

Local Area Energy Plan

Cyngor Gwynedd



Figure 1: Tanygrisiau, Gwynedd. Copyright: Meilyr Tomos 2024

Mae'r ddogfen hon ar gael yn Gymraeg / This document is also available in Welsh

Abbreviations

Acronym	Definition or meaning
ANW	Ambition North Wales
AM&T	Automated Monitoring & Targeting
BEIS	Business, Energy and Industrial Strategy
BEMS	Building Energy Management Systems
CCGT	Combined Cycle Gas Turbine
DESNZ	Department for Energy Security and Net Zero
DFES	Distribution Future Energy Scenarios
DfT	Department for Transport
DNO	Distribution Network Operator
LDP	Local Development Plan

Acronym	Definition or meaning
EfW	Energy from Waste
EPC	Energy Performance Certificate
ESC	Energy Systems Catapult
EV	Electric Vehicle
FES	Future Energy Scenarios
GDN	Gas Distribution Network
GHG	Greenhouse Gas
HGV	Heavy Goods Vehicles
LAEP	Local Area Energy Planning or Local are energy plan

Acronym	Definition or meaning
LGV	Light Goods Vehicles
LSOA	Lower Super Output Area, small area classification in the UK designed to have a comparable population
LULUCF	Land Use, Land Use Change and Forestry
MSOA	Middle Super Output Area, medium sized area classification in the UK designed to have a comparable population
NAEI	National Atmospheric Emissions Inventory
NGED	National Grid Electricity Distribution
PEDW	Planning and Environment Decisions Wales
REA	Renewable Energy Assessment
RIIO	Revenue = Incentives + Innovation + Outputs, a regulatory framework used by UK energy regulator, Ofgem

Acronym	Definition or meaning
RSP	Regional Skills Partnership
RTP	Regional Transport Plan
SAP	Standard Assessment Procedure
SDP	Strategic Development Plan
SLES	Smart Local Energy System
SMR	Steam Methane Reformation
SPEN	SP Energy Network
TfW	Transport for Wales
WG	Welsh Government

Acronym	Definition or meaning
WWU	Wales and West Utilities

Acronym	Definition or meaning
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Note: full definitions for terms used through the report are provided in the glossary at the end of the document.

Acknowledgements

This Local Area Energy Plan was prepared by Arup, Carbon Trust and Afallen on behalf of Cyngor Gwynedd and co-ordinated across the region by Ambition North Wales. Energy Systems Catapult is the Technical Advisor for the LAEP Programme in Wales.

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Figure 2. Harlech Beach, Gwynedd. Image Provided by Emma Carter (Arup)

Local Area Energy Plan outline

This plan collates evidence to identify the most effective route for Gwynedd to reach a net zero energy system

Overview

As part of this project, two separate documents have been produced. This will ensure the content is accessible to a variety of audiences whilst also making it easier to find information relevant for the reader.

These two documents are the:

- 1. Local Area Energy Plan** (this document) contains the overarching plan, focusing on the Gwynedd's area-wide local energy plan and actions.
- 2. Technical Report** contains the graphs, charts, maps and supporting data for the results published in the Local Area Energy Plan. It also provides more detail about the approach to modelling and scenario analysis that we took. To request further information, please contact Bethan Richardson (Cyngor Gwynedd Climate Change Programme Manager):
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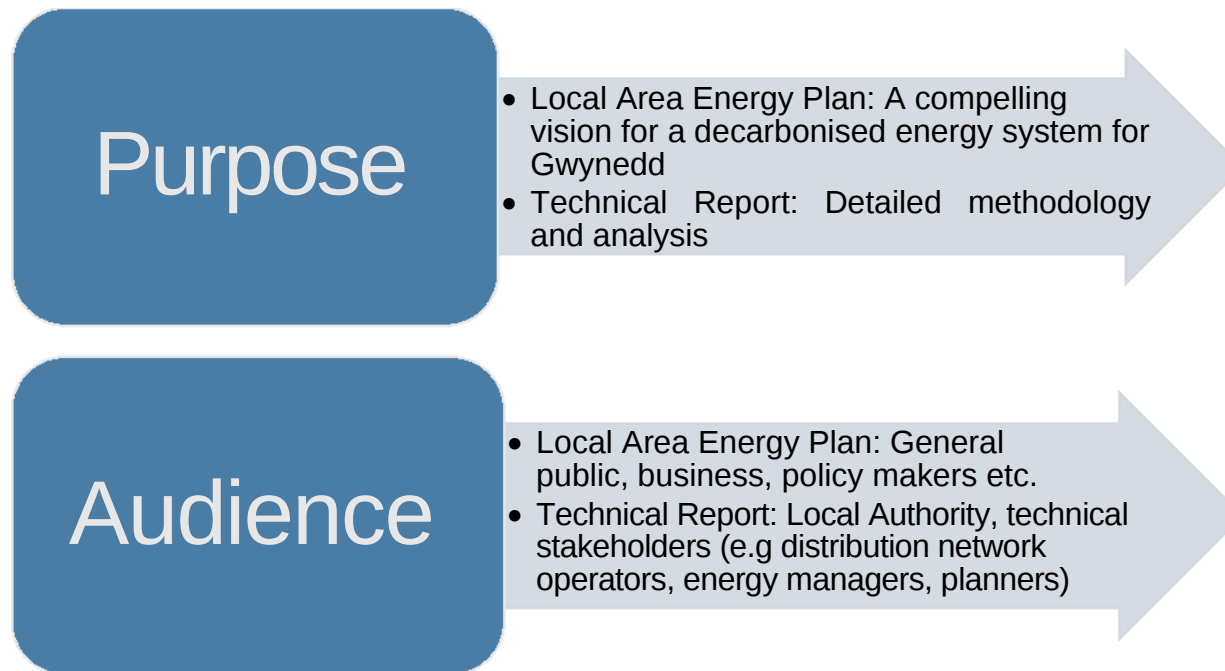


Figure 3. LAEP and support document's purpose and audience summary

A note on the use of “we” throughout this report:

Achieving the transformation that is needed for the energy system to reach Net Zero will not be easy and will need a collaborative approach. In this plan, the term “we” has therefore been used to refer to the range of people and organisations in Gwynedd who will support the ambition set out and agreed in this plan. Cyngor Gwynedd and Ambition North Wales have taken facilitating roles in developing this LAEP but cannot deliver the ambition it sets out alone.

Executive summary

Gwynedd has a vision to transition the local energy system to net zero

The vision for Gwynedd's future local energy system is:

Develop a local net zero carbon energy system for Gwynedd that encourages the development of affordable and reliable energy sources for the benefit of our local communities, supporting a transition to a prosperous and resilient economy, whilst protecting and enhancing the natural environment.

Gwynedd's **energy objectives** are collectively agreed and describe what needs to be done to create the enabling conditions needed to deliver this LAEP.

- To reduce and encourage efficient use of energy across Gwynedd and provide quality, affordable, accessible and energy efficient homes and buildings
- To maximise reductions in carbon emissions using local renewable energy sources while minimising financial costs
- To capitalise on opportunities to invest in low carbon energy and engage our communities to support leadership and ownership of renewable energy projects and to keep the benefits local
- To provide a climate resilient energy system capable of meeting future energy demand
- To empower the local economy, supporting the creation of high-quality jobs, thriving businesses, while safeguarding and building on the visitor economy

- To establish a mechanism with which to deliver local renewable energy to Gwynedd homes at a stable, cost-effective price to the end user

Our energy propositions describe what needs to change between now and 2050 to decarbonise Gwynedd's local energy system and achieve net zero by 2050.

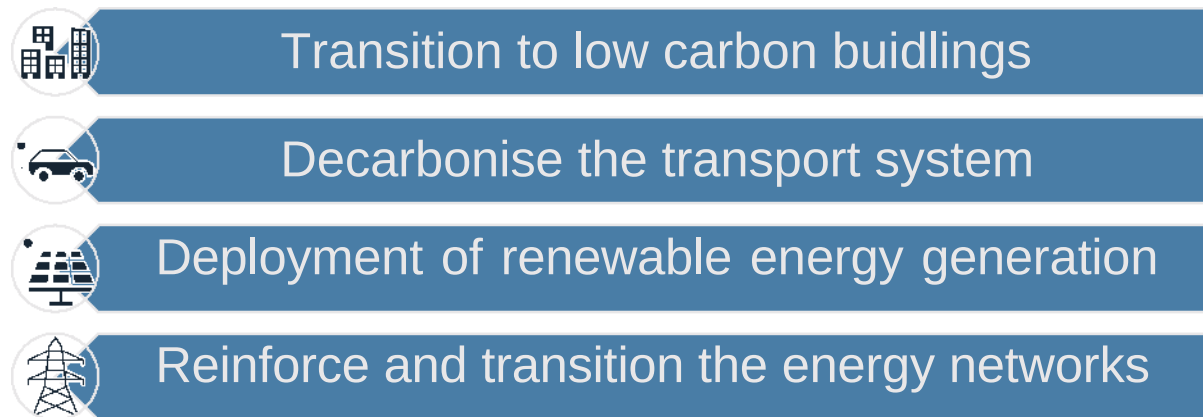


Figure 4. Summary of Gwynedd's vision, energy objective and energy propositions that are strategic foundation for this LAEP

Gwynedd's energy propositions in more detail

1. Transition to low carbon buildings

- Reduce heat demand and improve the energy efficiency of existing buildings through retrofitting measures
- Deploy heat pumps as the near-term, least regrets heating technology to decarbonise heating in homes.
- Transition away from fossil fuel-intensive heating systems to more efficient, low-carbon technologies.
- Low Regret Options: Rooftop solar PV, Heat Pumps, Retrofit

2. Decarbonise the transport system

- Reduce transport demand by improving active travel routes and enhancing the public transport network and encouraging shared transport modes.
- Where car journeys can't be avoided, facilitate the transition to Electric Vehicles (EVs).
- Low Regret Options: EV chargers, active travel infrastructure

3. Increase renewable energy generation

- Proactive engagement with developers seeking to unlock capacity.
- Investigating opportunities for local and community ownership of renewables, providing low cost, clean energy to residents.
- Consider storage technologies to minimise dependency and exposure to grid price volatility and connection challenges.
- Low Regret Options: Onshore wind turbines, Ground-mounted solar PV, Rooftop solar PV

4. Reinforce and transition the electricity and gas energy networks

- Reinforce the grid to manage increase in electricity demand.
- Consider ways to provide flexibility to the grid through storage technologies.
- Even if hydrogen is not used for heating, the gas grid will need to be repurposed to provide hydrogen for uses that are not easily electrified such as industry, and to manage costs in a fair way as home heating transitions away from gas.
- Low Regret Options: Flexibility, storage technologies

Figure 5. A more detailed description of Gwynedd's energy propositions and the corresponding low-regret system components to focus on in the near-term

Gwynedd's local energy system will need to change significantly to achieve net zero by 2050, Gwynedd's local energy system today has:

- 700 buildings across Gwynedd with heat pumps installed (domestic and non-domestic).
- 18% of domestic homes with EPC A-C (equivalent to 7350 homes across the country)
- 29 public EV charge points based on National ChargePoint Registry
- 9.3 MW rooftop solar PV installed capacity equivalent to 2325 houses with installations based on 4kW per roof.
- 29.8 MW ground mounted solar PV installed capacity which is equivalent to less than 0.1% of total land area across Gwynedd.
- 4.4 MW installed capacity

What Gwynedd's net zero local energy system could look like in 2050:

- Up to 70000 buildings heat pumps installed (domestic and non-domestic)
- Up to 63500 domestic homes retrofitted in 2050
- Up to 25000 public EV charge points
- Up to 215 MW rooftop solar PV installed capacity (equivalent to 53,750 houses * with installations)
- 495 MW ground-mounted solar PV installed capacity (equivalent to 0.4% of total land area across Gwynedd)
- Up to 12 MW installed capacity

*For context, 100MW is equivalent to 17 million 100W lightbulbs. The average Welsh home uses 3.325MWh/year of electricity, which is 0.003GWh

The rate of change required to achieve this:

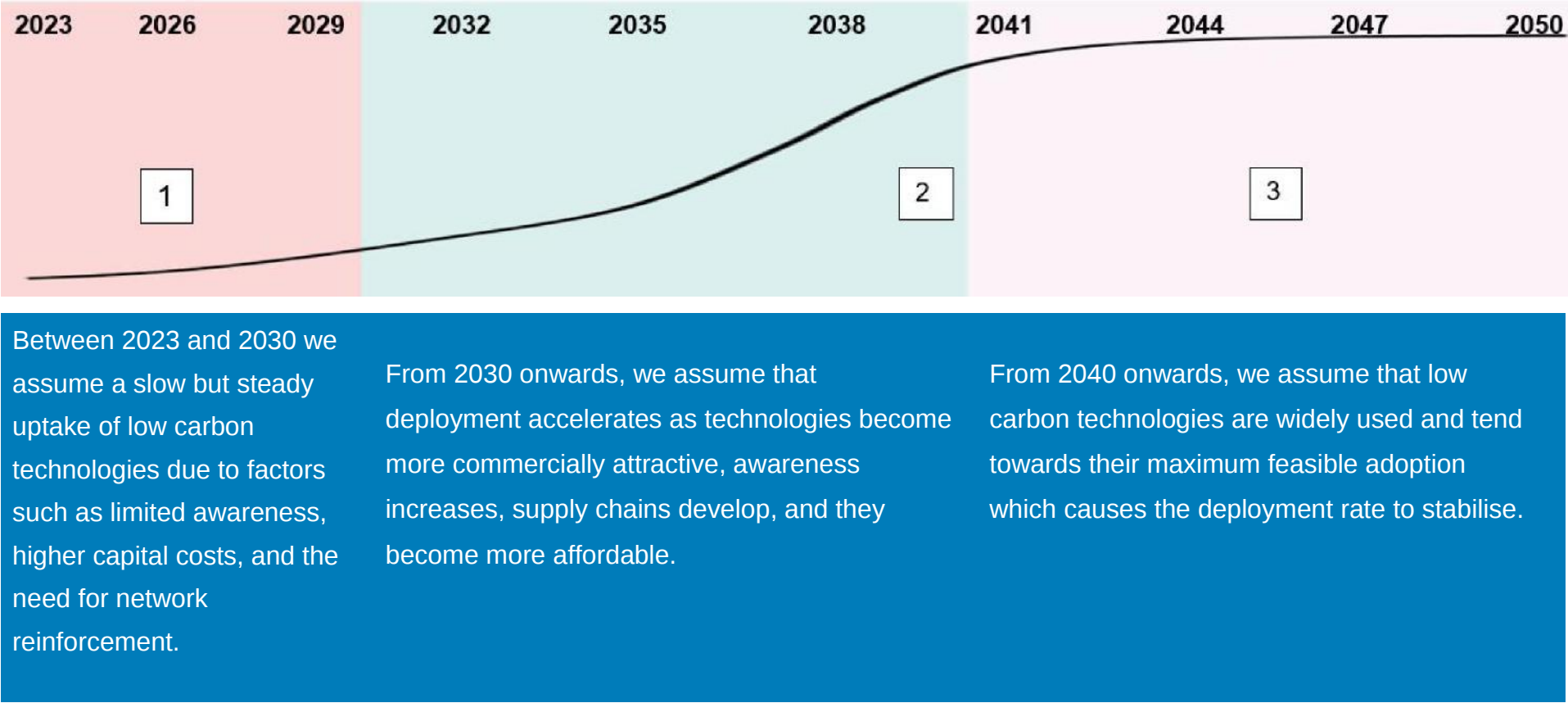


Figure 6. The summary of deployment of low-regret system components, showing quantities of technologies deployed today and what could be deployed by 2050 based upon minimum average annual rate of change required, considering the different

scenarios set out in Chapter 3: Summary of future energy scenario. The figure also includes a description of how the rate of deployment of low carbon technologies could change between 2023 (baseline year) and 2050

Achieving a net zero local energy system in 2050 aligns with the Well-being of Future Generations (Wales) Act 2015 and could lead to the following benefits:

Direct Impacts

- Up to 98% less GHG emissions than in 2023
- Up to 29% reduction in head demand from buildings compared to 2023
- Average amount of electricity demand across Gwynedd could increase by 2.6 times by 2050
- Natural gas could be phased out by 2050

Wider Impacts

- Diversified local energy supply improves energy security
- Reduced fossil fuel combustion from transport, heat and power improves air quality
- Emerging net zero industries attract investment and create high quality local jobs. Up to 4100 net jobs (FTE) created in 2050
- Highly insulated homes reduce heat demand and reduce fuel poverty

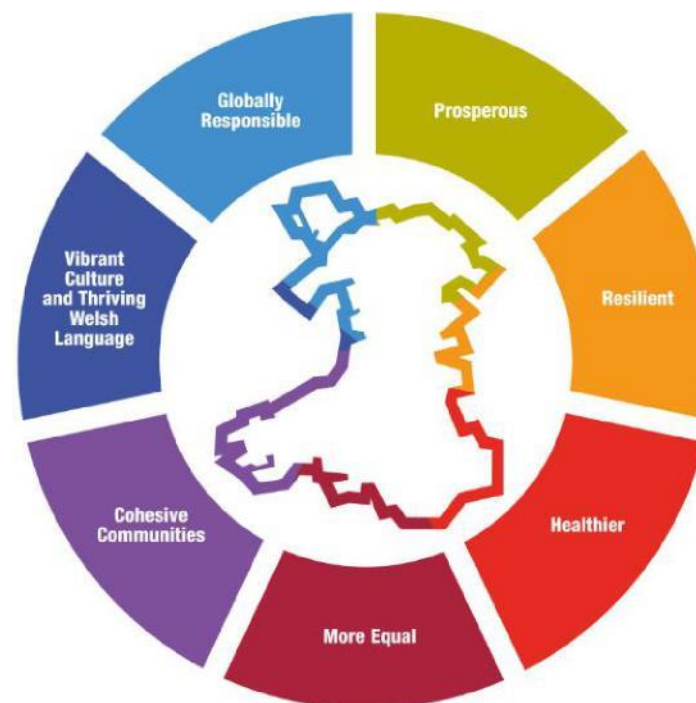
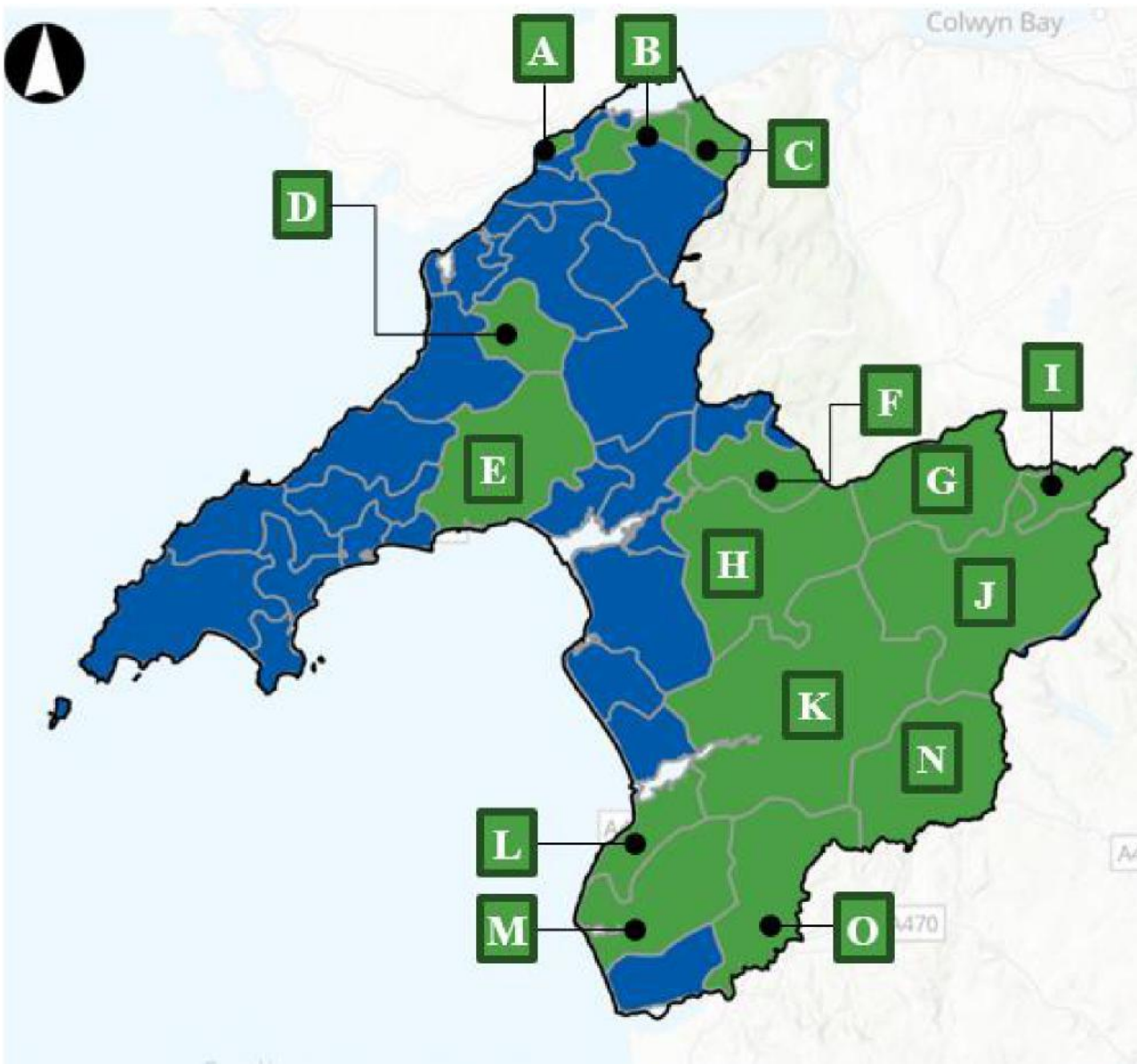


Figure 7. Illustration of the direct and wider benefits that a transition to a Net Zero local energy system could achieve. *based on the energy island scenario, see page 47 for further information

Energy propositions - Plan on a page – 2030

The Plan on a page identifies zones with particularly favourable conditions for specific energy components, with the potential for being ideal locations for innovative studies. The summary tables (shown below) detail the (i) installed capacity opportunity, (ii) required investment for each component and (iii) total investment necessary for both energy component installation and electricity network infrastructure in each zone by 2030.

