be a major barrier to making progress depending on the point of connection. The combination of solar PV with the EV charging infrastructure helps mitigate any risks in this area although it is anticipated that short-duration electrical storage would be required to support the functionality expected of this system architecture.

[1] Google Maps. (n.d.). Retrieved February 15th, 2024, from https://www.google.com/maps/place/Belfast/

Estimated figures for Solar Car Port with EV Charging

Parameter	Value	Notes
Solar PV peak power (across all car parks)	52.7 kW	Assumes that 80% of the car park area for Westminster (north, east, and west), Parkgate, Grampian Avenue, Ravenscroft, and Ashdale St car parks can be converted to an overhead solar PV array. Car park area is calculated by multiplying the number of spaces across all car parks by the area of one space which is assumed to be 2.4m by 4.8m
Solar PV installation cost [1]	£21,100	Uses the medium estimated construction cost for Large-scale solar at 2025 prices of 400 £/kW. The install cost does not include costs for super structure to support solar panels.
Annual generation from solar PV [2]	47,800 kWh	Total annual energy generated by all car parks installed with solar PV on this project. Calculation uses specific photovoltaic power output of 907 kWh/kWp (accurate for Ashdale Street, Belfast).
Number of parking spaces with EV charging	75	Assume that 25% of the available spaces in the Westminster (north, east, and west), Parkgate, Grampian Avenue, Ravenscroft, and Ashdale St car parks are converted to EV charging stations
Power rating per EV charge point	22kW	Assumes that all stations are 22kW fast chargers
Total annual electricity demand from EV charging	3,432 MWh	Assumes that chargers are in use for an average of 8 hours per day and an average of 5 days per week
Demand coverage from installed solar PV	1.4%	
Annual CO_2 Savings [3]	2,140 kgCO_2e	The energy generated from solar PV is converted to a carbon saving using the HM treasury Green Book grid average for commercial/public sector consumption-based data. This is averaged for 15 years between 2025 and 2039, inclusive, representing an assumed project lifetime of 15 years. The average figure over the 15-year project lifetime is 0.045 kgCO2e/kWh.

Cost estimates for this project are shown in the table above. The range of variables for this project requires a much deeper feasibility study and business model exploration to better understand the following aspects not fully covered in this conceptual project definition:

- The potential and cost to install solar PV in one or more of the identified car parks.
- The potential and cost to add EV charging to these car parks and to connect these to the electricity distribution network.
- Any other technologies or infrastructure that may be required to support the project such as electrical battery storage or superstructures for supporting the EV installation.
- The business models and commercial arrangements that would make the project viable.
- The cost-benefit analysis including carbon savings which should look to verify the underpinning assumptions around road traffic and public transport integration.

Indeed, it is possible that other car parks owned by BCC would serve as more appropriate and relevant assets for deployment of a solar car port with EV charging. The estimates provided here may, however, serve to deliver the strategic case for pursuing those feasibility studies and future commercial offerings.

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1 UK Government Department for Energy and Net Zero - Electricity Generation Costs (2023)
2 https://globalsolaratlas.info/map?c=54.596769,-5.889619,11&s=54.596769,-5.889619&m=site
3 HM Treasury Green Book Table 1: Electricity emissions factors to 2100, kgCO2e/kWh

The Next 5 Years:

Next Steps

Pathway Actions & Responsibilities

Delivering the scale of change demanded by Belfast's Pathway to Net Zero will take coordinated action from a variety of stakeholders, driven primarily – at least in the early stages after delivery of this LAEP – by Belfast City Council.

The following pages describe the **what, when and who** for a breakdown of actions relating to the LAEP Pathway and/or mitigation of risks associated with the forthcoming implementation phase.