Ranges have been calculated by taking the minimum and maximum results from each future energy scenarios.



Key and Region	Installed Capacity (i), Required Investment (per component) (ii), Total Required Investment (iii)
A: Parc Menai	Rooftop PV: 1.6MW: £1.7m: Total £5.8-19m
B: Minfford /Parc Bryn Cegin	EV Charger: 1.1MW: £870-880k: Total £7.5-48m
C: Llanfairfechan	EV Charger: 79kW: £65k: Total £0.46-3.7m
D: Carmel	Insulation Measures: 550-750 homes: £4-57m: Total £6.9-60m
E: Rhoslan	Ground mounted PV: 63MW: £27m. Insulation Measures: £4-66m: Total £36-98m
F: Manod	EV Charger: 240-250kW: £200k: Total £3.3-27m
G: Tryweryn	Heat Pumps: 110-220kW: £81-170k. Ground-Mounted PV: 24MW: £10m. Total: £12-21m
H: Maentwrog	Heat Pumps: 350-750kW: £270-560k: Total: £3.0-26m
I: Glan-Yr-Afon	Heat Pumps: 80-170kW, £60-130k Ground Mounted PV: 23MW, £9.8m Offshore Wind: 11MW (2050), £8.0m (2050). Total: £11-17m
J: Bala	Ground Mounted PV: 4.2MW: £1.8m: Total: £9.0-57m
K: Dolgellau	Insulation Measures: 580-910 homes, £5-73m: Total £11-78m
L: Fairbourne	Rooftop PV: 700kW, £770k: Total: £3.9-37m
M: Tywyn	Rooftop PV: 1.9MW, £2.1m: Total £7-63m
N: Cemmaes Rd / Glantwymyn	Heat Pumps: 180-390kW, £130-290k EV Charger: 150kW, £120k. Insulation Measures: 130-150 homes, £1-15m. Total: £1.9-16m
O: Machynlleth	Rooftop PV: 540kW: £600k: £2.8-20m

Figure 8. Gwynedd’s spatial representation opportunities across the four scenarios including 2030 ambition and investment (million £). Zone boundaries are defined by primary substation service areas. Note: intervention should still be carried out in ‘progress’ zones to transition the local area to Net Zero. Green zones are to accelerate pilot projects whereas blue are those in progress

To deliver the LAEP, we have developed a series of actions and next steps that we'll need to take

Action routemap

Although the exact form of the decarbonised energy system in 2050 is uncertain, there are actions we can take now with relative certainty that will help us maintain the ability to meet our 2050 Net Zero ambition and capitalise on the opportunities that this transition will bring.

Our action routemap takes each energy proposition and outlines critical, enabling actions that we will take collectively alongside our stakeholders in the coming decade, with a particular focus on what we can achieve in the next 5-7 years.

The sequencing of activities in the routemap is highly dependent on the political, regulatory and strategic context it has been created in. Therefore, we expect it to evolve over time and be regularly updated to make sure it stays relevant. Cyngor Gwynedd's routemap can be found in Chapter 4: Action planning.

Next steps

Progressing energy propositions: For each prioritised proposition, we will undertake a series of development activities to progress towards delivery (such as feasibility studies, detailed technical and commercial development, business case, commercialisation and procurement).

Governance: Where possible, we will integrate oversight of LAEP delivery with existing governance structures.

Monitoring: We will work with regional and national partners to develop a monitoring framework which builds on existing processes and helps us understand the progress Cyngor Gwynedd and all other stakeholders are making towards their committed actions and ambitions set out in this plan.

Engagement & collaboration: Many stakeholders with an interest and influence over the local energy system have come together to help shape this LAEP, and it is important that this collaboration continues as we deliver this plan. The development of this LAEP has brought those with interest and influence together.

1. Introduction



Figure 9. Cob, Porthmadog, Photo provided by Ambition North Wales

What is Local Area Energy Planning (LAEP)?

Overview

A LAEP sets out the changes required to transition an area's energy system to Net Zero greenhouse gas (GHG) emissions against a specified time. By exploring a range of technologies and scenarios through whole energy system modelling and analysis, the most cost-effective preferred pathway to Net Zero can be identified (1). The process follows standardised guidance defined by ESC (1).

Being data-driven and evidence-based, a LAEP uses a whole energy system approach that is led by local government and developed collaboratively with defined stakeholders. It sets out to identify the most effective route for the local area to meet its local Net Zero target, as well as contributing towards meeting the national Net Zero target (2).

A LAEP results in an indicative costed spatial plan that identifies the change needed to the local energy system and built environment, detailing what changes are required, where, when and by whom. The level of detail in a LAEP is equivalent to an outline design or masterplan and is intended to identify core areas that require focus over the next 25 years. It proposes future sector-specific action plans that set out how each part of the area will be designed and built. Additional detailed design work will be required for identified specific actions, projects and programmes to progress to delivery. For example, a LAEP may identify 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 or design company, along with assessment of commercial viability and delivery mechanisms.

Vision of a LAEP

A LAEP defines a long-term vision for an area but 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. This LAEP sets out the start of Gwynedd's net zero energy transition journey.

Scope of a LAEP

The UK government's 2021 Net Zero Strategy (2) estimates that 82% of the UK's emissions are "within the scope of influence of local authorities".

The scope of a LAEP covers the current and projected future energy consumption and associated greenhouse gas (GHG) emissions, primarily focusing on an area's built environment (all categories of domestic, non-domestic, and industrial buildings), energy used for road transport (excl. energy used in rail, aviation, and shipping), local renewable generation and the energy networks needed to support this consumption. Elements included in a LAEP are:

- Electricity, heat and gas networks
- The future potential for hydrogen
- The built environment (industrial, residential, and commercial), its fabric and systems,
- Flexibility (in terms of shifting when demand is placed on the grid), and the storage and generation of energy,
- Providing energy to decarbonised transport (i.e., the electricity required for electric vehicle charging infrastructure).

Some GHG emissions sources are excluded from scope, because they are either not directly associated with the energy system (e.g. emissions from land, land use and forestry) or are produced from assets that are national (e.g. rail, aviation and shipping). More information on the boundary and scope can be found in Chapter 1: Introduction and the Technical Report (Chapter 1).

It identifies near-term actions and projects, providing stakeholders with a basis for taking forward activity and prioritising investments and action. Site-specific data is used where available, with remaining areas covered by nationally available dataset.

Benefits of a LAEP

The LAEP takes a 'whole systems approach' aligned to the Wellbeing of Future Generations Act (3) "way of working" on integration. This provides consideration to the most cost-effective solutions to future energy system. For example, deploying different heat decarbonisation technologies to avoid a high-cost upgrade of the electricity network.

By working closely with local stakeholders, incorporating their data, knowledge and plans, a LAEP is built on a common evidence base. The outputs can then be used reliably by stakeholders from planners to network operators, to community groups, to businesses and the general public, knowing they are working towards a common goal built on strong foundations.

The energy transition across Wales

Overview

The Welsh Government's Net Zero Wales plan (4) establishes an increased level of ambition on decarbonisation, with a legally binding target to reach net zero emissions by 2050. It is the first national government to fund the roll out of LAEP to all its local authorities. The programme is being co-ordinated through a regional approach, where LAEPs are being developed for local authorities in mid Wales, Southwest Wales, North Wales and the Cardiff Capital Region. The rationale for taking this approach was because there are efficiencies on data collection and management, as well as reinforcing the links between the regional and local plans to maximise opportunities across LA areas and between regions. Several suppliers have been selected to produce the LAEPs for each region, as detailed in the map.

To contribute to the Welsh Government's commitment of producing a "National Energy Plan" in 2024, upon completion of the LAEP programme Energy Systems Catapult (5) will aggregate the LAEPs into a national view. To support this task, they are working with the Welsh Government to create and import standardised LAEP outputs for aggregation into the DataMapWales platform (6). Energy Systems Catapult is also providing technical advisory support to the Welsh Government throughout the programme. The LAEPs will also form the basis of the 'National Energy Plan' Welsh Government has committed to produce in 2024.

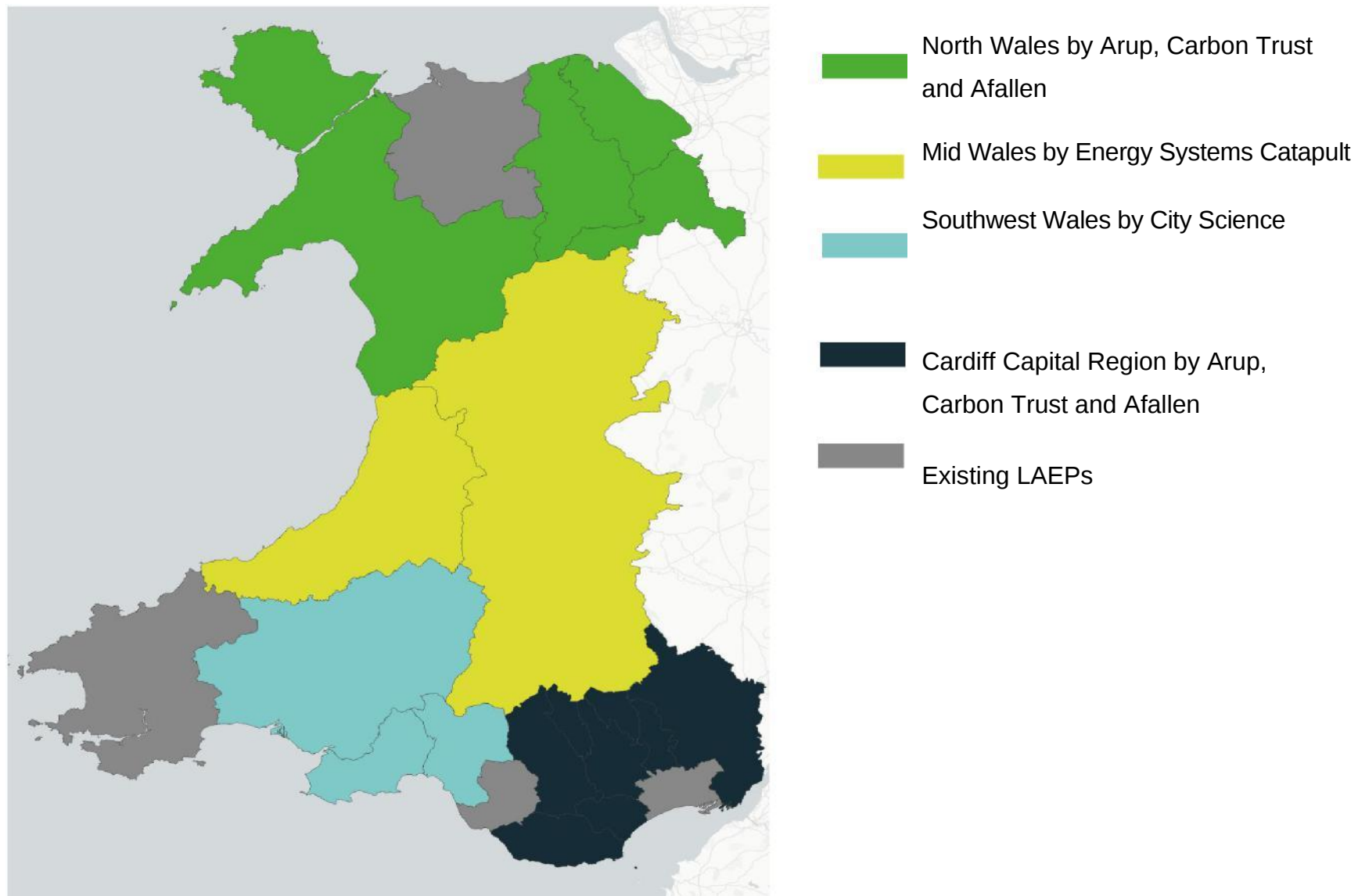


Figure 10. Progress made to date developing LAEP's across Wales

Boundary and Scope

A LAEP considers energy use, supply and generation within the boundary of Gwynedd.

There are three core parts to the local energy system:

- **Infrastructure** – The physical assets associated with the energy system such as electricity substations.
- **Supply** – Generation (renewable and non-renewable), storage and distribution of energy to local consumers for use in homes, businesses, industry and transport.
- **Demand** – The use of energy driven by human activity e.g. petrol/diesel used in vehicles, gas burned for heat in homes.

The whole energy system across all sectors is considered in the planning process to ensure that the interactions and dependencies between generation and use of different energy sources are fully considered. This identifies where different systems can work together to improve the overall resilience and flexibility of the energy system.

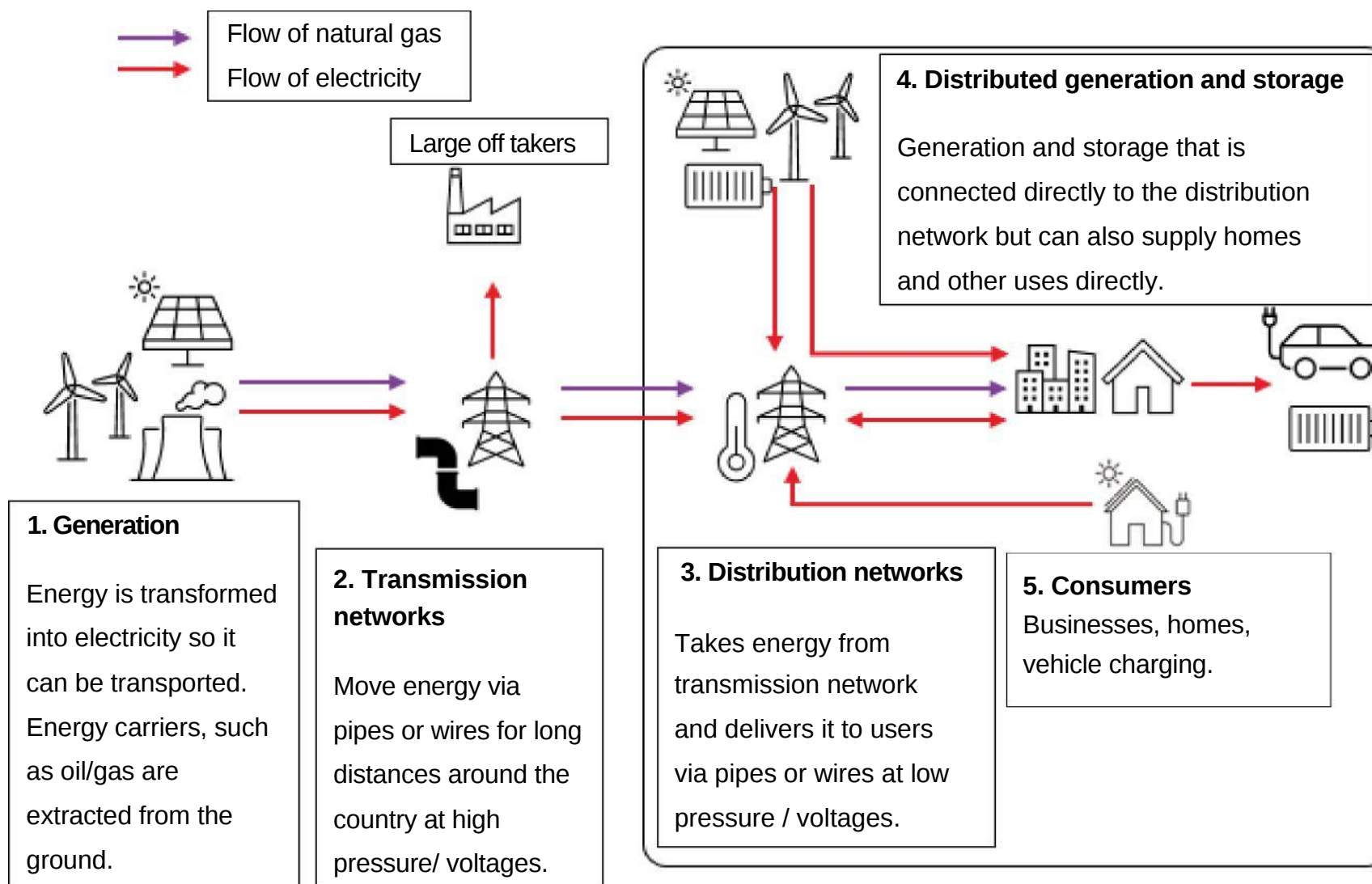


Figure 11. An illustration of the transmission and distribution of gas and electricity from supply to consumer, and what parts of this system are included in the system boundary for LAEP.

Scope for the Welsh LAEPs

The diagram above indicates the parts of the local energy system which are in-scope for the LAEPs across Wales. This scope is defined by ESC's LAEP Guidance (1).

Geographic Boundary

We used the geographic boundary for Cyngor Gwynedd to set the boundary for the LAEP. Figure 12 displays the parts of the local energy system which are in-scope for the LAEPs across Wales. This scope is defined by Energy Systems Catapult's LAEP Guidance (1).

Exclusions from the LAEP

The following parts of the energy system within Gwynedd County are excluded from the LAEP:

- Existing and future energy assets that are likely to be overseen by central government e.g. offshore wind, grid scale batteries, hydrogen SMR
- non-energy sources of greenhouse gas emissions occurring within the Gwynedd (for example, emissions from industrial processes, agricultural land use and livestock are excluded)
- Energy used for shipping, aviation and rail are excluded on the basis that they are not local uses of energy
- Large electricity generators connected to the transmission network and/or more than 100 MW are considered national assets and excluded, for example, Dinorwig Power Station.
- Glyn Rhonwy pumped storage project (100MW) has been included within the deployment modelling process to indicate the importance of tidal power.

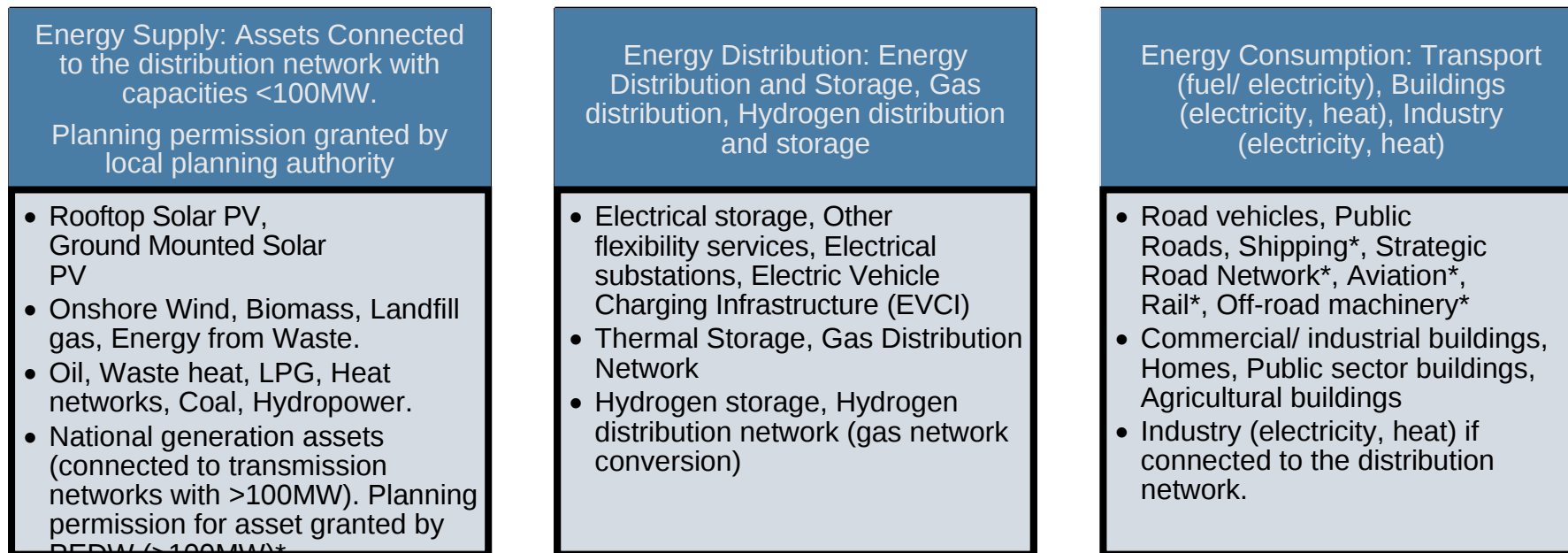


Figure 12. Schematic of the local system scope for LAEP, * indicates those out of scope of LAEP.

Our Vision for Gwynedd's future local energy system

Future energy system vision and objectives

The energy system vision

Cyngor Gwynedd, along with stakeholders from across Gwynedd who have an interest and influence over the local energy system, came together to produce a vision statement that underpins the ambition for Gwynedd's future Net Zero energy system.

Energy Objectives

Accompanying this vision, we have developed specific energy system objectives for our LAEP. These objectives served as foundation elements by which the LAEP will be delivered, which also align closely to Cyngor Gwynedd's broader Council objectives. The proposed actions outlined in Chapter 4 are designed to implement changes that will help achieve these energy objectives.

A vision for Gwynedd

- Develop a local net zero carbon energy system for Gwynedd that encourages the development of affordable and reliable energy sources for the benefit of our local communities, supporting a transition to a prosperous and resilient economy, whilst protecting and enhancing the natural environment.

Energy objectives

- To reduce and encourage efficient use of energy across Gwynedd and provide quality, affordable, accessible and energy efficient homes and buildings.
- To provide a climate resilient energy system capable of meeting future energy demand.
- To maximise reductions in carbon emissions using local renewable energy sources while minimising financial costs.
- To empower the local economy, supporting the creation of high-quality jobs, thriving businesses, while safeguarding and building on the visitor economy.
- To capitalise on opportunities to invest in low carbon energy and engage our communities to support leadership and ownership of renewable energy projects.
- To establish a mechanism with which to deliver local renewable energy to Gwynedd homes at a stable, cost-effective price to the end user

Navigating this report

LAEP contents

This LAEP presents a vision for a net zero local energy system for the whole area of Gwynedd, with a routemap to get there, including a set of recommended actions for Cyngor Gwynedd and key stakeholders, whilst recognising the role of other actors across government, the energy sector, local businesses and the community.

Plan structure

This plan is structured into four main topic areas:

- **The current energy system (Chapter 2)** - description of the existing energy system within Gwynedd, and relevant policies and objectives.
- **The future energy system (Chapter 3)** - presentation of future scenarios for a net zero local energy system, including risks and “low regrets” measures, which are very likely to be part of the future energy system regardless of uncertainty around certain aspects of the future.
- **Actions planning (Chapter 4)** - a routemap and action plan to use to drive the local energy system transition in Gwynedd, including what needs to happen, what we will do and when.
- **Next steps (Chapter 5)** – outlines immediate next steps and what is needed to create an enabling environment for the delivery of this plan, and a net zero local energy system.

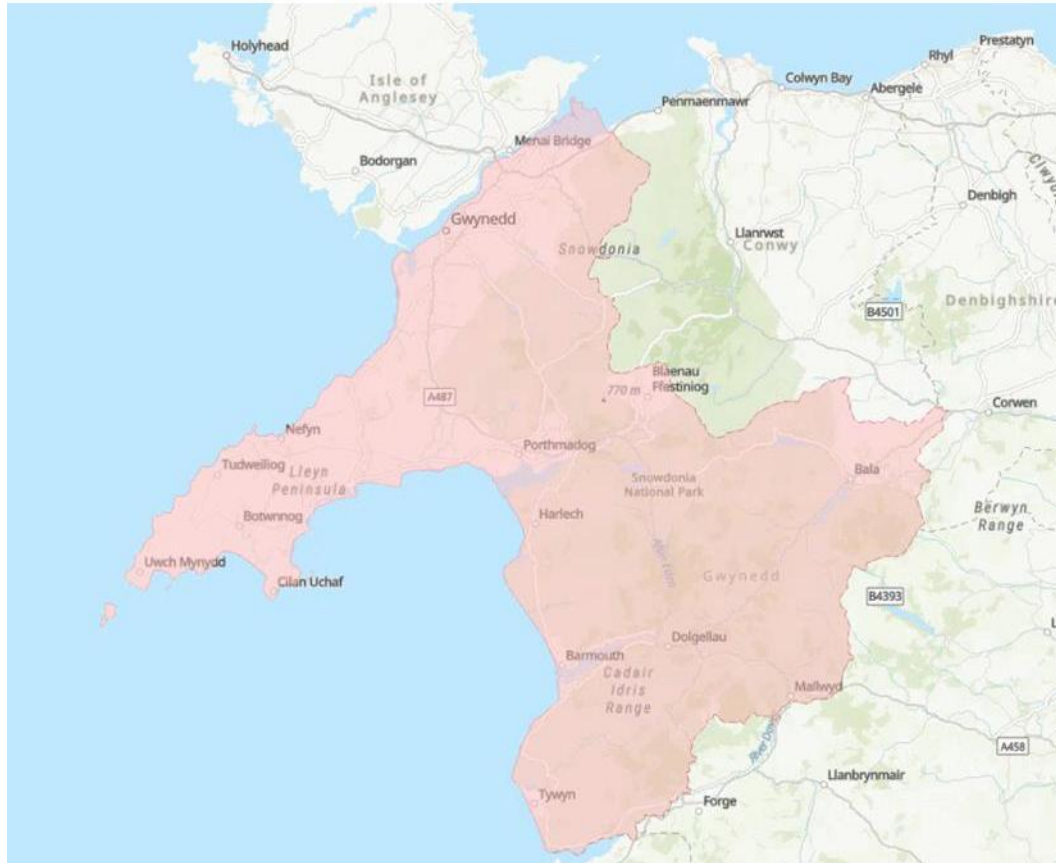


Figure 13. Geographic boundary of the Gwynedd LAEP

2. The current energy system



Figure 14. Eryri National Park, Gwynedd. Photo provided by Ambition North Wales.

Policy and funding context

Net Zero Wales (4) is the Welsh Government's emissions reduction plan for the current carbon budget period between 2021-2025. This is a statutory document required by the Environment (Wales) Act (7), which sets out policies and proposals to help Wales meet its carbon budget and be on track to meet its legally binding net zero target for 2050. The Well-Being of Future Generations (Wales) Act (3) is in place to ensure that this transition fosters greater equality and positive outcomes for all.

The Welsh Government's devolved powers vary across different parts of the local energy system, which means that policies and strategies at Welsh and UK level will influence how Wales transitions to a net zero energy system in the next 25-30 years. It is imperative that the LAEP is regularly reviewed and adapted to this dynamic landscape.

We recognise that policy is one of our key levers for supporting the transition to net zero. So, using our own statutory powers, we, as a Local Authority, have also established plans and policies relating to decarbonising energy use across our own operations, and have started to look further to how we influence changes in our local communities through our place-making role.

Figure 15 summarises some key local, regional and national, and UK wide policies and strategies that will influence this LAEP.

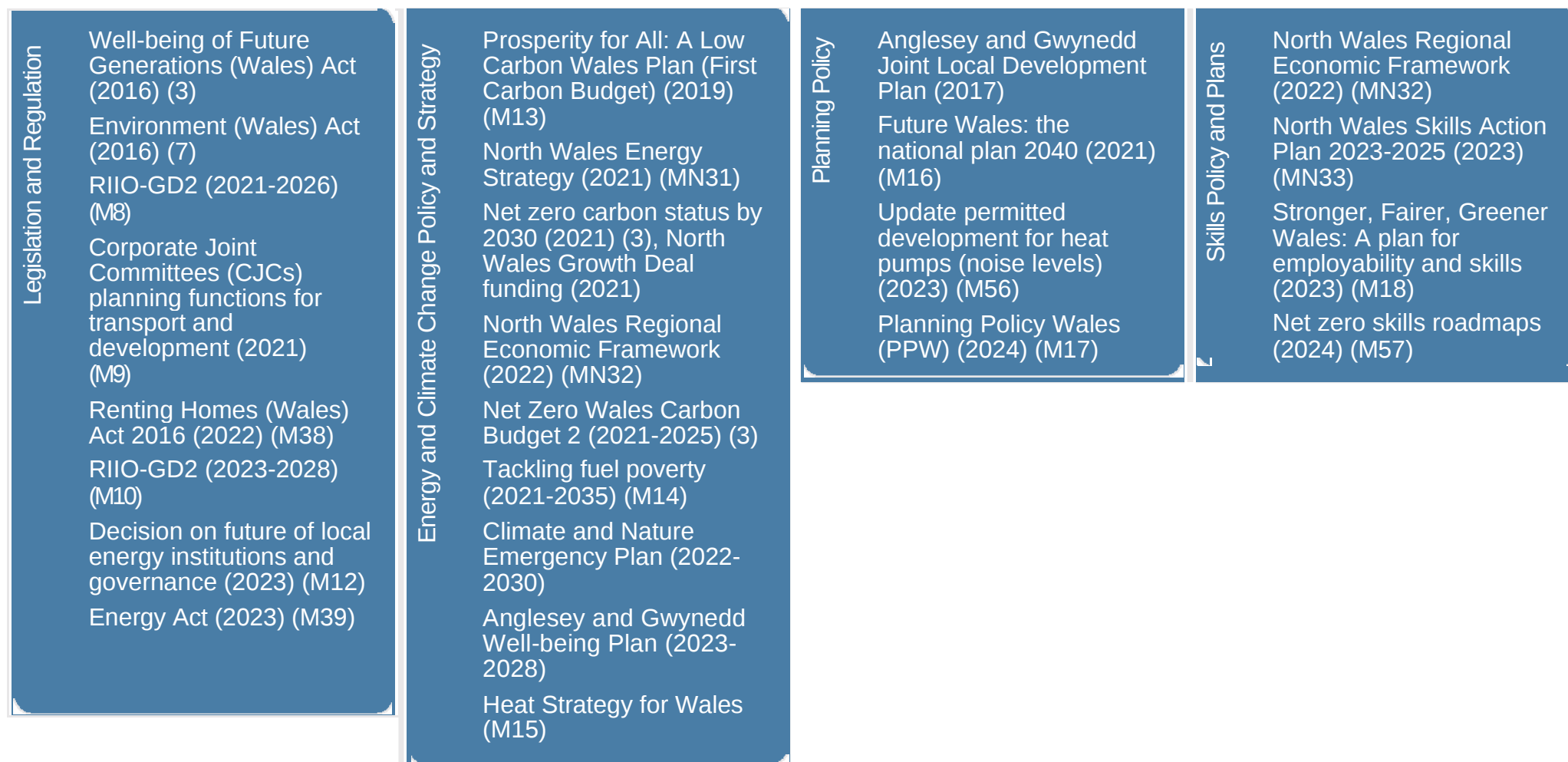


Figure 15. Summary of key cross-cutting regulation/ policies at local, regional and national level. (4) (3) (7) (8) (9) (10) (11) (12) (13) (14) (15) (16) (17) (18) (19) (20) (21) (22) (23) (24) (25)

Buildings regulation and policy	Transport strategy and policy	Renewable energy strategy and policy	Industry and Hydrogen strategy and funding
• Gwynedd Council Carbon Management Plan (2015)³ • Cyngor Gwynedd Housing Strategy (2019-2024)³ • Cyngor Gwynedd Housing Action Plan (2020/21-2026/27)³ • Update to min. energy performance requirements in Building Regulations (Part L) (2022)**(M19) • Update to Welsh Housing Quality Standard 2023** (M20) • Low carbon heat grant (£20 million) (2023)** (M37) • Bioler upgrade grant increased to £7500 (2023)*(M30) • Clean Heat Market Mechanism (2024)**(M21)	• Active Travel (Wales) Act (2013)** (M22) • Electric Vehicle Charging Strategy and Action Plan (2021)** (M23) • Llwybr Newydd: Wales Transport Strategy to 2040 (2021)**(M24) • National Transport Delivery Plan 2022-2027 (2021)**(M25) • Gwynedd Active Travel Network Map (2023)³ • Gwynedd Green Fleet Plan (2023-2029)³ • Regional Transport Plan (2025)α (MN35) • Strategic Development Plan (TBC)α (MN34)	• Contracts for difference (2023)* (M27) • Refresh of Renewable energy targets (2023)**(M26) • Meet the equivalent of 100% of electricity needs from renewable sources by 2035** • 1.5GW of renewable capacity to be locally owned (exc. Heat pumps)** • 580000 heat pumps to be installed by 2035 (subject to UKG support and technology cost reductions)**	• Hydrogen strategy (2021)* (M28) • Net zero hydrogen fund (£240 million)* (M29) • Regional Economic and Industrial Plan α (MN36)

Figure 16. Summary of sector-specific regulation/ policy at local national and regional level progressing from least recent in 2012 (top) to most recent in 2023 and in future (bottom). Regulations are either on a UK*, National**, Regional(α) or Local Level(β) (26) (27) (28) (29) (30) (31) (32) (33) (34) (35) (36) (37) (38) (39) (40) (41)

Our collaborative approach to developing and delivering our LAEP

Stakeholder engagement approach

Delivering our LAEP calls for a collective effort from all types of organisations in and beyond the local authority boundary. The local energy system extends beyond Cyngor Gwynedd's influence which is why stakeholder engagement is the foundation for the development of our LAEP.

With the support of our delivery partners, we prioritised stakeholders based on their level of local knowledge of and / or influence over specific elements of the local energy system and their role in the development of the LAEP. The importance of recognising the involvement of regional stakeholders such as housing authorities and regional skills providers emerged early in the development of the LAEP. They have a unique role, ensuring cohesion of action for specific element(s) of the energy system across neighbouring LAEPs in the same region and offering regional efficiencies where local objectives are aligned.

We engaged stakeholders at different stages of the development process to make sure stakeholders could help shape the plan and key development milestones. We held regional steering groups for North Wales, attended by the regional and local authority leads, as well as bi-weekly meetings with the local authority leads. Two workshops were held regionally and involved primary stakeholders from across each local authority in North Wales. These workshops were used at stages where it was important to agree a way forwards that was appropriate for the region, as well as each local authority.

As part of the overarching programme, a national forum brought together all suppliers, local authority leads, the regional leads, Welsh Government and the Technical Advisor to share learnings and maintain a consistent approach across Wales. The suppliers and regional leads also had regular catch ups to share assumptions and challenges. This report is accompanied by a Technical Report which includes more detailed information on the analysis methodology and engagement of stakeholders throughout the plan's development.

Sector	Examples of stakeholders engaged
Buildings	Housing developers
Transport	Transport providers
Renewable energy generation	Energy project developers, community energy groups, landowners
Industry and private sector	Local businesses, larger industrial players
Community engagement	Charities, social enterprise,
Networks	Distribution Network Operators, gas distribution networks
Public sector	Public services board, public service providers, Welsh Government, educational institutions

Figure 17. Summary of stakeholder engagement and key statistics

22 organisations engaged

7 workshops organised – 74 stakeholders attended at least one workshop.

At least 185 hours of engagement with stakeholder's based on a 2.5 hour workshop

Gwynedd's energy baseline

Overview



Figure 18. Trefor, Gwynedd. Photo provided by Ambition North Wales

This section provides a detailed overview of the local energy system baseline, and describes the methodology and assumptions used to understand current energy infrastructure, what types of energy are used, what technologies are used to convert it from one form to another (e.g. heat) and how much is consumed.

The baseline presented is for 2023, the most recent and representative of the current energy system, but the availability of data for this year varied across sectors. Buildings data reflects energy consumption in 2023 but transport and industry data for North Wales uses data representative of activities in 2019. This has minimal impact on the results because transport and industry datasets are the least likely to be impacted by grid electrification between 2019-2023 and are likely to remain consistent. Transport energy demand will have been impacted by COVID-19, so 2019 is the most representative dataset for the energy system in 2023.

Some of the data collected that has locational characteristics is reported by “modelling zone”. Figure 19 shows the geographic boundary of Gwynedd (purple) which is also the boundary used for this LAEP. The primary substation service areas that supply energy within the geographic boundary are shown in red. Where primary substation service areas intersected one or more Local Authority boundaries, they were divided into smaller modelling zones. Most of the analysis, results, and maps in this report are presented in terms of these smaller modelling zones, which may also be called “substation zones” or simply “zones.”

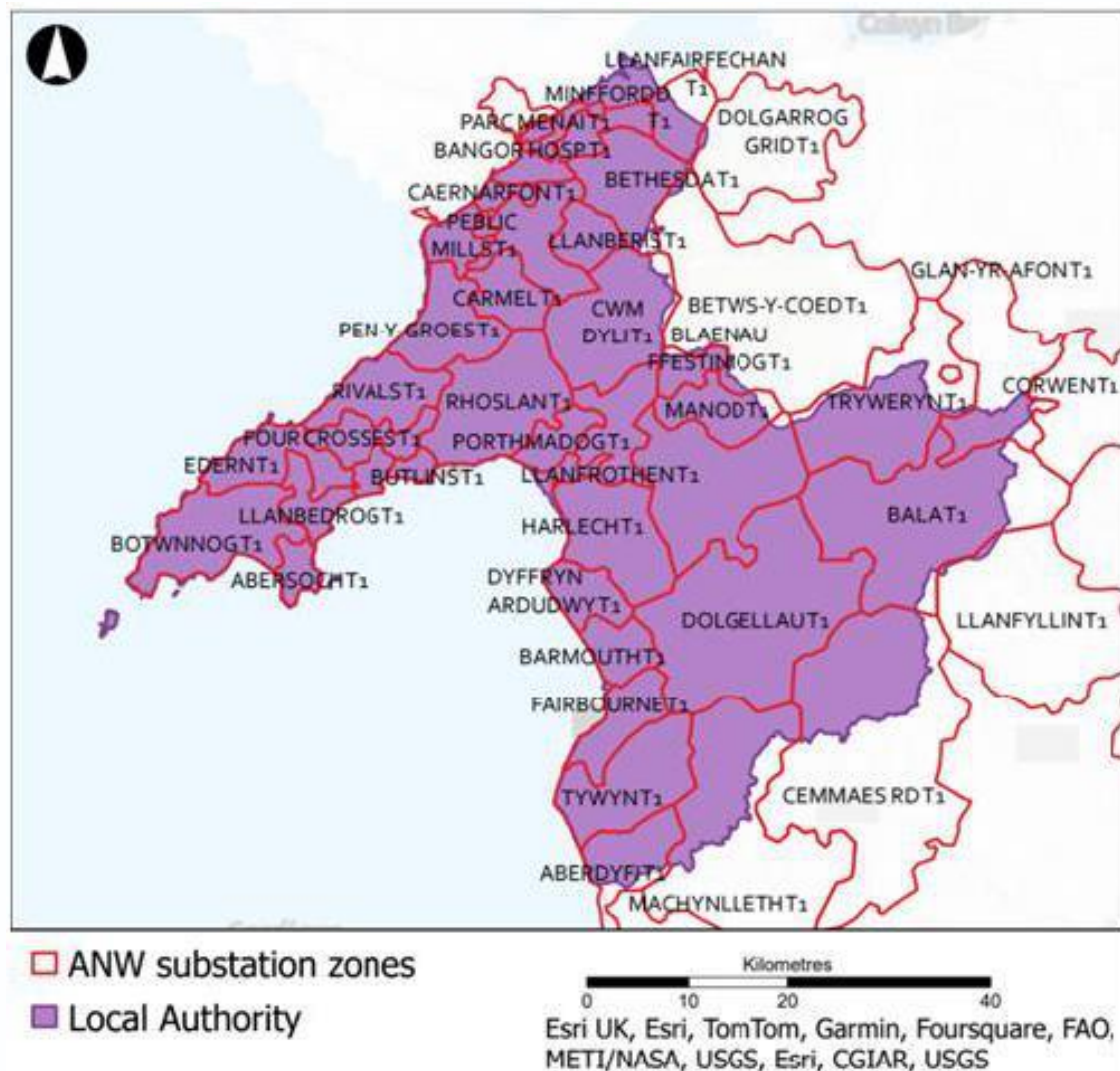


Figure 19. Geographic boundary of the Gwynedd used to define the boundary for this LAEP (purple) and the associated modelling zones within the LAEP boundary (red).

How to read a Sankey diagram

Sankey diagrams are a way of visualising energy transfer from energy sources to energy demands via different forms of energy (e.g. electricity, heat), and the technologies used to convert it from one form to another for different uses (e.g. gas boiler converts natural gas to heat energy through combustion). They are read from left to right and show a snapshot of the energy transfers in time e.g., 2050. Energy transfers are drawn to scale and so are helpful to identify the size of each transfer for comparison. Energy transfers are drawn to scale which helps to compare the relative amounts of energy across different energy transfers.

The Sankey diagram presents energy transfers in units of GWh per year.

For comparison:

- The average Welsh home uses 3.325 MWh/year of electricity, which is 0.003 GWh for comparison with the scale on the Sankey. In terms of gas, a typical home uses 12 MWh/year, which is 0.012GWh for comparison with scale on the Sankey (42).

The Sankey diagram is designed to be read from left to right. The left represents the different energy supply sources including generation technologies and imports from the national grid. The center represents how the energy is being converted, i.e boiler, electricity etc. The right indicates the energy demand and storage for each energy vector, heat demand, electricity demand, transport demand.

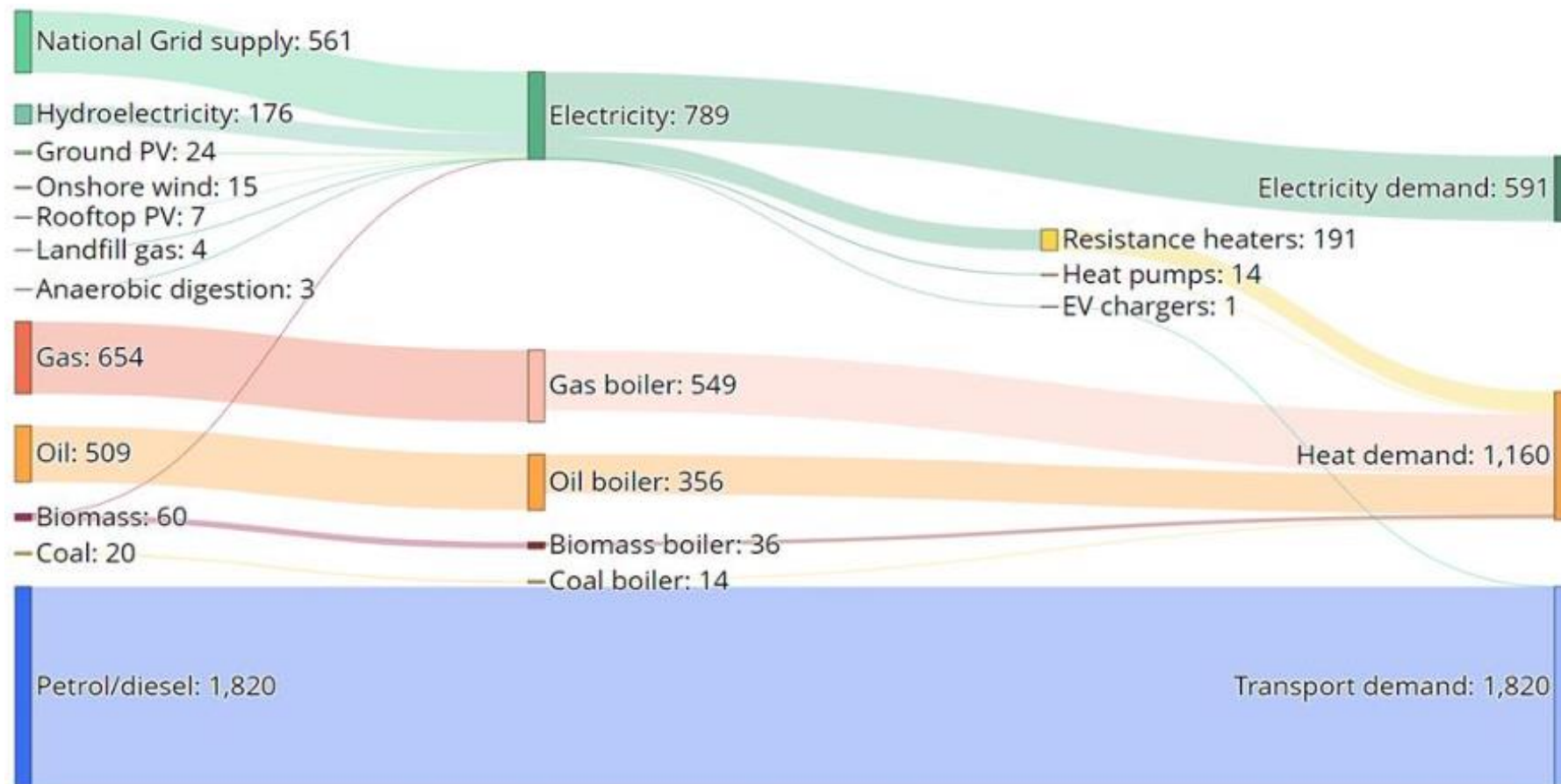


Figure 20. How to read a Sankey diagram (using the baseline Sankey for Gwynedd - units are GWh/year).