Area	What		When	Who	
	Action	Rationale		Responsible	Supporting
Collaboration and Capacity Building	Form a LAEP delivery group across council departments, local businesses and other local stakeholders, appointing points of contact for each party, and arranging regular forums	To maintain momentum and collaboration post-LAEP delivery	Short-term	BCC	All LAEP stakeholders
	Inform electricity networks of any plans for low carbon technologies to be connected to the distribution network.	Ensure that decarbonisation measures – which are likely to tend towards high electrification of aspects such as heat and transport – are not planned without network buy-in.	Ongoing	BCC	NIE SONI
	Collaborate, with housing providers and registered social landlords, to develop the retrofit plan for low-income households in relation to the Domestic Retrofit Measures OPP	Success of the OPPs relies upon consensus amongst the delivery stakeholders	Short-term	BCC NIHE	TBC
	Engage, monitor data, and asses the impact of emerging solar PV deployment across Belfast	Risk raised during stakeholder workshop about scale of solar PV recommended deployment	Ongoing	NIE SONI	BCC

Area	What		When	Who	
	Action	Rationale		Responsible	Supporting
Planning and Preparation	Advance the Belfast Retrofit Delivery Hub by creating a one-stop shop to provide guidance and support to citizens and businesses on the transition to Net Zero	Helps to build a more mature supply chain and connect citizens or businesses to that supply chain	Ongoing	NIHE	BCC
	Develop a procurement framework for street-by-street retrofit	This will help facilitate the delivery of the Domestic Retrofit Measures OPP and serve as a demonstrator to other areas of Belfast.	Implementation framework – Assess Phase	BCC	TBC
	Engage the market to offer heat supply agreements to potential off-takers and attract investment from heat network developers	This is the preferred strategy for Belfast City Council to progress DHN potential in the local area. Market intelligence suggests that DHN developers prefer to commission their own feasibility studies (e.g. as part of an end-to-end design, commission and operate service).	Implementation framework - Engage Phase	BCC	-
	Commission a feasibility study for the 'Solar PV Car Port with EV Charging' OPP	This is identified as an Outline Priority Project (OPP) for the Belfast LAEP	Implementation framework - Prioritise Phase	BCC	-
	Commission a feasibility study for the 'Solar PV on Public Buildings' OPP	This is identified as an Outline Priority Project (OPP) for the Belfast LAEP	Implementation framework - Prioritise Phase	BCC	-
	Commission a feasibility study for the 'Oil to Low Carbon Heating Transition' OPP	This is identified as an Outline Priority Project (OPP) for the Belfast LAEP	Implementation framework - Prioritise Phase	BCC	-
	Develop the outline business case for each of the 5 OPPs	This is identified as a critical step in the LAEP implementation process	Implementation framework - Prioritise Phase	BCC	TBC
	Commission a study into Belfast's heat pump incentivisation strategy aligned to LAEP identified heat pump deployment areas and building types.	This LAEP recommends where heat pumps are the most cost-effective option on the pathway to Net Zero, but the type of heat pumps deployed (LT ASHP, HT ASHP, GSHP, Hybrid) are reserved for post-LAEP decision making.	Implementation framework - Prioritise Phase	BCC	TBC
	Commission a study on how gas hybrid heat pumps impact or benefit the electricity network	This is identified as an Enabling Action on the LAEP Pathway	Winter 2024-2025	Phoenix Energy and NIE	BCC
	Commission a study for on-street public parking in Belfast and establish a pipeline of demonstrators.	This acts as an enabler to maintain the ambition of having 800 new public charge points by 2027 across Belfast	Implementation framework - Prioritise Phase	BCC	TBC
	Form a delivery plan for Belfast's near-term roll out of solar PV.	The scale of solar PV deployment and its necessity to be a near-term action to contribute most effectively to decarbonisation means that solar PV requires special attention across domestic and non-domestic buildings	Implementation framework - Prioritise Phase	BCC	TBC