Energy Demand Across Gwynedd

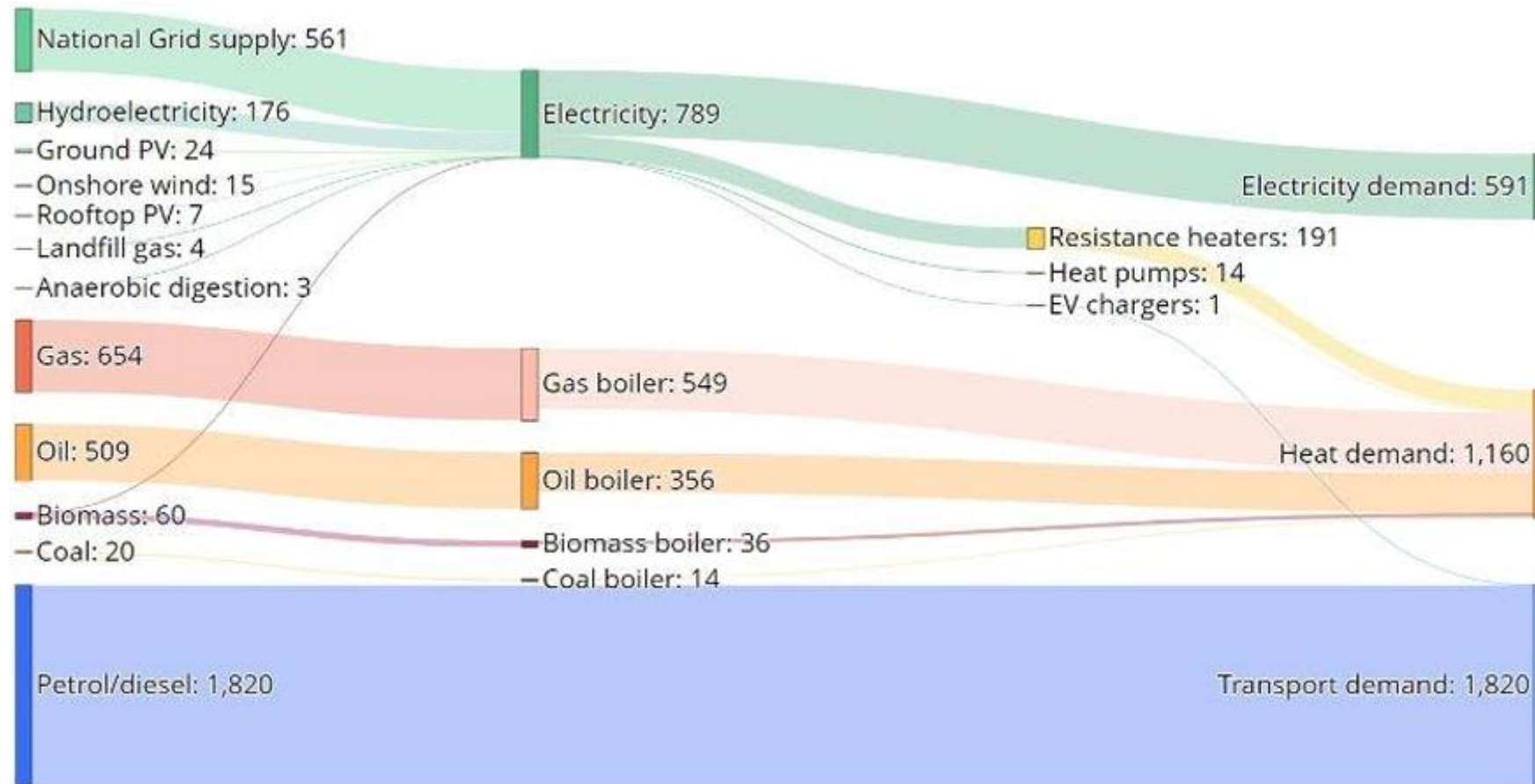


Figure 21. Sankey Diagram showing energy input, energy conversion and energy demand and storage/output for Gwynedd in GWh/year (2023).

Electricity

- 17% of total energy demand
- 29% of electricity is from renewable sources
- As of 2019, Gwynedd had over 100 MW of installed capacity of renewable energy
- Hydropower is the largest renewable energy source across the County

Industry

- Data taken from the NAEI Point Source database (DESNZ – formally BEIS) identifies no ‘major industrial loads’, found that industry required 0% of total energy demand
- Key industries across Gwynedd are agriculture and tourism as the key economic sectors. There is limited heavy industry across Gwynedd

Transport

- Transport accounts for 51% of the total energy demand
- Dominant fuel types for vehicles are petrol or diesel
- Of households within Gwynedd, 82% own a car and 0.25% of vehicles are electric or hybrid. (43)
- Currently 29 EV chargers are listed on the National ChargePoint Registry (2023 data) (44)

Heat

- Heat accounts for 32% of total energy demand
- The main source of demand is heat in buildings
- The main domestic building archetype are semi-detached or detached homes accounting for 47% overall
- 31% of homes have less than 100mm of loft insulation

Buildings and Industry Energy Demand (MWh per year)

Buildings

Building Archetypes

- 64500 domestic buildings
- 7600 non-domestic buildings

EPC Ratings

On average, properties across Gwynedd exhibit below average EPC ratings (only 24% of properties achieving A-C EPC rating compared with Wales-wide (40%)). This is the third lowest proportion of energy efficient homes across England and Wales, partially due to the age of building stock

Insulation

On average, properties here exhibit below average levels of insulation (e.g 31% of homes have less than 100mm of loft insulation).

Major Industrial Loads

Building Heat Energy Demands

The areas of greatest baseline heat demand (for buildings) align with more heavily populated areas, where gas boilers are the predominant heating type. Around half (50%) of properties are connected to the gas grid (heated using gas boilers), with demand also being met by oil/LPG (23%) electric heaters (7%). The remaining homes are heated by biomass and solid fuels (including coal).

Industrial History of Gwynedd

Historically, the slate industry was the most important industry in Gwynedd. Today, Gwynedd is not heavily industrialised, but some parts are more commercialised than others

Major Industrial Loads

No major industrial loads were identified across Gwynedd

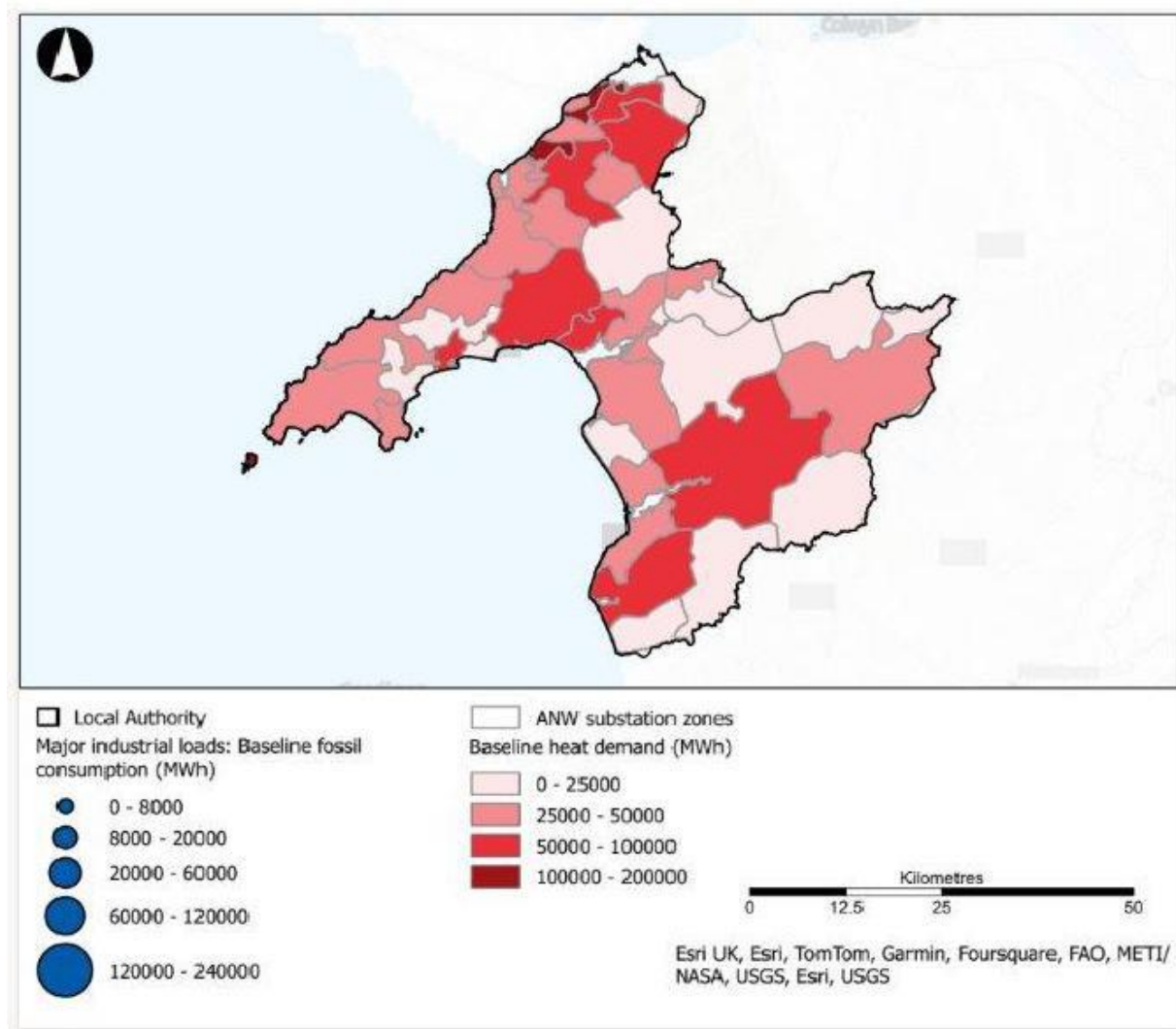


Figure 22. Major industrial loads (2019) and heat demand (2023) by substation zone across Gwynedd. The data is based on meter level gas consumption (MWh/ year).

Electricity Demand In Buildings (MWh per year)

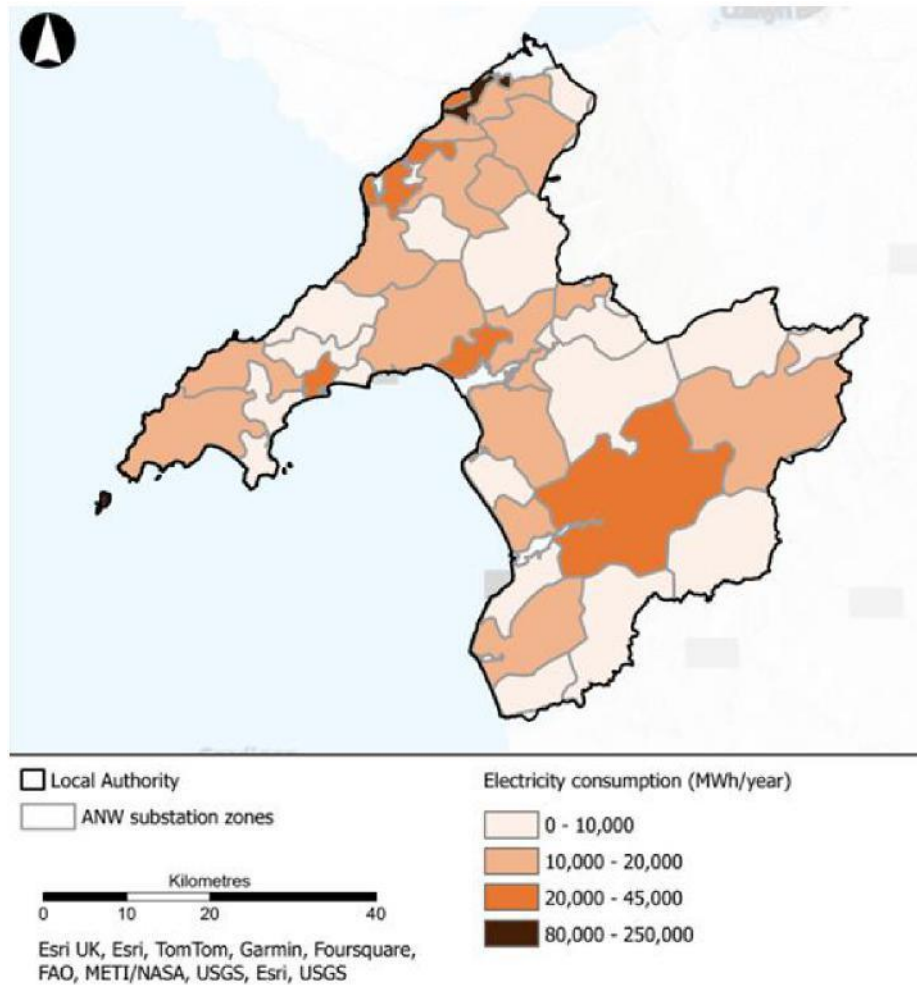


Figure 23. Electricity consumption (MWh/year) (domestic and non-domestic properties) by substation zone across Gwynedd (2023). Data is based on meter level electricity consumption data.

Electricity Trends

Electricity consumption (total domestic and non-domestic) varies across the country. Areas of lower electricity energy consumption are around Bangor, in the north of the country. Areas of higher energy consumption tend to be located around the more rural areas of coastline and in the south of the county (possibly due to an increased number of buildings being off the gas grid, resulting in increased consumption of electricity for heating).

Transport Energy Demand (kWh per year)

Transport trends show transport related energy consumption varies across the county. Areas of higher energy consumption tend to align with the main thoroughfares of the A5, A55, A587 and A470 as well as rural areas, where car usage is increased due to limited public transport options. Areas of lowest energy consumption tend to be in and around main towns such as Bangor in the north, Porthmadog in the west, likely due to better public transport connections and active travel routes through key towns. Areas that are more rural in nature, along the coastline and the Llŷn Peninsula where there are fewer roads, also display low energy consumption

- Bus: An integrated network of longer distance and local bus services offer opportunities for travel within and beyond the county. Strategic routes between main hubs, including Bangor, Caernarfon, Pwllheli, Porthmadog, Blaenau Ffestiniog, Dolgellau and Bala are well served by the TrawsCymru and local bus networks. This includes the Sherpa'r Wyddfa services, an established fflecsi service on Pen Llŷn along with two new fflecsi services operating in the Dyffryn Dulas and Dolgellau areas
- Currently 29 EV chargers are listed on the National Chargepoint Registry (2023 data) (44)
- Currently 79% of homes own 1 car. (43)

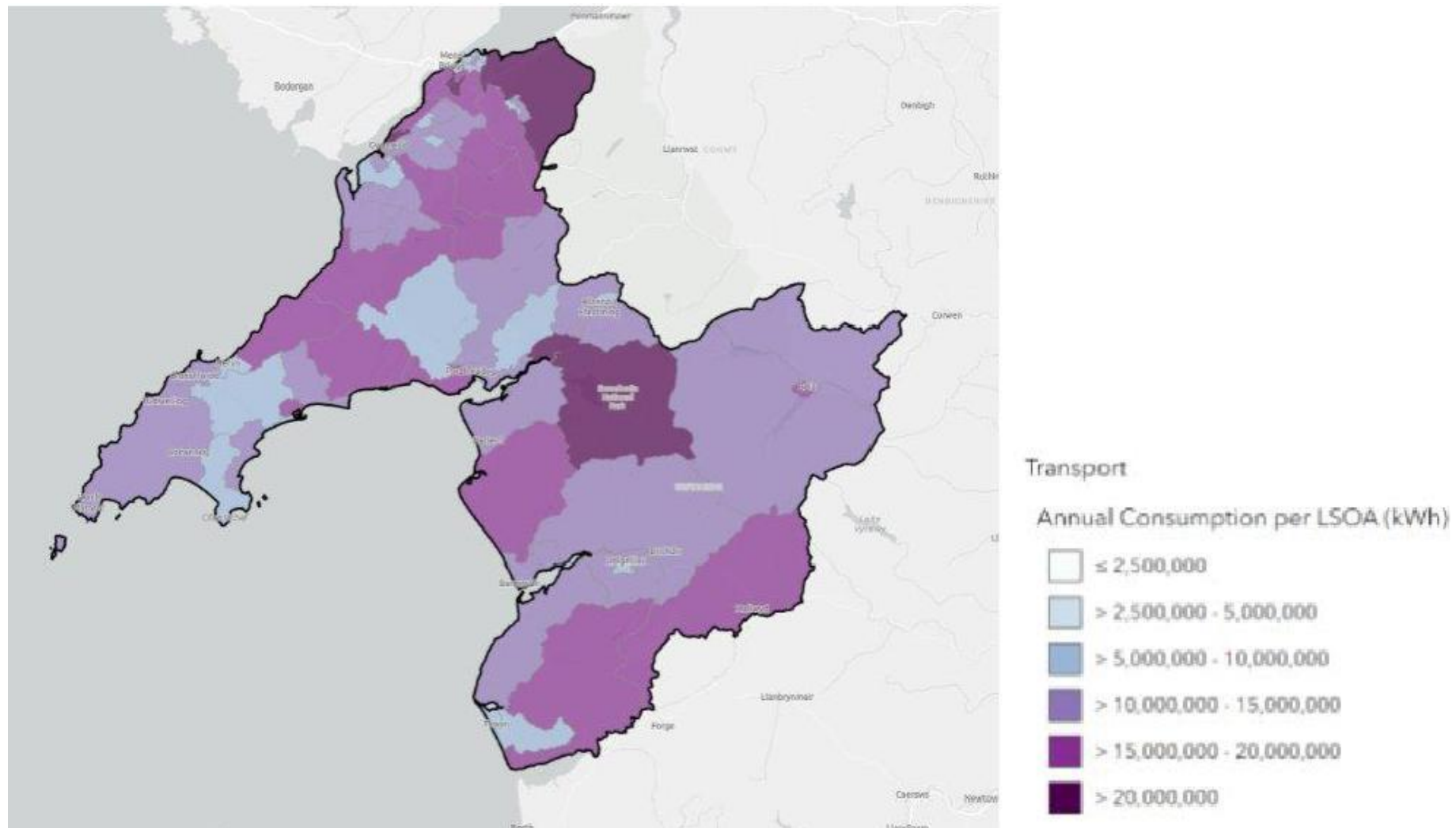


Figure 24. Transport energy consumption (combined total across cars, light goods vehicles (LGV) and heavy goods vehicles (HGV) by LSOA in 2019 (units in kWh/year)

Energy Generation (MW) and Rooftop Solar PV Capacity (MW) (2023)

Electricity Generation

Total local renewable capacity:

There is 100 MW of renewable electricity generation capacity in Gwynedd, across a number of different generating technologies (compared to a total of 3,505 MW in Wales in 2021) (45)

Largest local renewable contributor:

Hydroelectricity is the largest source of local electricity generation with a capacity of (55 MW). The largest local source of hydroelectricity is Maentwrog power station in Blaenau Ffestiniog

Solar PV:

29.8 MW of ground-mounted solar PV and 9 MW of rooftop solar PV across the county

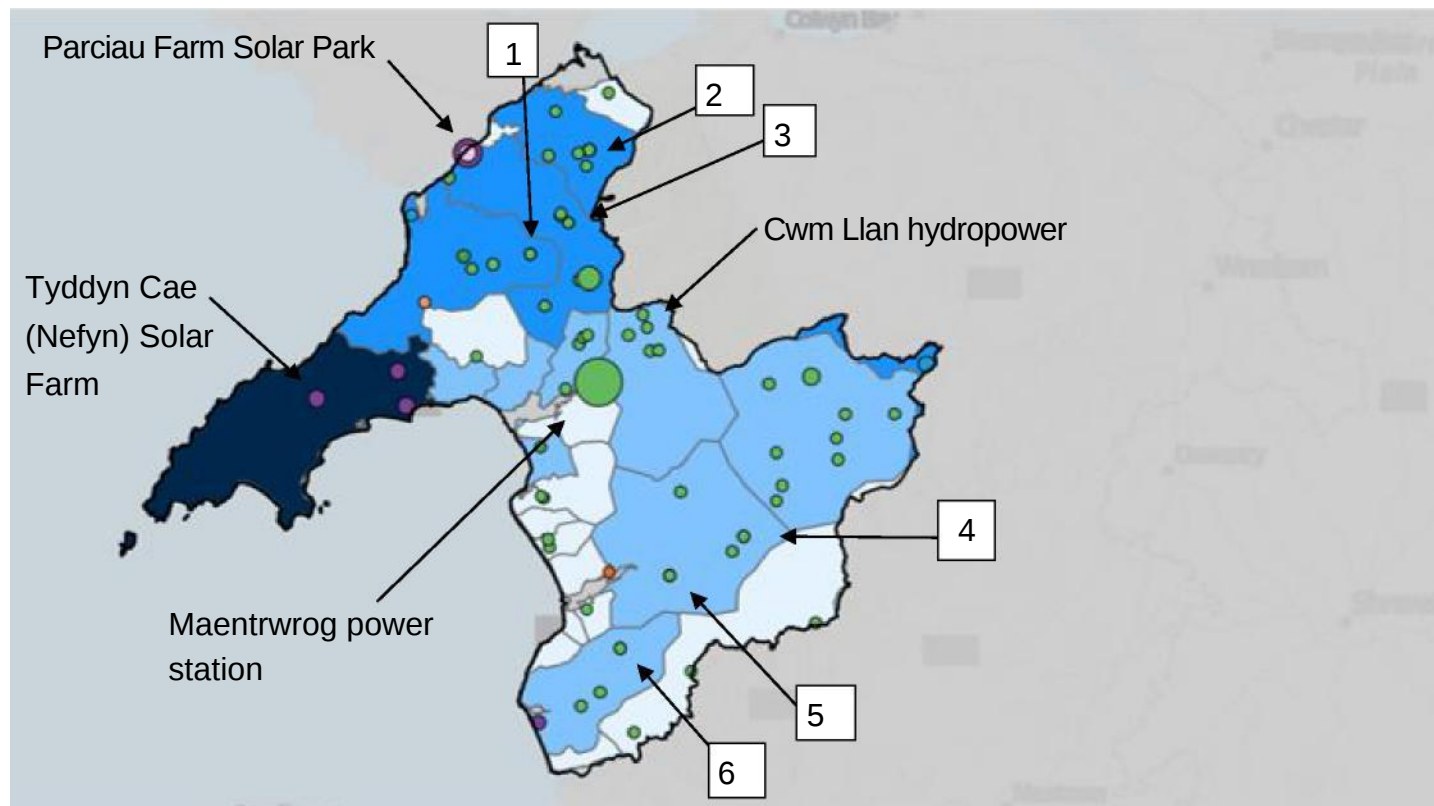
Onshore Wind Power

4.4 MW of onshore wind

Heat Generation

Land fill gas: 1MW

Gas and oil (fossil fuels): 5% of the electricity generation capacity is from locally generated fossil fuel sources (oil and gas)



Baseline Local Generation Technology

- Anaerobic Digestion
- Biomass
- Energy from Waste
- Fossil (Gas)
- Fossil (Oil)
- Hydropower
- Landfill Gas
- Onshore Wind
- Sewage gas

Baseline Local Generation Existing Capacity (MW)

- 1
- 5
- 10
- 50
- 100

Roof PV by district

Baseline rooftop PV (MW) by outward code

- 0 - 0.2
- 0.2 - 0.8
- 0.8 - 1.6
- 1.6 - 2.5
- 2.5 - 4.0

Esri UK, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS, Esri, USGS



Figure 25. Local energy generators and their respective capacities (MW) and domestic and non-domestic rooftop solar PV (MW) by outward code (2023). Data is based on Energy generation Wales (2021) and Renewable Energy generation database (2023) (units in MW). The numbers indicate overlapping hydropower sites: 1) Clogwyn Y Gwin Hydro (0.08 MW) and Treweunydd (0.45 MW), 2) Gerlan Hydro Ltd (1.07 MW) and Caseg Hydro (0.50 MW), 3) Afon Gennog (0.10 MW) and Afon Las Hydro (0.10 MW), 4) Harnog (0.36 MW) and Wern Gawr Hydro (0.10 MW), 5) Ganllwydd Hydro Power Station (0.64 MW), Afon Ty-Cerig Hydro (0.20 MW), and Cwm Mynach (0.19 MW), 6) Cadair Hydro (0.38 MW) and Llechen (0.09 MW). Assets over 100 MW are not in scope of this LAEP because these are considered national assets.

Networks and Infrastructure

Electricity generation and demand headroom in a local authority's electricity distribution network refers to the remaining primary substation capacity at the time of peak generation or demand, crucial for maintaining a stable and reliable power supply to meet the community's needs. The generation headroom is the amount of generation available on the network without needing reinforcement and the demand headroom is the gap between the capacity of the electricity network to supply the electrical demand and the actual demand.

- Electricity supply headroom: Presently, Gwynedd faces challenges due to existing grid limitations, which often lead to delays in new connections and substantial associated expenses. These constraints impact the ability to develop new energy sources and infrastructure, highlighting the need for grid upgrades and enhancements.
- Electricity demand headroom: Demand headroom in Gwynedd varies across the region, from near zero to 8MW per LSOA. Demand headroom follows a similar pattern to supply headroom, with relatively high demand and generation headroom around Eryri National Park and the northeast of the county.

Electricity Supply Headroom

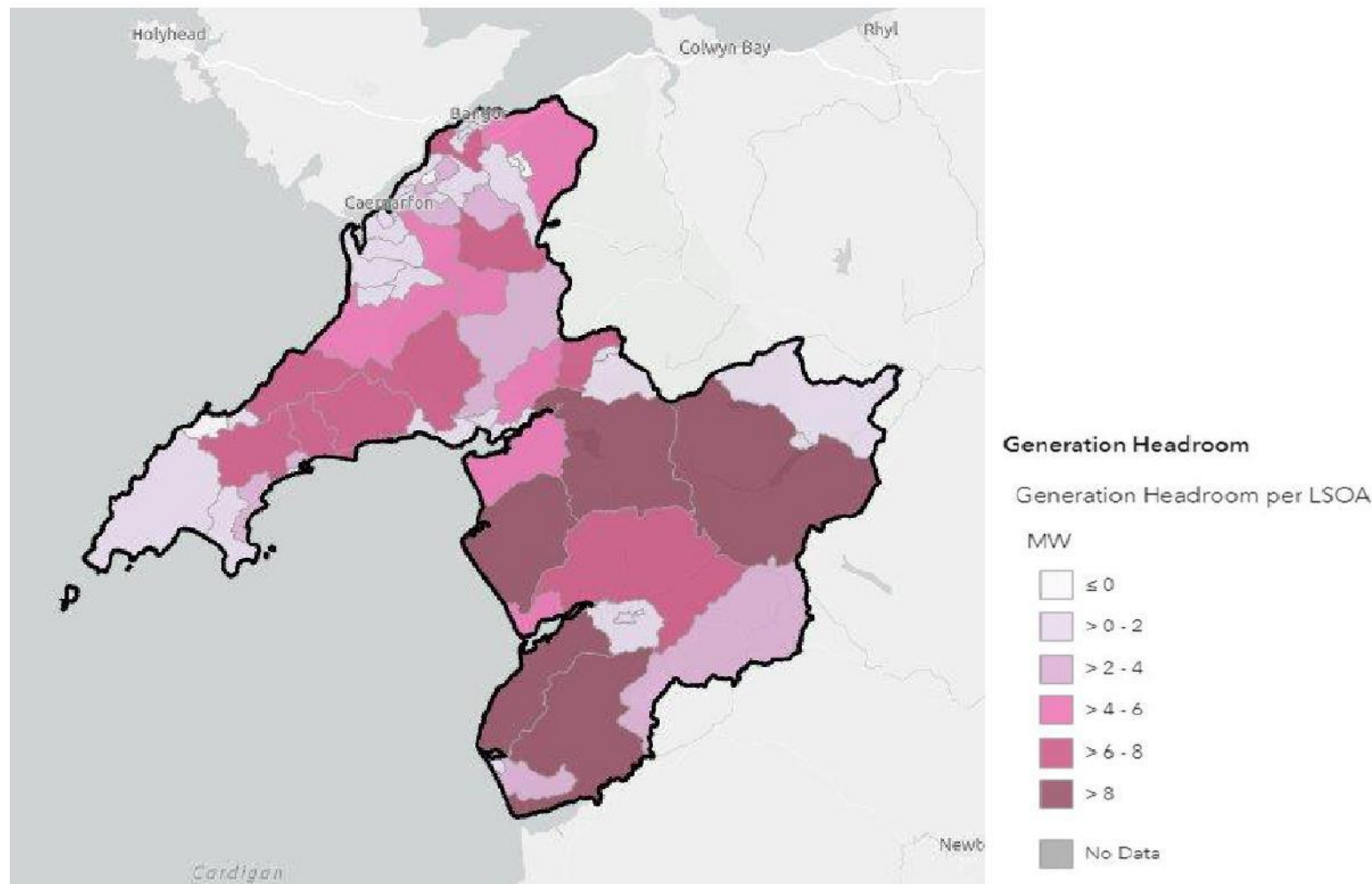


Figure 26. Electricity generation headroom (MW) by LSOA (2023)

Electricity Demand Headroom

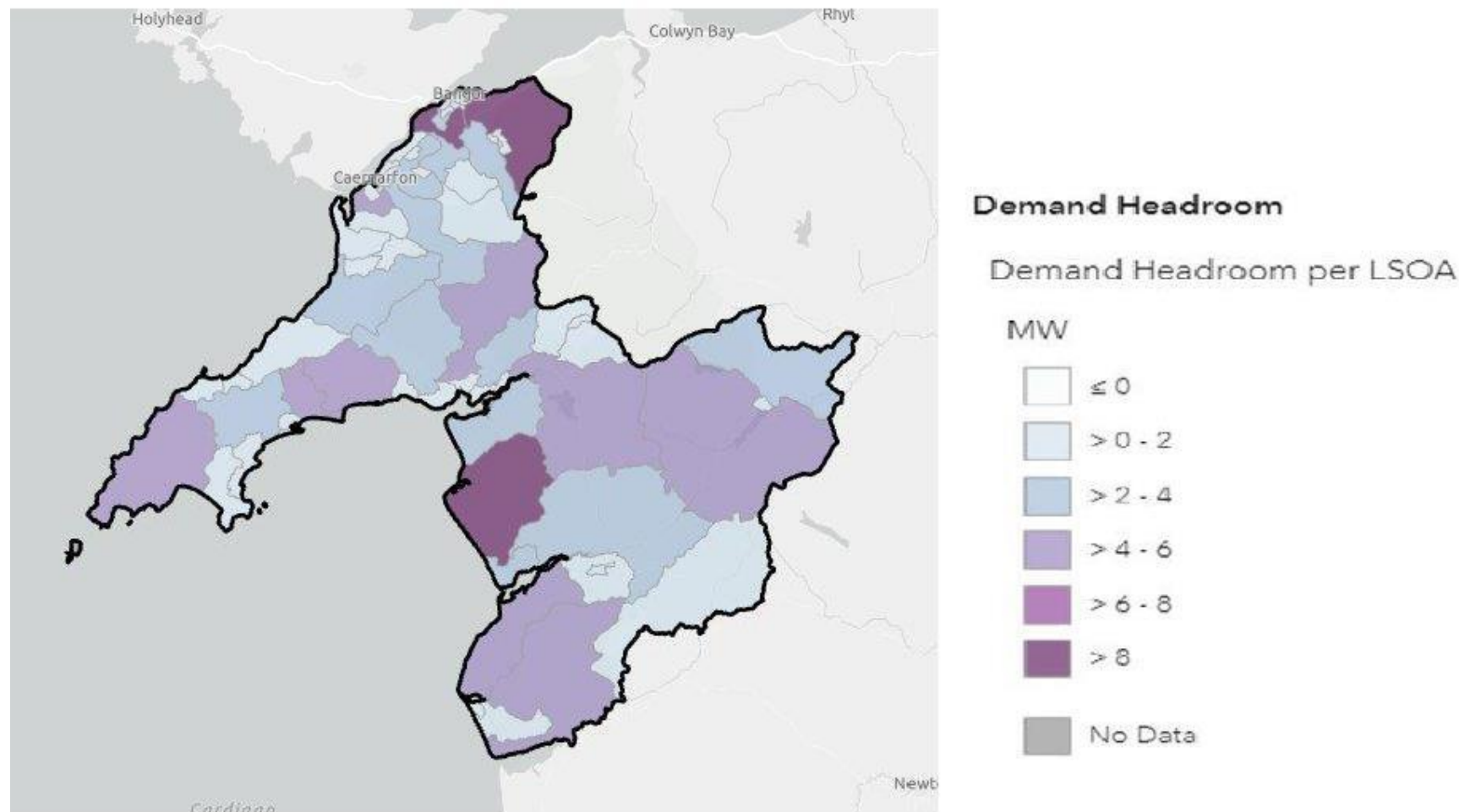


Figure 27. Electricity demand headroom (MW) by LSOA (2023)

Off Gas Grid Properties

Gas connections:

Half of all properties are not connected to the gas network. This is most prominent around Llanbedr to the west, the Llŷn Peninsula and the east of the county around Eryi National Park.

- 50% of properties use natural gas for heating
- 24% of properties use oil or LPG for heating
- 13% of properties use direct electric for heating
- Circa 3% of properties use wood burners for heating. During workshops, a number of stakeholders raised questions about domestic wood fuel consumption (including logs for domestic firewood) for use in closed stoves (wood burners) and open fires. There is limited regional data available on the wood fuel market, including the use of informal 'grey' wood and limitations around volume to mass conversion factor.
- Remaining properties use air or ground source heat pumps or coal for heating

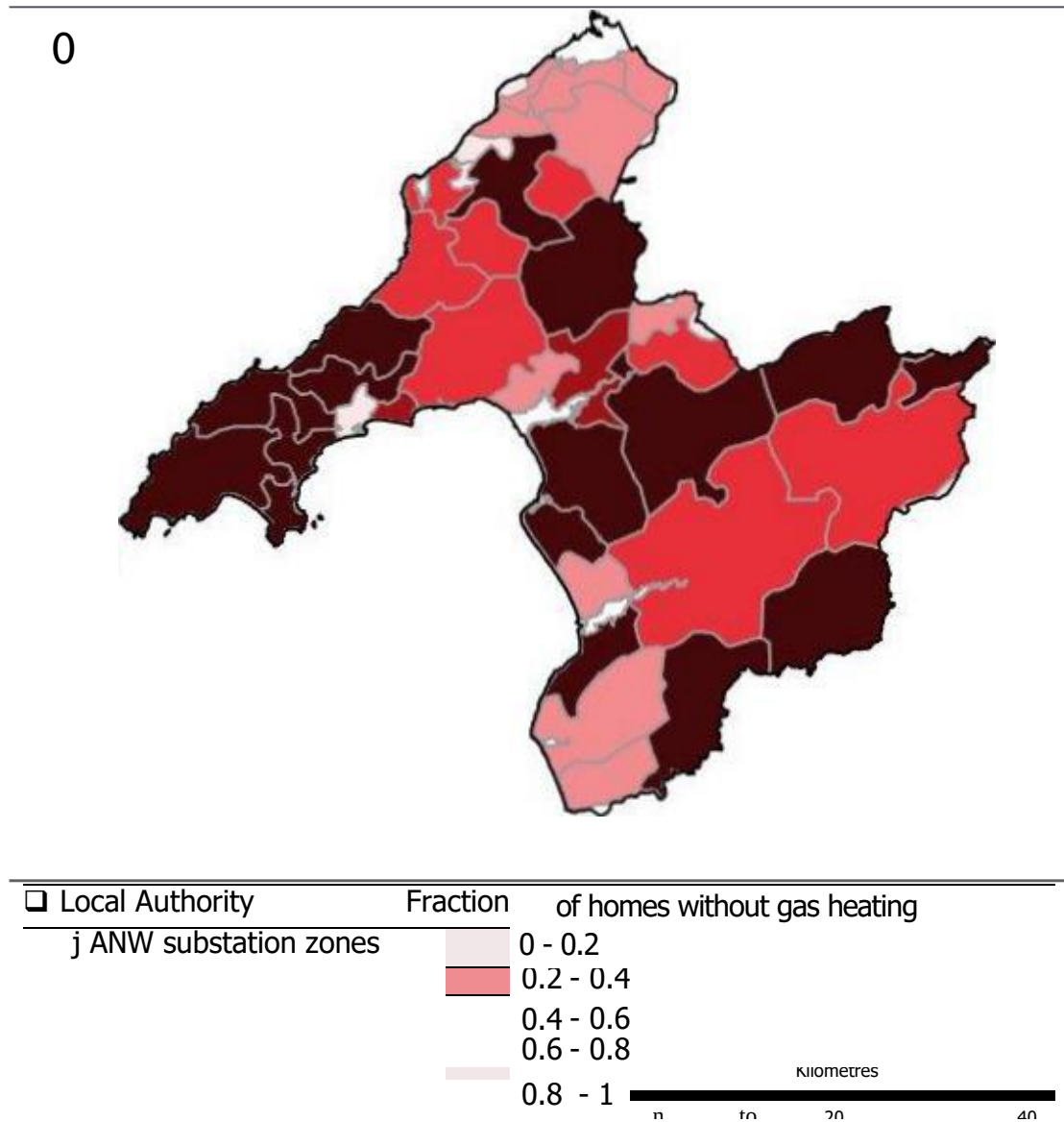


Figure 28. Percentage of properties that are not connected to the gas distribution network (2023)

Local Environmental, Social and Economic Factors that Influence Energy

Area

Total land area

2,540 km² – The second largest county in Wales

Designated investment zones

Snowdonia Enterprise Zone - Cyngor Gwynedd has been working together with Welsh Government to facilitate the development of two of Meirionnydd's key strategic sites – Trawsfynydd Site and Snowdonia Aerospace Centre, Llanbedr

Land characteristics

Predominately rural in nature with a unique natural environment, including high value landscape and biodiversity assets. Across the county, smaller towns are generally located inland, with larger towns such as Bangor, Caernarfon and Pwllheli located along the coast

Designated landscapes

Eryri National Park – 2130km² A living, working area, and is home to over 26,000 people.

Llŷn Area of Outstanding Natural Beauty – 150km²

Demographics

Population density

46 persons per km squared (Wales average: 148.9) – the third least densely populated local authority in Wales (ML12).

Population growth in the last 10 years (2009-2019)

In Gwynedd, the population size decreased by 3.7% from around 122,900 in 2011 to 117,400 in 2021 (ML13).

Socio-economic

Fuel poverty

In 2019, a total of 22% of households across Gwynedd were identified to be in fuel poverty (Wales average: 12%) (ML14)

Communing Patterns

Approximately 89% of residents work in the county, although responses to the Commuting patterns by Wales local authority and measure received limited survey data responses (ML15)

Jobs and main industries

Tourism and agriculture strongly influence Gwynedd's economy. The tourist industry is also a key employer with an economic value of nearly £1 billion

GHG Emissions

5.2 tCO₂ per capita (Wales average: 7tCO₂ per capita) (46)

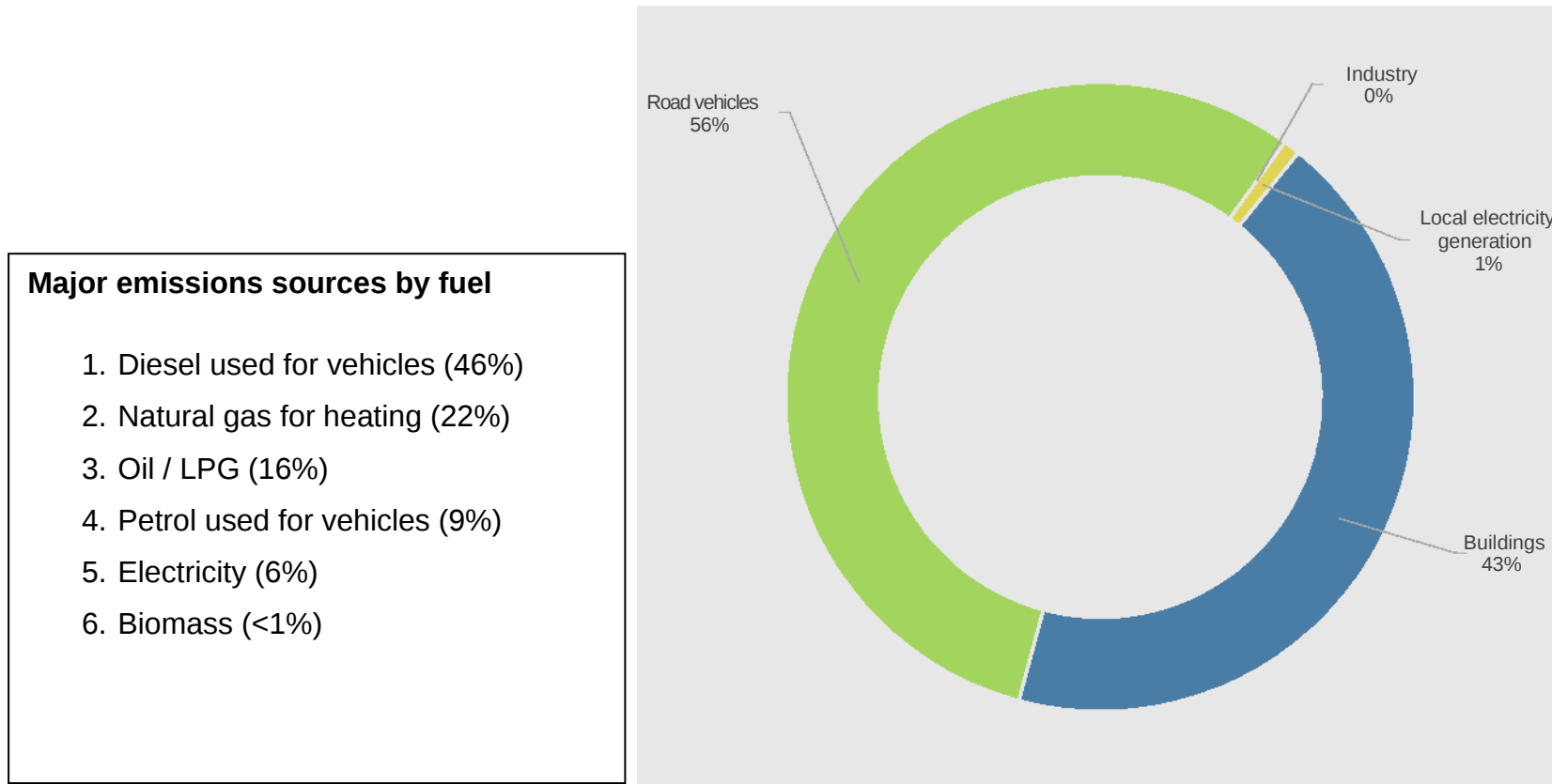


Figure 29. Gwynedd GHG emissions statistics for 2023 [excluding LULUCF – land use, land use change and forestry]

Progress to date

Since declaring a climate and ecological emergency in September 2019, we have been working hard to progress towards the commitments set out in our Climate and Nature Emergency Plan. This Plan represents the first step on the Council's journey to transition to a "net zero carbon" council by 2030 and sets out how we will play our part to achieve Wales's ambition to have a net zero public sector by 2030, and a net zero Wales by 2050. This will involve closing the gap of around 26,800 tCO₂e by a combination of reducing our emissions and increasing our capacity to absorb carbon.

We will continue to work with our staff and partners, including a wider range of individuals and organisations, and communities to put this at the heart of all decision-making. Some important milestones are summarised in Figure 30.