Area	What		When	Who	
	Action	Rationale		Responsible	Supporting
Skills	Seek to resolve any skills gaps in the supply chain for delivering the actions and projects recommended by the LAEP.	Near-term actions	Medium-term	NIHE	BCC
	Find a sponsor to communicate the career opportunities of the energy transition to young people		Short-term	BCC	TBC
Decisions	Validate the rate of technology deployments proposed in the LAEP with the local supply chain.	Incorrect assumptions on technology deployment rates could have significant effects on post-LAEP implementation	Short-term	BCC	TBC
	Re-assess whether the 2030 carbon target can be met given the scale of measures and deployment required by the LAEP Pathway. If not, consider whether decarbonisation in other areas could compensate, offsets could be used as a temporary stop-gap, or the target should be reviewed.	Stakeholders expressed concern over the lack of funding and other barriers required to realise the scale of measures recommended by the LAEP	Short-term	BCC	TBC
Policy	Build the case for grant or loan funding for domestic retrofit (heating, fabric upgrades) to be adopted in NI	Identified as a Policy Need on the LAEP Pathway	Short-term	BCC	TBC
	Build the case for a regulatory framework and grant schemes for district heating to be adopted in NI	Identified as a Policy Need on the LAEP Pathway	Short-term	BCC	TBC
	Build the case for Minimum Energy Efficiency Standards (MEES) to be adopted in NI	Identified as a Policy Need on the LAEP Pathway	Short-term	BCC	TBC
	Build the case for introducing carbon credits to support industry use of biomethane	Identified as a Policy Need on the LAEP Pathway	Short-term	BCC	TBC
	Explore the need for NI gas boiler concessions in anticipation of biomethane availability supporting extended use of gas boilers	Identified as a Policy Need on the LAEP Pathway to mitigate the UK Government planned gas and oil boiler phase out in 2035 (unconfirmed)	Short-term	BCC	TBC

Area	What		When	Who	
	Action	Rationale		Responsible	Supporting
Engagement	Seek citizen and local business views on key aspects of the LAEP such as DHN, retrofit, and renewable generation	It is more value-adding to gauge citizen and local business views from the recommendations in the LAEP where the types of measures as well as where and when they are deployed can be discussed in greater detail	Implementation framework - Engage Phase	BCC	TBC
Funding	Approach private financial providers or create a decarbonisation fund for homeowners who are not eligible for existing schemes	Stakeholders expressed concern over the lack of funding and other barriers required to realise the scale of measures recommended by the LAEP	Implementation framework - Engage Phase	BCC	TBC
	Identify and communicate funding opportunities available for businesses, and highlight funding gaps	Stakeholders expressed concern over the lack of funding and other barriers required to realise the scale of measures recommended by the LAEP	Implementation framework - Connect Phase	BCC	TBC
	Identify and communicate funding opportunities available for homeowners or landlords, and highlight funding gaps	Stakeholders expressed concern over the lack of funding and other barriers required to realise the scale of measures recommended by the LAEP	Implementation framework - Connect Phase	BCC NIHE (Retrofit Delivery Hub)	TBC
	Complete a cost-benefit analysis for electricity network funding of retrofit measures	It may be cheaper to fund retrofit measures than invest in the required additional network capacity if no retrofit measures are in place (see Annex C – Wider Factors Analysis – Public Attitudes and Preferences).	Short-term	BCC NIE SONI	TBC
Business Models	Support community energy organisations which can develop shared ownership of large rooftop solar installations on public and commercial buildings	This is identified as a critical step in the LAEP implementation process relevant to the identified OPPs	During implementation framework - Assess Phase	BCC	TBC
	Explore Heat Supply Agreements as the primary mechanism for establishing viability of Belfast's near-term District Heat Networks	This is identified as a critical step in the LAEP implementation process relevant to the identified OPPs	During implementation framework - Assess Phase	BCC	TBC
	Explore commercial arrangements for solar PV deployment on council owned buildings.	This is identified as a critical step in the LAEP implementation process relevant to the identified OPPs	During implementation framework - Assess Phase	BCC	TBC

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If there are any questions about the method or outputs in this LAEP, then please feel free to contact the Energy Systems Catapult team on:

laep@es.catapult.org.uk

Energy Systems Catapult
7th Floor, Cannon House
18 Priory Queensway
Birmingham B4 6BS

Telephone +44 (0)121 203 3700
Email info@es.catapult.org.uk
es.catapult.org.uk