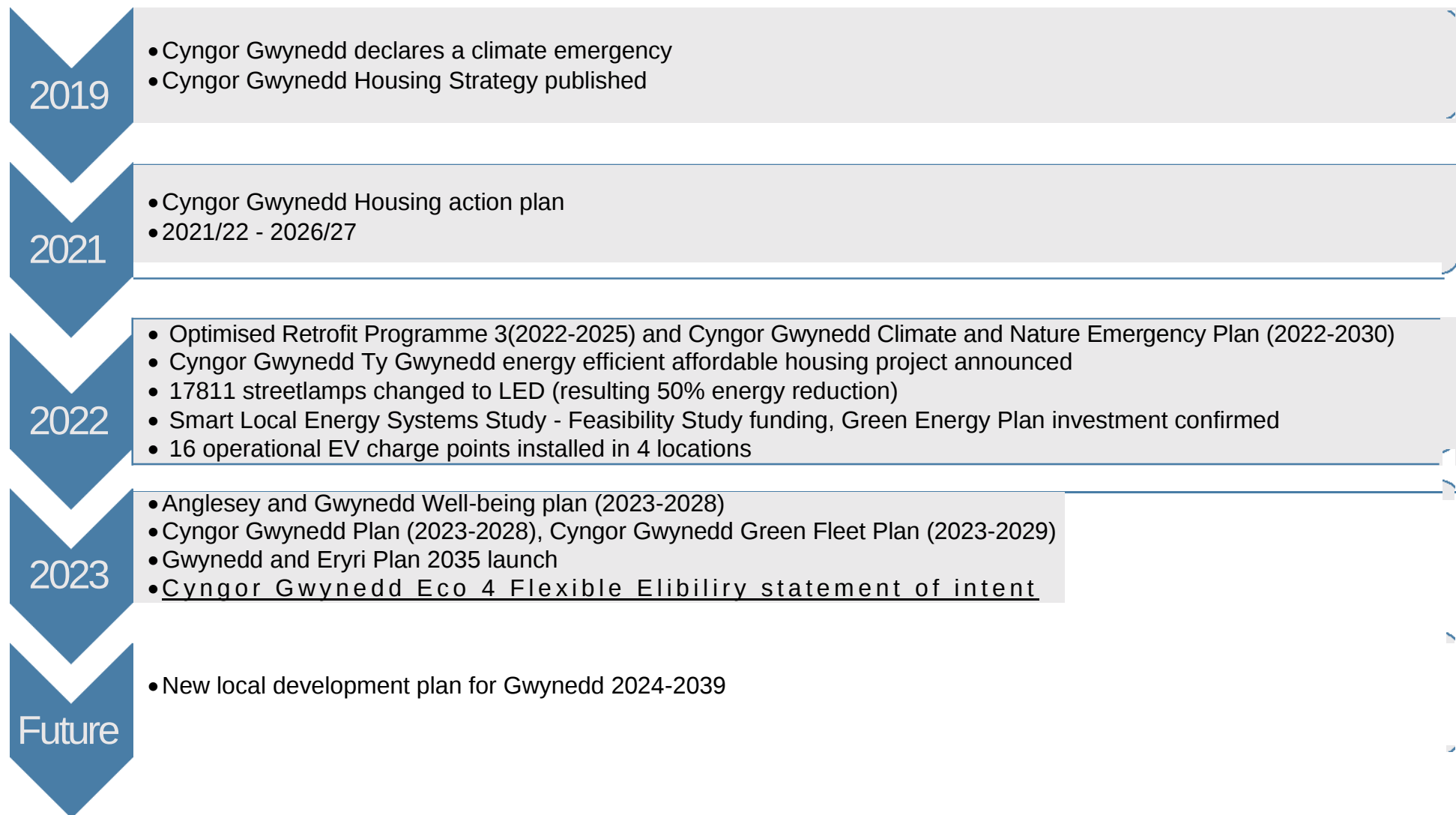


Figure 30. Summary of activities to date that have contributed to decarbonizing the local energy system from LA

Cyngor Gwynedd successes to date:

- Invested nearly £8million on carbon management projects including replacing streetlamps with LED lamps, investment in EV charge points at depots and our offices, in addition to purchasing low emission fleet and refuse collection vehicles.
- Undertaken a baseline assessment of our carbon footprint and identified relevant governance, monitoring and reporting mechanisms for our approach to decarbonisation.
- Our energy conservation service has helped 1,671 people with energy vouchers worth £81,773.
- We have achieved a 20% reduction in our carbon emissions from our procurement processes between the 2019/20 baseline year and 2022/23

Cyngor Gwynedd Carbon Management Plans

Gwynedd Council formed a partnership with the Carbon Trust in 2009 and, as a result, two Carbon Management Plans have been approved.

The Carbon Management Plans (CMP) were comprehensive strategic plans which outlined:

- Gwynedd Council's carbon performance in the baseline year of 2005/6
- The identification of carbon improvement and reduction opportunities
- The provision of recommendations to improve and reduce carbon
- The setting of carbon reduction targets

Cyngor Gwynedd Energy Conservation Measures:

Cyngor Gwynedd has invested in automated Monitoring & Targeting (aM&T) systems to reduce energy waste across its sites and continues to upgrade its systems. Encompassing the use of half-hourly Automated Meter Reading device data and energy management software, this technology was the main contributor to the 20.7% reduction in gas use seen by comparing 2019/20 to 2022/23, equivalent to a financial saving of £114,000. The latest upgrade makes use of Artificial Intelligence technology and will take us a step closer to the ultimate goal of zero waste. In parallel with aM&T, Cyngor Gwynedd has also invested in a large number of Building Energy Management Systems allowing centralised control of heating systems.

Cyngor Gwynedd Targets	% Change from baseline (2005/6 to 2020)
Street Lighting	-80.3
Fleet	-35.7
Business Travel	-58.0
Waste	-55.5
Buildings and Solar PV	-59.9
Total Emissions Reduction (from baseline)	-58.3

Table 1. Cyngor Gwynedd carbon management plan targets and results

Plans for the future

Regeneration

Since 2012, Gwynedd Council has been working together with Welsh Government to facilitate the development of two of Meirionnydd's key strategic sites – Trawsfynydd Site and Snowdonia Aerospace Centre, Llanbedr.

Cwmni Eginio (CE) was established in 2021 by Welsh Government to deliver a site development plan for Trawsfynydd, focused on socio-economic growth.

Renewable generation

Cyngor Gwynedd Solar PV Panels scheme - Phase 4 will result in the installation of additional solar panels on 70 of our buildings. Other renewable energy projects in Gwynedd include a recently approved planning application for a 4.99 MW solar PV farm in Llanbedrog, Pwllheli.

Council fleet and local transport

At the start of 2024 we are purchasing an additional 67 vehicles and installing EV charging points for fleet and public use. We are also investigating other alternatives, including projects run by Ambition North Wales to develop hydrogen as a potential fuel source.

The launch of our joint strategic plan for Gwynedd and Eryri 2035, also include proposals for additional EV charging infrastructure, and improved public transport service, within and around the National Park. This includes electric buses on the new TrawsCymru service between Caernarfon, Porthmadog and Blaenau Ffestiniog. There are also community owned transport initiatives across the county, including community car clubs, for example, Car-n-arfon, part of the Co Wheels network.

Community energy

Gwynedd has a wealth of local community energy initiatives and groups working to promote renewable energy, reduce carbon emissions and empower local communities including:

- Cyd Ynni a cooperative that has demonstrated success over recent years in delivering energy and community projects including solar, wind and hydro projects.
- Ynni Ogwen, a community energy cooperative based in Bethesda that focus on developing small-scale hydroelectric projects and promoting energy efficiency in the local area.
- Datblygiadau Egni Gwledig (DEG), a social enterprise supporting community led action across northwest Wales.
- Energy Local, a local market in power via Energy Local Clubs. This enables households to club together to show when they are using local clean power when it is generated.

Housing

The Council does not own any housing stock; social housing in the county is owned by Adra, Grŵp Cynefin and North Wales Housing who are all currently carrying out a number of energy efficiency initiatives with partners, for example, Project Sero Net Gwynedd.

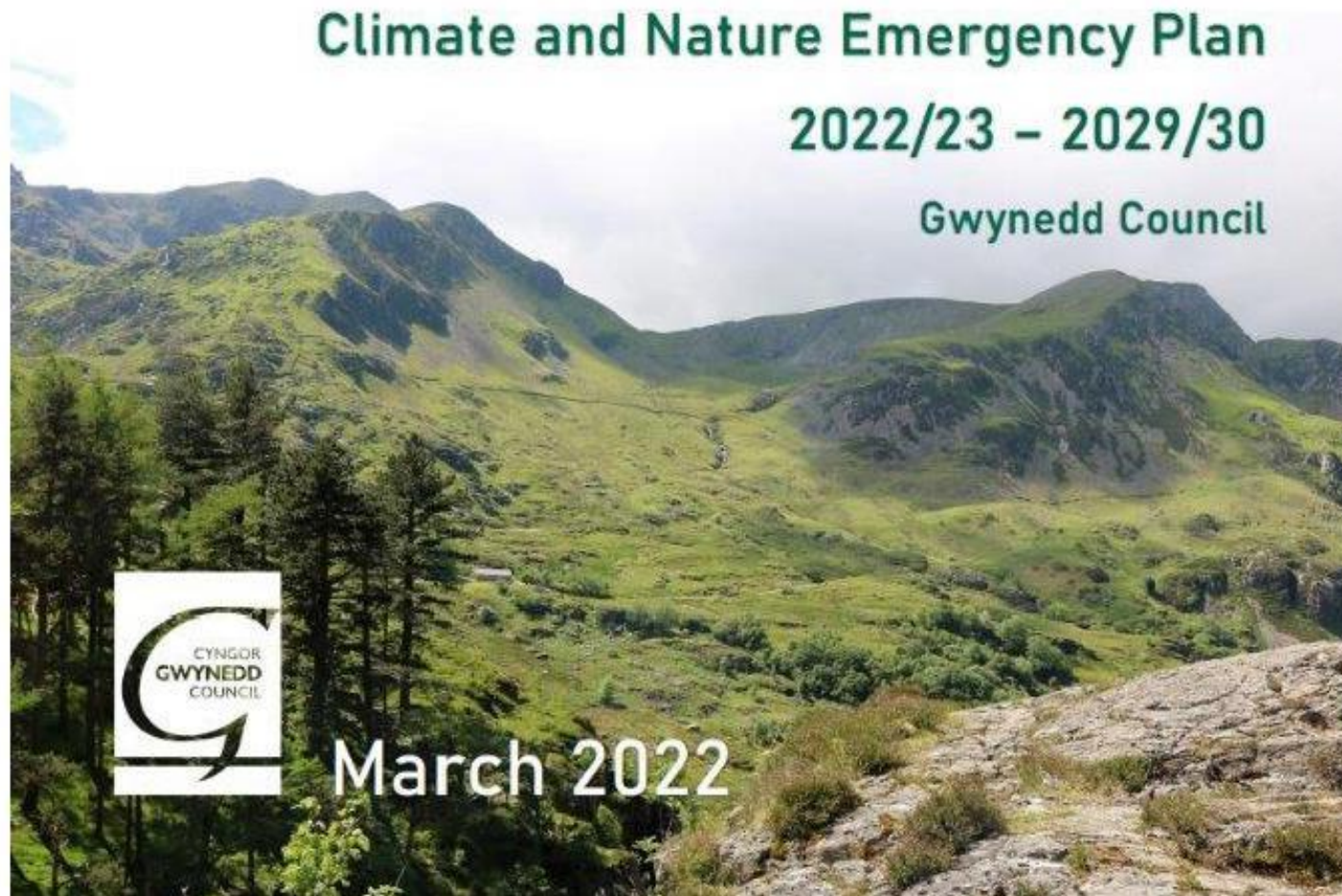


Figure 31. Cyngor Gwynedd Climate and Nature Emergency Plan (2022)

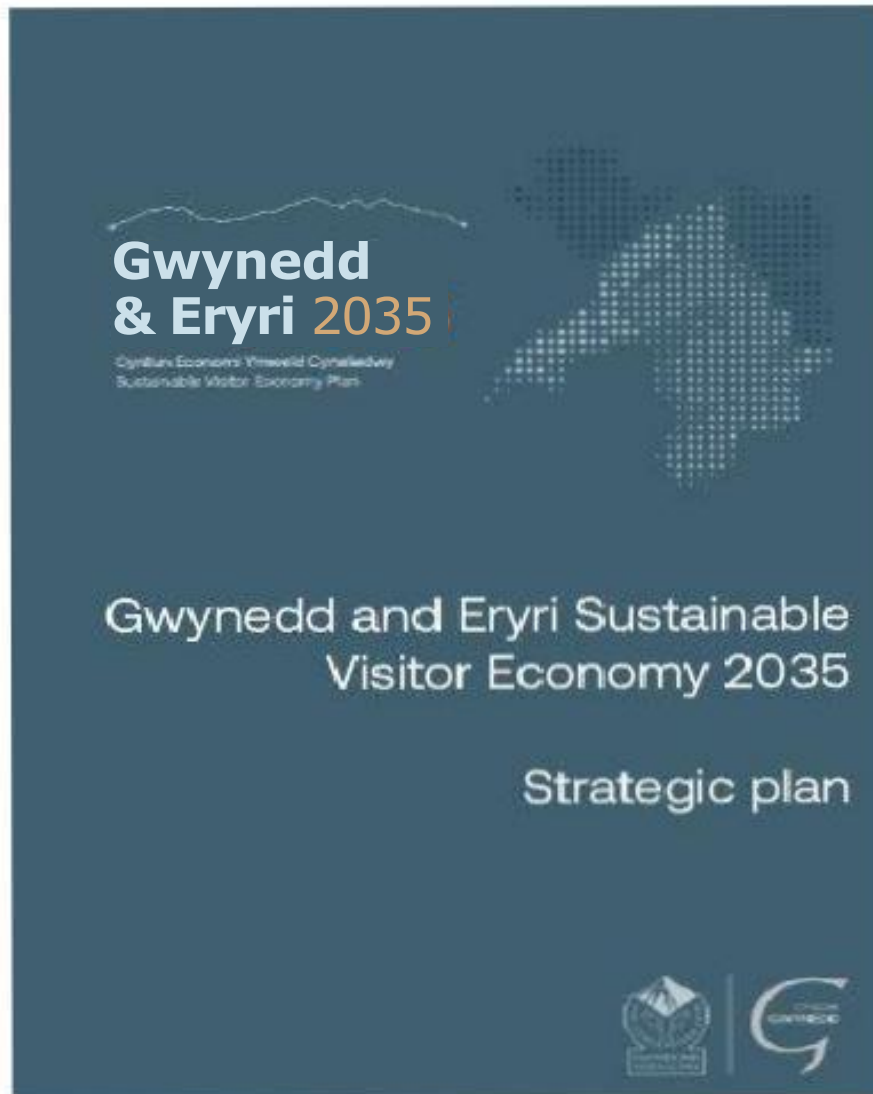


Figure 32. Gwynedd and Eryri Sustainable Visitor Economy Strategic Plan (2023)

3. Chapter 3: The Future Energy System

Overview



Figure 33. Image provided by Meilyr Tomos (Gwynedd County Council)

Vision

Develop a local net zero carbon energy system for Gwynedd that encourages the development of affordable and reliable energy sources for the benefit of our local communities, supporting a transition to a prosperous and resilient economy, whilst protecting and enhancing the natural environment.

Objectives of the plan

We have worked with stakeholders to define the following objectives for our plan:

- To reduce and encourage efficient use of energy across Gwynedd and provide quality, affordable, accessible and energy efficient homes and buildings.
- To provide a climate resilient energy system capable of meeting future energy demand.
- To maximise reductions in carbon emissions using local renewable energy sources while minimising financial costs.
- To empower the local economy, supporting the creation of high-quality jobs, thriving businesses, while safeguarding and building on the visitor economy.
- To capitalise on opportunities to invest in low carbon energy and engage our communities to support leadership and ownership of renewable energy projects.
- To establish a mechanism with which to deliver local renewable energy to Gwynedd homes at a stable, cost effective price to the end user

Scenario analysis

We know that we need to transition our energy system in Gwynedd to net zero by 2050. We also know that there are multiple plausible and attractive future energy systems for Gwynedd, depending on a range of factors. This includes how the cost of technologies might change over time, as well as wider policy decisions that will be made by Welsh and UK Governments. These factors will influence the uptake of hydrogen, for example.

To inform our plan, we used scenario analysis to explore what a net zero future energy system could look like under different future outcomes, including considering the potential for reduction measures and potential energy sources. We modelled four future energy scenarios and modelled the most cost- and carbon-effective way to meet demand in each one. Through doing this, we were able to identify technologies that played a significant role in all the future scenarios modelled. These technologies represent low- and no-regrets options (meaning that they are likely to be most cost-effective and provide relatively large benefits) which are very likely to be important parts of the future energy system, regardless of the uncertainty of the future. Under all scenarios, those low- and no-regrets actions can be taken now to set Gwynedd on track to a net zero carbon future.

Through this analysis, we identified the commonalities that will support us in meeting our vision and objectives. This forms the basis of our plan.

We are confident that these actions will be required regardless of any future uncertainties.

Deployment modelling

We looked at how aspects of each energy proposition might be deployed between now and 2050, creating deployment pathways. Deployment pathways indicate:

- the scale of change required over time,

- the sequencing of activity that needs to happen to achieve a net zero energy system.

Deployment pathways for different components were informed by broader plan objectives, local and regional strategic priorities, policies and national targets and using this context, helped us to define a suitable level of ambition, and bring all this evidence together into an action plan.

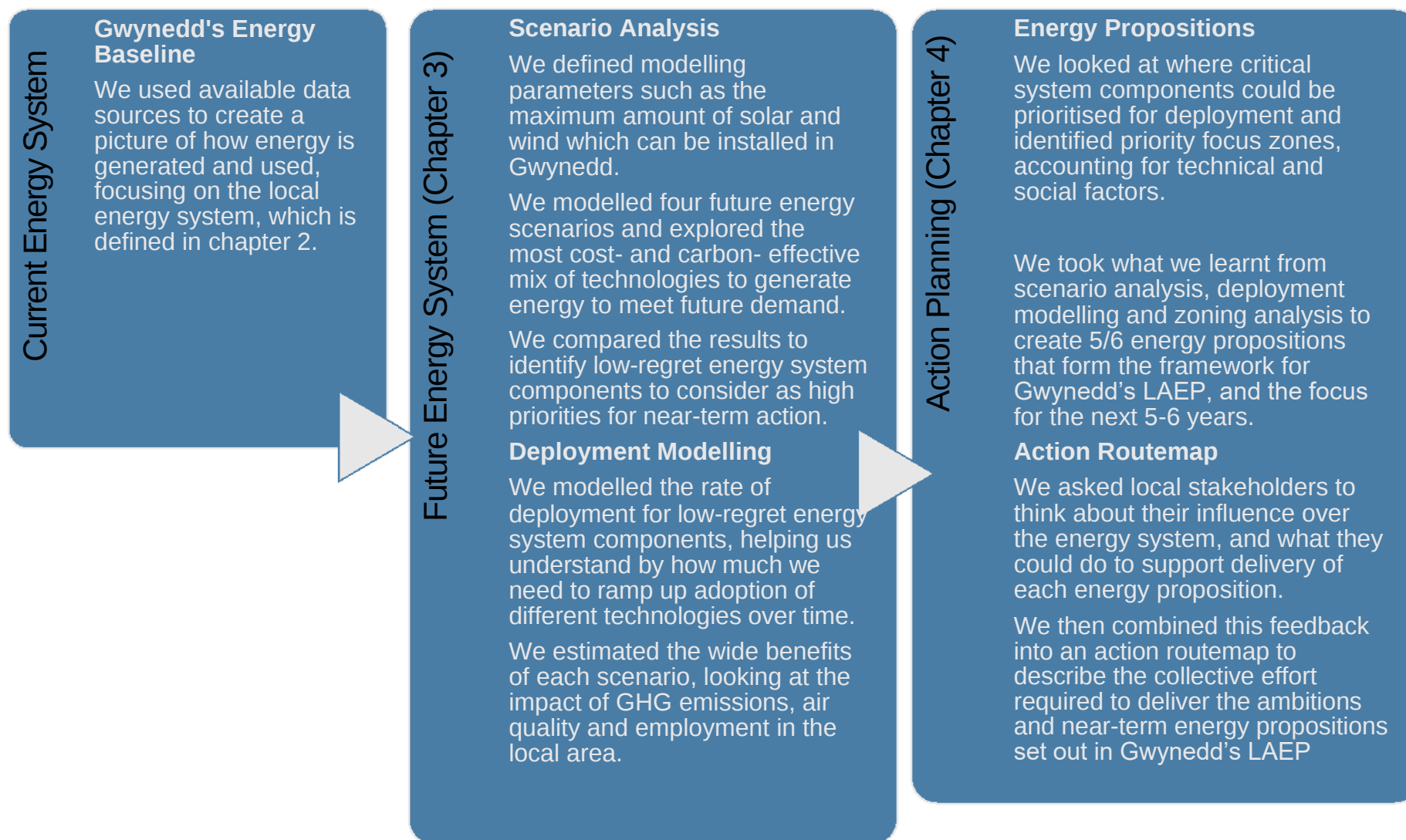


Figure 34. Summary of steps taken to produce the LAEP

Scenario Analysis

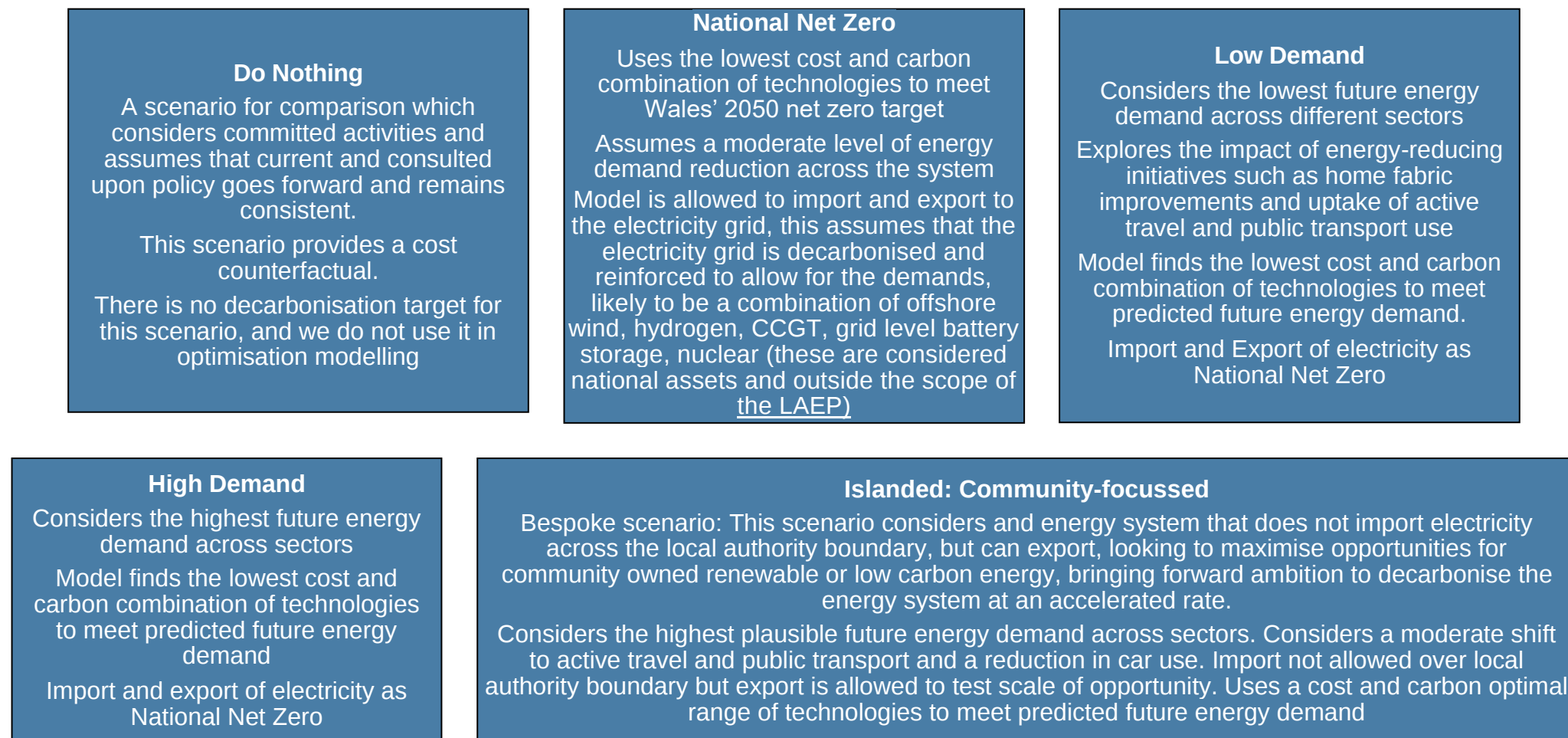


Figure 35. Summary of future energy scenarios

Analysis – National Net Zero future energy scenario energy flows (GWh, 2050)

Figure 36 shows one potential future energy system (National Net Zero) for Gwynedd that was modelled for 1 year on a 24-hour basis. This system is a result from modelling the most cost and carbon optimal system (optimisation modelling) based on a set of pre-defined modelling parameters and assumptions about the future energy system in Gwynedd. We have explored several future energy scenarios to help us create a strategic plan of action for decarbonising the local energy system. More details on the scenarios and results from the modelling can be found in the Technical Report (Chapter 5). This modelling helps inform the deployment modelling and the actions that go into the plans but is not the "final plan" for Gwynedd.

Figure 36 details a Sankey diagram for potential future 2050 energy supply system within:

- Hydrogen: Hydrogen could be imported or generated from electrolysis to power Heavy Goods Vehicles
- Renewable Energy: Significant increase in renewable energy generation compared to baseline, particularly ground-mounted solar PV (17 times) rooftop PV (24 times) and anaerobic digestion (47 times)
- Tidal Energy: Introduced to produce 70 GWh per year.
- Canopy PV will make a small contribution, serving both electricity and heat demand

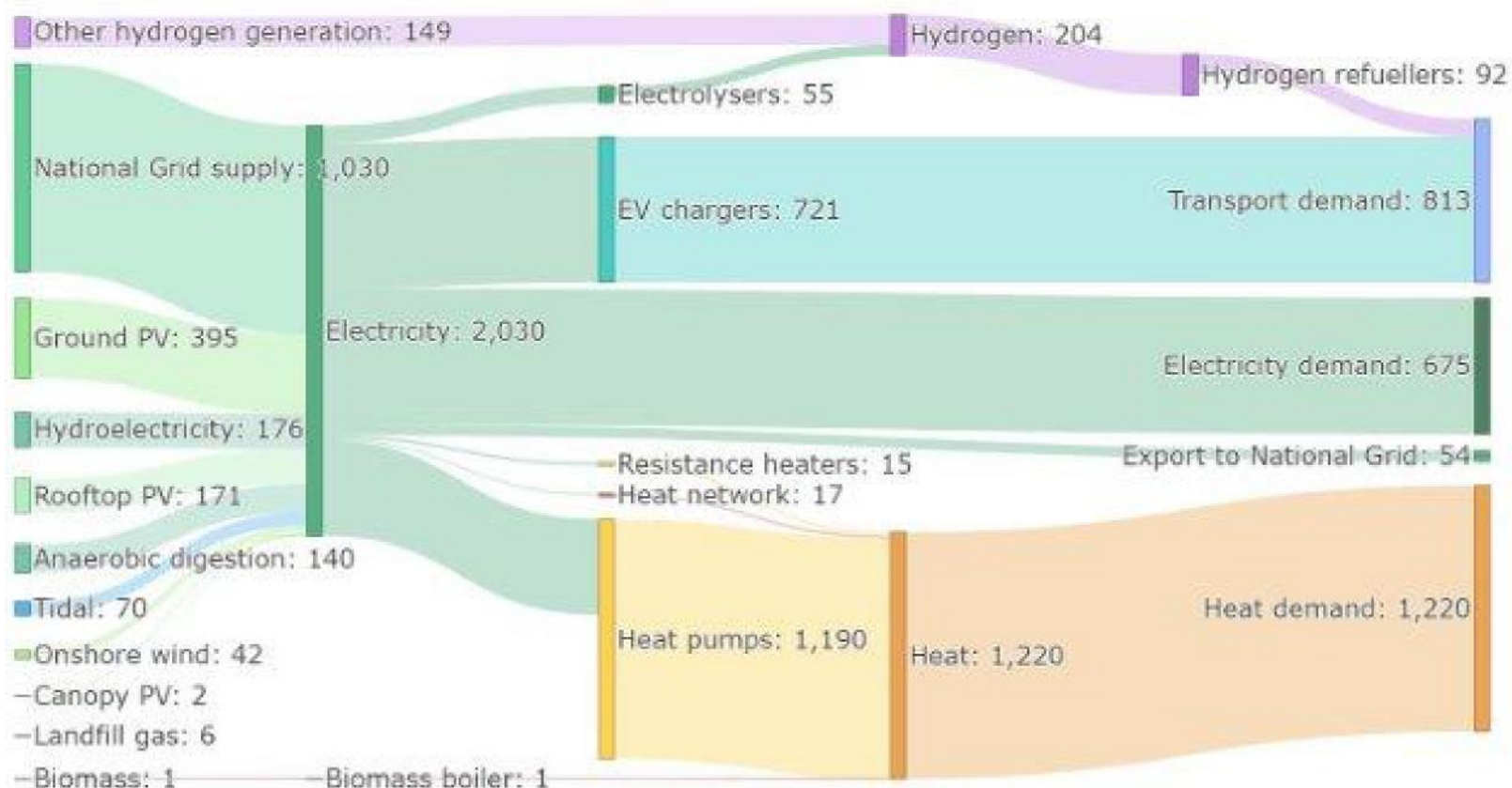


Figure 36. Sankey diagram for a potential future 2050 energy system – National Net Zero scenario (energy flows in GWh). Based on a 24-hour model run

The majority of transport demand will be met through EV chargers. Hydrogen refuellers meets 11% of demand. A small portion of the generated electricity demand (2.7%) will be exported to the National Grid. Energy demand is 2.6 times larger than the baseline. Heat supply will be predominantly met by heat pumps (98%). For comparison, the average Welsh home uses 3.325 MWh/year of electricity,

which is 0.003 GWh for comparison with the scale on the Sankey. In terms of gas, a typical home uses 12 MWh/year, which is 0.012 GWh for comparison with scale on the Sankey.

Energy System Components

Energy system components	Baseline (GWh)	National Net Zero (GWh)	High Demand (GWh)	Low Demand (GWh)	Islanded: Community-focussed (GWh)
Import from Grid	561	10301'	10401'	8541'	0 (no import in scenario)
Hydroelectricity	176	176			
Ground-mounted PV	24	3951'			
Onshore wind	15	421'			
Rooftop solar PV	7	1711'			
Landfill gas	4	61'			4
Biomass	60	1↓			
Coal	20	0↓			

Canopy PV	0	2↑			
Tidal	0	70↑			
Other hydrogen generation	0	149↑	147↑	142↑	65↑

Table 2. Comparison of energy sources across the scenarios (GWh in 2050)

Table 2 and Table 3 (overleaf) shows what energy components are present in each future energy scenario and on average, the amount of energy generated/converted/transferred over a one-year timescale. This has then been benchmarked against the baseline results.

Optimisation modelling shows ground-mounted, rooftop solar and onshore wind generation consistently increasing across all scenarios, contributing to meeting both Gwynedd's energy demand but also exporting in times of surplus to the National Grid, and serving broader energy needs.

In contrast, biomass generation sees a decline across all scenarios, likely due to a reduced dependency resulting from the enhanced output of solar and wind farms. In contrast, use of coal sees a decline across all scenarios, and hydrogen is generated to meet electricity demand as a dispatchable form of energy, where renewable energy sources are not generating is incorporated into the energy mix in all scenarios, sustaining the transport demands across the county.

Energy system components	Type	Baseline (GWh)	National Net Zero (GWh)	High Demand (GWh)	Low Demand (GWh)	Islanded: Community- focussed (GWh)
Anaerobic Digestion (plant)	Conversion	3	1401'	1421'	971'	1,3501'
Pumped storage	Storage	0	0	0	0	1171'
Electrolyser	Conversion	0	551'	541'	621'	1371'
EV chargers	Transfer	1	7211'	7401'	7211'	7401'
Export to National Grid	Transfer	0	541'	531'	741'	21'
Heat pumps	Transfer	0	1,1901'	1,1901'	7961'	1,2001'
Heat networks	Conversion	0	171'	171'	171'	171'
Resistance heaters	Conversion	191	151	151	71	11
Biomass boilers	Conversion	36	11	11	11	11

Hydrogen refuellers	Transfer	0	921k	901k	921k	901k
Hydrogen CCGT	Conversion	0	0	0	0	11k

Table 3. Comparison of energy conversion/ transfer technologies across the scenarios (GWh in 2050) Table 3

focuses on the different conversion and transfer technologies that the optimisation model has chosen:

- We see a significant uptake in EV chargers to meet the increased uptake of electric vehicles, and hydrogen refuellers used to supply hydrogen to heavy goods vehicles that service the area.
- Heat pumps are the dominant conversion technology used for heat in buildings, and this is consistent across all scenarios. While heat networks and other technologies contribute to this demand, their usage is comparatively less.
- We also see surplus electricity exported to the National Grid in all scenarios serving wider energy needs.
- Anaerobic digestion increases substantially in the bespoke "Islanded: community –focussed" scenario. Since this scenario does not allow import from the national grid, and other technologies such as ground-mounted PV and solar have reached the maximum capacity (due to constraints applied such as best most versatile land), anaerobic digestion is selected to meet the electricity demand in the system. This is a demonstration of the capacity that would need to be met by on-demand sources.
- Pumped storage has been included within the bespoke scenario to take account of the Glyn Rhonwy pumped storage project. The scheme was granted a Development Consent Order in 2017.
- There was no additional capacity identified for hydropower schemes across Gwynedd. Data on hydropower resource is limited due to lack of information on 'existing barriers' (e.g weirs / waterfalls). There may be future opportunities arising for small scale or larger scale pumped hydropower (or pumped storage) opportunities across Gwynedd, however this will require further analysis.

Deployment Modelling

Impact on Energy Demand

Deployment modelling sets out how quickly each energy component could be deployed in each optimisation scenario and the Do Nothing scenario. The rate of change in the Do Nothing scenario is based on current deployment rates and policy levers, whereas the other scenarios show trajectories that meet the optimisation models, taking into account the need for growth in the supply chain.

Figure 37 shows the projected energy demand by sector and scenario for 2023, 2030 and 2050. Key headlines include:

- All scenarios show a potential for an increase in total energy demand between 2023 and 2030 and then a reduction by 2050 (against both 2023 and 2030).
- The initial increase in demand is primarily driven by transport demand, as is assumed in line with population growth. This growth is then outweighed by the shift away from private vehicles to public transport and active travel towards 2050 and a result of electric vehicle uptake, which are more energy efficient than ICE (internal combustion engine) vehicles.
- The greatest reduction in total energy demand to 2050 is seen in the Low Demand scenario, primarily driven by a decrease in buildings heat demand. This is due to an increase in insulation retrofits compared to the other scenarios. The other scenarios all have a similar energy demand of approximately 2,700 GWh in 2050.

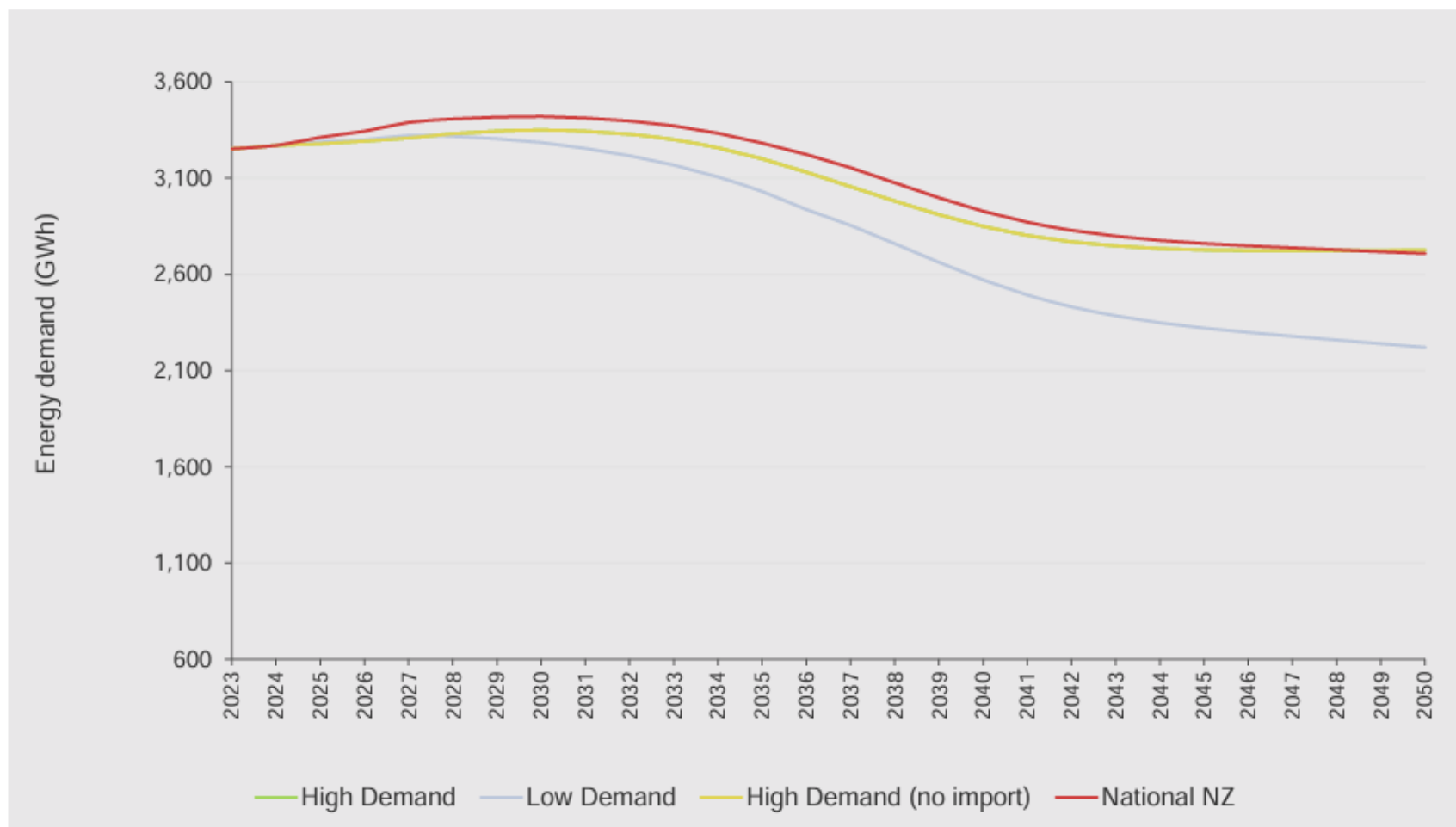


Figure 37. Total energy demand between 2023 and 2050 for each future energy scenario

Impact on GHG emissions

Figure 38 shows the gap in the GHG emissions between the Do Nothing and the future energy scenarios. Our deployment modelling provides additional evidence on the realism of delivering the changes suggested by the optimisation modelling. It helps us to determine the actions needed in the next five years to set us on the pathway to net zero in 2050. There are also bigger systemic changes that will be needed to achieve the scale of change set out in this plan.

The plan shows that the system doesn't meet net zero in 2050. Offsetting would be needed to reach net zero, however this is not in the scope of the LAEP.

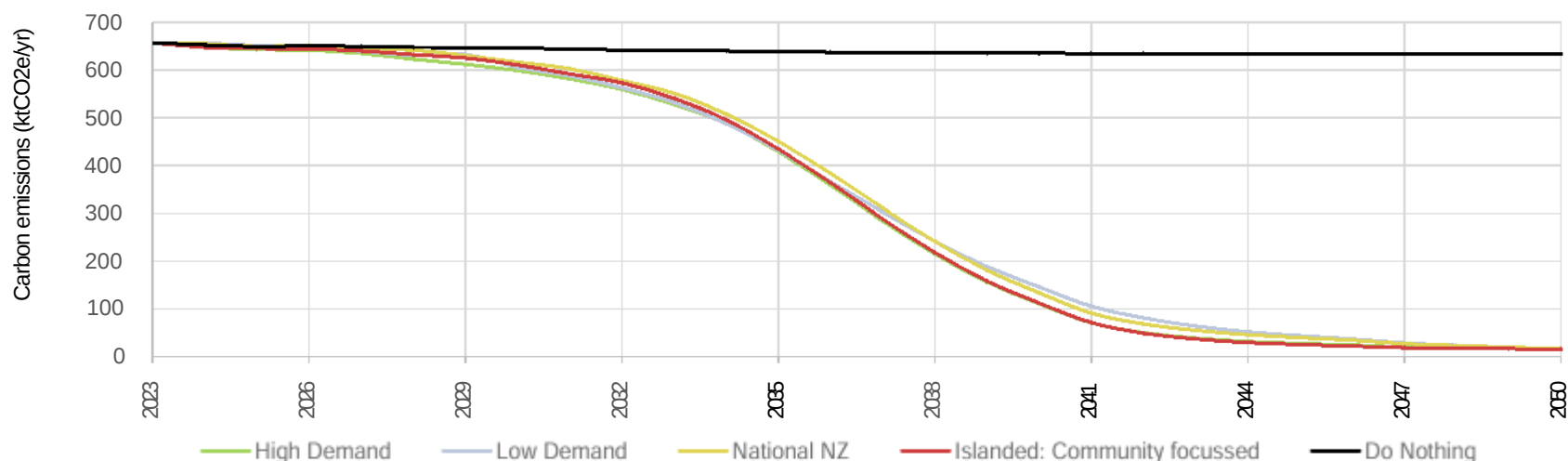


Figure 38. GHG emissions (ktCO2e) over time for each scenario compared to the Do Nothing scenario (bottom) % GHG emissions reduction for each scenario compared to the Welsh Government emissions reduction targets. High demand, Island Community Focused and National NZ

Impact on GHG emissions

The deployment modelling also shows how these pathways contribute to the Welsh Government emissions reduction targets (shown in Figure 38). In 2023, Gwynedd's emissions were 40% lower than 1990 levels, with all pathways performing slightly worse than the targets to 2050. Pathways suggest a residual amount of GHG emissions remains in 2050 even with the ambitious changes set out in each scenario. This emphasizes the importance of exploring alternative ways to address hard-to-reduce GHG emissions through mechanisms such as offsetting.

Scenario	2030	2040	2050
Welsh Gov targets	-63%	-89%	-100%
National Net Zero	-44%	-88%	-98%
High Demand	-46%	-90%	-98%
Islanded: Community focussed	-44%	-90%	-99%
Low Demand	-45%	-87%	-99%
Do Nothing	-41%	-42%	-42%

Figure 39. The percentage of GHG emissions reduction for each scenario compared to Wales's legislated emissions reduction targets.

Socio-economic impacts

Reducing the amount of energy used in Gwynedd and using renewable energy sources for power generation can have wider environmental, social and economic benefits so it is important that they are fully understood to support decisions that impact the future of the energy system. For example, for every £1 invested in energy efficiency measures, the NHS can save £0.42 (amounting to annual savings of £1.4 billion in England alone) (47).

Employment impacts

Investments in local energy systems can be expected to have employment benefits by providing local, skilled jobs. These will include direct jobs from construction and operational phases of the development of new projects as well as associated jobs needed in the supply chain to bring the project to completion (also known as multiplier effects) (48).

Impact on air quality

It can also impact the quality of the air which in turn impacts: human health, productivity, wellbeing and the environment, which is why it is so important to understand when planning future policy or programmes of work. Activity costs presented in Table 3.3 show estimates for the impact of air pollution per unit of fuel consumed in each future energy scenario and estimates for the employment impacts associated with each future energy scenario, compared to the Do Nothing scenario. This analysis shows that the four future energy scenarios explored could improve air quality and minimise associated damage costs associated with poorer air quality. It also suggests that the four future energy scenarios would lead to a net increase in jobs available to the local community. More detailed analysis on deployment can be found in the Technical Report (Chapter 4).

Metric Zero	Do Nothing	National Net	High Demand	Low Demand	Islanded: Community focussed
Energy change (GWh, relative to 2023)	~0	-544 (-17%)	-527 (-16%)	-1,031 (-32%)	-526 (-16%)
Change in GHG emissions (ktCO₂e, relative to 2023)	23 (-3.5%)	-641 (-97.5%)	-641 (-97.5%)	-643 (-98%)	642 (-97.5%)
Cumulative air quality activity costs between 2023- 2050 (£'million) (2022 prices)	£771	£408	£383	£403	£482
Employment impacts between 2023-2050 relative to the Do Nothing Scenario (Net Full Time Equivalent)	0	2,400	2,400	4,100	3,400

Table 4. Summary of economic impacts for each scenario: employment impacts and air quality activity costs. Figures shown relate to the period 2023-2050. Air quality costs are presented using 2022 prices are not discounted

Summary of deployment of critical energy components across Gwynedd

Figure 40 summarises the deployment rates* for near-term system components, so we can better understand where we are now and where Gwynedd needs to get to, providing a starting point to frame the challenge for more detailed analysis. It's important to note that there is still a high degree of uncertainty associated with this deployment modelling as there are many variable factors and unknowns. For example,

- Technological advance and innovation
- Supply chains and how they develop
- Large scale activity to decarbonise infrastructure at other levels: regional, UK and beyond

*This is an indicative capacity to be brought forward e.g for ground-mounted solar PV deployment, this could comprise different sized solar farms.

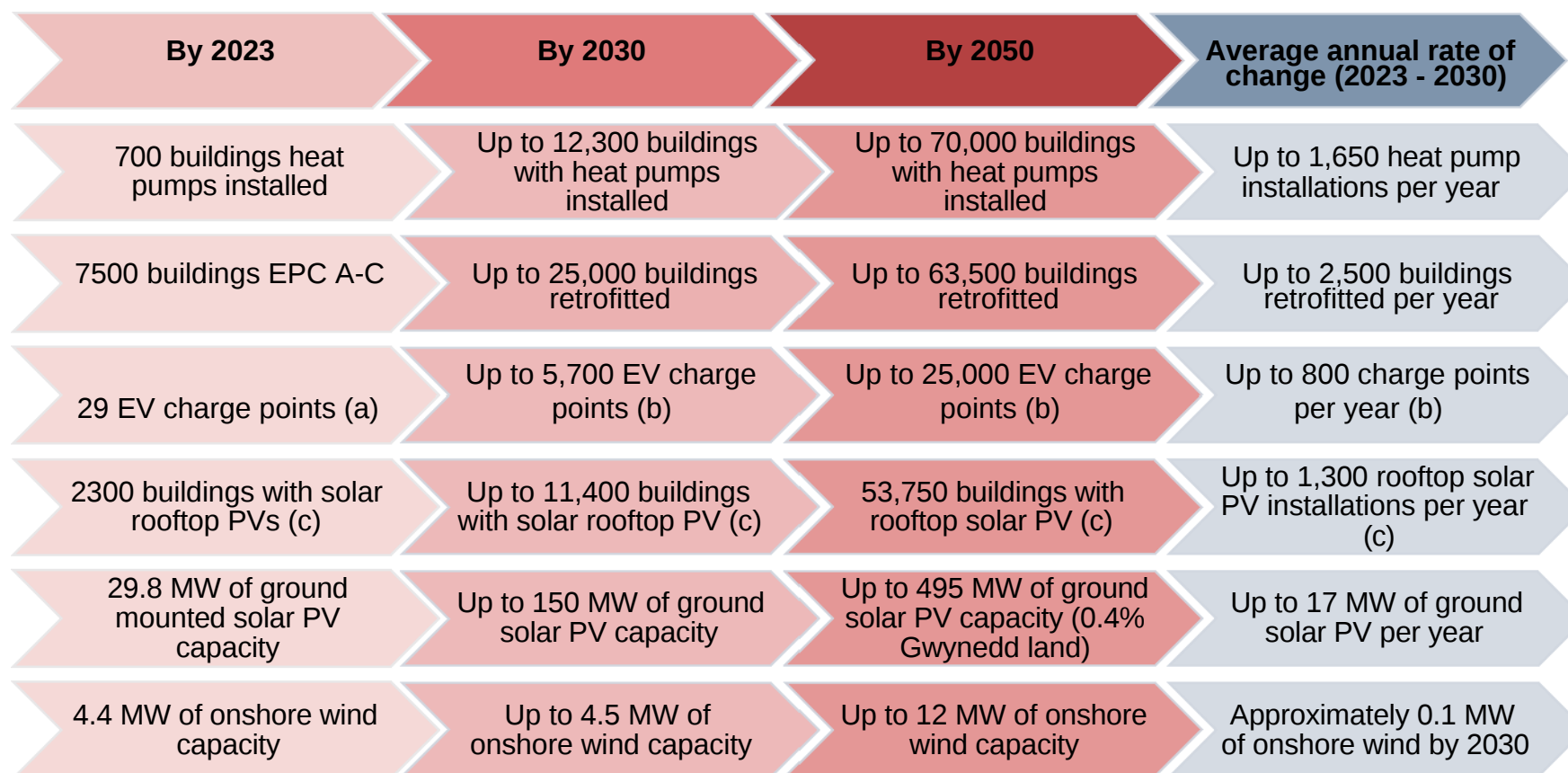


Figure 40. Summary of key deployment metrics from optimisation modelling. a) According to the National Charge Point Registry (44) as of May 2023. Refers to individual charge points. b) Assuming 4kWp per charge point. Note that the power rating selected will be dependent on location and use case. E.g. Rapid chargers are more suitable at service stations due to the length of stay of customers. Based on the Wales EV Charging Strategy (30), most chargers in Gwynedd are likely to be slow chargers (<7kW) with a small number of fast (7-22kW) and rapid (42-350kW) EV chargers. c) Assuming 4kWp per roof and per installation.

4. Actions and Recommendations



Figure 41. Trefor, Gwynedd. Photo provided by Ambition North Wales

Energy Propositions

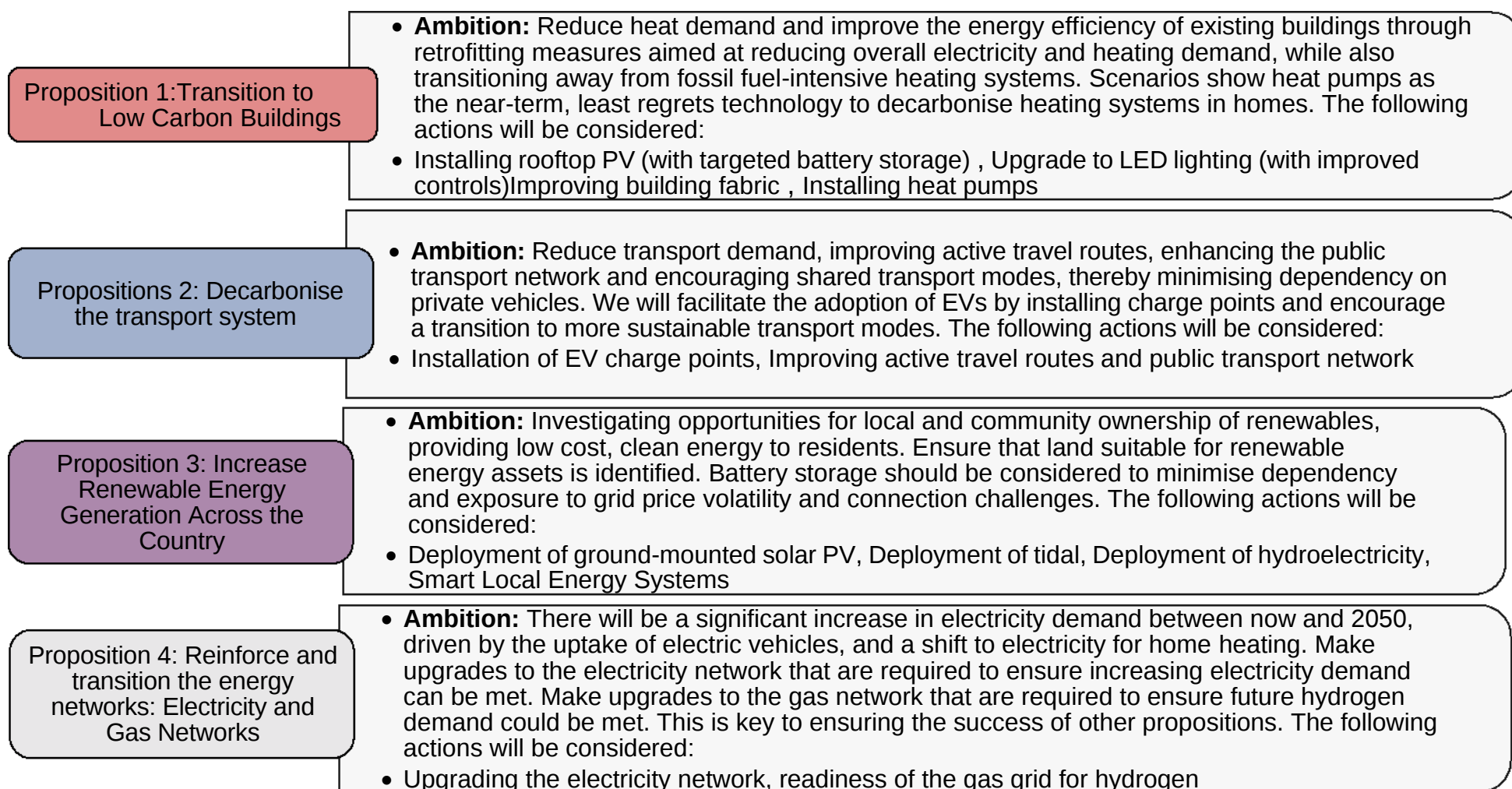


Figure 42. Summary of propositions

Although the exact form of the decarbonised energy system in 2050 is uncertain, there are actions that local stakeholders can take now with relative certainty that will help Gwynedd maintain the ability to contribute to Wales' 2050 Net Zero ambition and capitalise on the associated opportunities.

As Cyngor Gwynedd, our role in delivering each energy proposition will vary. Some actions call for council led action in the material delivery of programmes, whilst others require the council to act as the facilitator for market-driven change. Through the LAEP process, we also identified that some of the actions are best delivered collaboratively through the regional partnership.

Plan on a page

As a starting point, Gwynedd's "plan on a page," (Figure 43), highlights zones in blue, where there are particularly favourable conditions for deploying the near-term energy system components in each energy proposition: heat pumps, EV chargers, rooftop solar PV, ground-mounted solar PV, onshore wind, and insulation retrofits. To prioritise where each low-regret energy system component should be deployed, each modelling zone was ranked using two or more of the following considerations:

- Off-gas home – prioritise zones with higher baseline proportion of off-gas housing. These homes will be the most challenging to transition to hydrogen and therefore are the most likely no-regrets targets for conversion to heat pumps.
- Socioeconomics - prioritise zones with higher baseline rates of deprivation (lower WIMD score).
- Property ownership - prioritise zones with the highest baseline percentage of social housing.
- Substation generation headroom – prioritise zones with the most baseline generation headroom available.
- Listed buildings – prioritise zones with the least number of currently listed buildings.
- Domestic energy efficiency – prioritise zones with the highest baseline percentage of homes with an EPC rating of D or below.
- Built additional substation capacity - prioritises zones where the least upgrades are required in the high demand scenario, since heat electrification is typically a major contributor to grid upgrade requirements (which may be back-logged by several years).

- Built EV charging capacity – prioritise zones with the most EV charging built in the high demand scenario.
- Built additional capacity of each local generation technology (rooftop PV, ground-mounted PV, or onshore wind) – prioritise zones where the most additional new capacity is built between the baseline and 2050 high demand scenario.

For more details on the methodology behind the “plan on a page”, please see Chapter 4 of the Technical Report.

In Figure 43, green areas show modelling zones identified as a priority focus zones, where conditions are most favourable to trial deployment of energy system components at pace and scale. Blue areas show “progress” zones where the conditions are less favourable in the near-term for delivery compared to the green areas, and where only tried and tested delivery models should be deployed. A consistent level of deployment will still be required in these zones to transform the local energy system at the pace indicated by the deployment analysis.

Energy Propositions – Plan on a Page – 2030

Figure 43 identifies zones with particularly favourable conditions for specific energy components, with the potential for being ideal locations for pilot studies. The summary tables (shown below) detail the (i) installed capacity opportunity, (ii) required investment for each component and (iii) total investment necessary for both energy component installation and electricity network infrastructure in each zone by 2030.

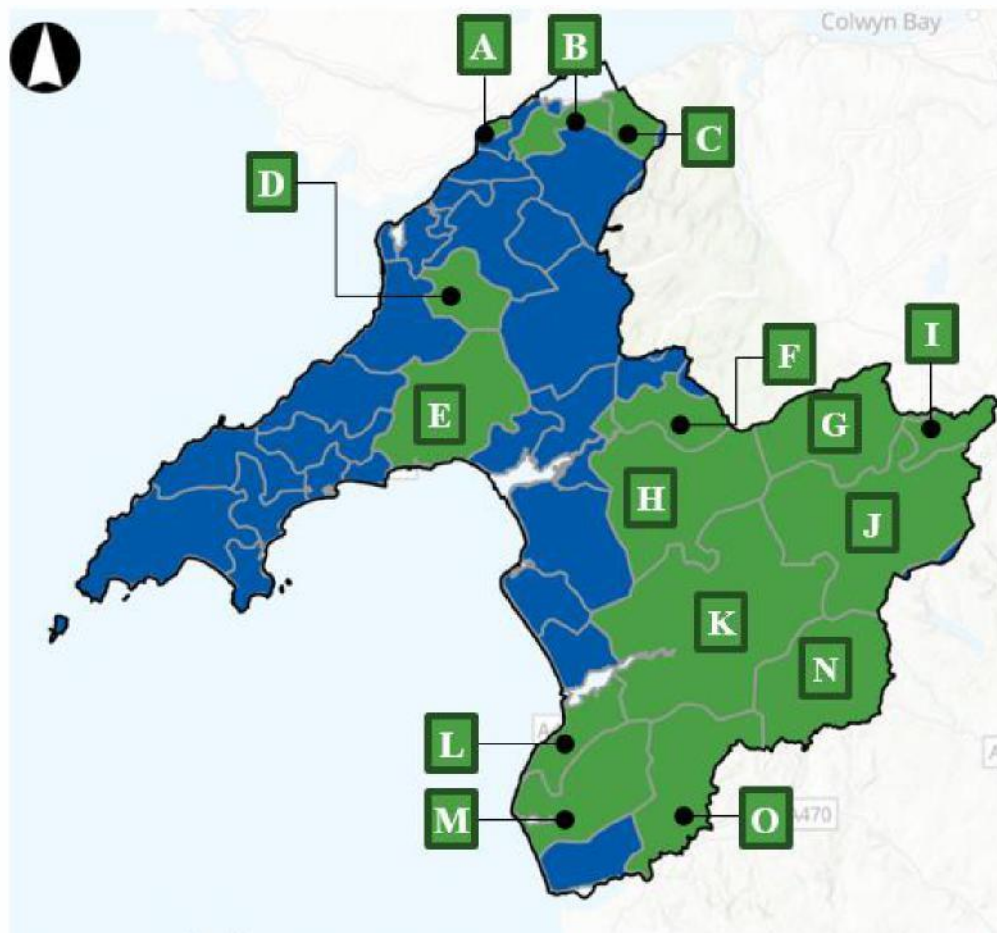


Figure 43. Gwynedd's spatial representation of opportunities across the four scenarios including 2030 ambition and investment (million £). Zone boundaries are defined by primary substation service areas. Note: intervention should still be carried out in 'progress' zones to transition the local area to Net Zero. Green zones are to accelerate pilot projects whereas blue are those in progress

Key and Region	Installed Capacity (i), Required Investment (per component) (ii), Total Required Investment (iii)
A: Parc Menai	Rooftop PV: 1.6MW: £1.7m: Total £5.8-19m
B: Minfford /Parc Bryn Cegin	EV Charger: 1.1MW: £870-880k: Total £7.5-48m
C: Llanfairfechan	EV Charger: 79kW: £65k: Total £0.46-3.7m
D: Carmel	Insulation Measures: 550-750 homes: £4-57m: Total £6.9-60m
E: Rhoslan	Ground mounted PV: 63MW: £27m. Insulation Measures: £4-66m: Total £36-98m
F: Manod	EV Charger: 240-250kW: £200k: Total £3.3-27m
G: Tryweryn	Heat Pumps: 110-220kW: £81-170k. Ground-Mounted PV: 24MW: £10m. Total: £12-21m
H: Maentwrog	Heat Pumps: 350-750kW: £270-560k: Total: £3.0-26m
I Glan-Yr-Afon	Heat Pumps: 80-170kW, £60-130k Ground Mounted PV: 23MW, £9.8m Offshore Wind: 11MW (2050), £8.0m (2050). Total: 11-17m
J: Bala	Ground Mounted PV: 4.2MW: £1.8m: Total: £9.0-57m
K: Dolgellau	Insulation Measures: 580-910 homes, £5-73m: Total £11-78m
L: Fairbourne	Rooftop PV: 700kW, £770k: Total: £3.9-37m
M: Tywyn	Rooftop PV: 1.9MW, £2.1m: Total £7-63m
N: Cemmaes Rd	Heat Pumps: 180-390kW, £130-290k EV Charger: 150kW, £120k. Insulation Measures: 130-150 homes, £1-15m. Total: £1.9-16m
O: Dolgellau	Rooftop PV: 540kW: £600k: £2.8-20m

Ranges have been calculated by taking minimum and maximum results from each future energy scenarios.

Routemap – short term

Transition to low carbon buildings

Action, Action Reference (AR) and Proposed Lead	Estimated Timeline
Work with third parties to provide local data on fuel poverty and efficiently target the area's most in need. Monitor performance of ECO4 buildings post retrofit to ensure building performs as predicted in terms of kWh/m2/ year. Proposed Lead: Cyngor Gwynedd. AR: 1.01	2026
Continue with the roll-out of council-owned building retrofit to make buildings as energy efficient as possible. This will include a programme of PV solar installation on Council property from 2024 – 2026. Proposed Lead: Cyngor Gwynedd. AR: 1.02	2026
Collaborate with partners to promote and facilitate energy saving schemes. We will offer Gwynedd residents advice and information regarding: • how to save energy and money through the Nyth and Eco 4 schemes • benefits and opportunities of using low carbon building methods when building homes and low carbon heating/energy systems. Proposed Lead: Cyngor Gwynedd. AR: 1.03	2026
Work with Welsh Government and other key local partners (including RSLs, community groups and others) to support the roll out of energy efficiency improvements through the new WG's Warm Homes Programme and ECO4 flex scheme. We will closely work with Ofgem to consider the	2026

Action, Action Reference (AR) and Proposed Lead	Estimated Timeline
expansion of the current eligibility criteria of ECO4 route 4. Proposed Lead: Cyngor Gwynedd. AR 1.04	
Using secured grant funding, continue to upgrade from T5 to LED lighting across council portfolio (six sites identified). Proposition Lead: Cyngor Gwynedd. AR: 1.05	2030 (Ongoing)
Identify delivery options for heat pump deployment (where appropriate across Gwynedd) at key sites across Gwynedd by 24/25, including at 3 council sites, £1.75m WG funding secured with £195k match funding by Cyngor Gwynedd. Proposition Lead: Cyngor Gwynedd. AR: 1.06	2026
Review the potential for heat network deployment across Gwynedd and consider feasibility / strategies for future roll-out with a focus on replicability subject to gaining additional funding. Proposition Lead: Cyngor Gwynedd. AR: 1.07	2026
Continue to publicise and signpost opportunities associated with retrofit to local suppliers (through contracts to tender). Project Lead: Cyngor Gwynedd. AR: 1.08	2030 (Ongoing)
Work with housing associations and social housing providers across Gwynedd to encourage and support energy conservation, the adoption of net zero technologies and new retrofit techniques that could be used to reduce energy demand and retrofit older properties. Project Lead: Cyngor Gwynedd. AR: 1.09	2026

Action, Action Reference (AR) and Proposed Lead	Estimated Timeline
Work with Ambition North Wales to identify potential funding for future community/campus heat network decarbonisation projects that will benefit the whole community. Project Lead: Bangor University/ Ambition North Wales. AR: 1.10	2030 (Ongoing)
Work with Ambition North Wales to identify potential funding for the Smart Campus Pilot Project. Project Lead: Bangor University/ Ambition North Wales. AR: 1.11	2028
Apply lessons learnt from Optimised Retrofit Programme to retrofitting the privately rented and owner-occupied sectors through Welsh Zero Carbon Hwb (49). Project Lead: Welsh Government. AR: 1.12 (B.1.8)	2030 (Ongoing)
Using the learning from other information hubs to develop an information service that provides a trusted source of retrofit and energy efficiency information for consumers. Explore the potential of establishing an advice hub to support regional decarbonisation / low carbon energy initiatives. Project Lead: Welsh Government. AR: 1.13 (B.2.1)	2026
Work with Community Interest Companies (CIC) to provide a regional service of wrap around support for residents covering education, behaviour change, energy advice and support. Project Leader: Warm Wales. AR: 1.14 (R1.4)	2028

Action, Action Reference (AR) and Proposed Lead	Estimated Timeline
Provide support and incentives for households to install energy efficiency measures and low-carbon heating systems, ensuring such support is targeted at those in fuel poverty and/or in most need. Project Leader: Registered Social Landlords. AR: 1.15 (3A)	2030 (Ongoing)
Ensure PAS 2035 surveys and a clear plan for retrofit measures are prepared for individual social homes, in accordance with the Welsh Housing Quality Standard (WHQS) (27). Project Leaders: Local Authorities Registered Social Landlords. AR: 1.16 (3C)	2030 (Ongoing)
Review current support provision to tenants and landlords in the private-rented sector to ensure minimum energy efficiency standards are met. Review enforcement provisions to ensure minimum statutory standards within the sector are achieved. Project Leaders: Welsh Government Local Authorities. AR: 1.17 (3D)	2026
Explore development of support mechanisms for small to medium sized enterprises (SMEs) to encourage uptake of energy efficiency improvements to commercial buildings. Project Leaders: Business Wales/ M-Sparc North Wales Mersey Dee Business Council. AR: 1.18 (5C)	2030 (Ongoing)
Work with local authorities and regional bodies to determine an approach to coordinated, street-by-street approach to retrofit and the mechanisms for delivery (e.g. governance, resource, finance, policy). Co-ordinate a retrofit plan for all housing tenures which expands on the Optimised Retrofit Programme (50). Project Leaders: Welsh Government AR: 1.19 (B.1.7)	2030 (Ongoing)

Action, Action Reference (AR) and Proposed Lead	Estimated Timeline
Identify specific local planning constraints (e.g. permitted developments i.e. 3 metre rule for heat pumps, permissive planning for listed buildings, new build regulations) limiting progress to net zero and delivering the LAEPs and work with Welsh Government to resolve these. Project Leaders: Welsh Government Local Authorities. AR: 1.20 (B.5.1; 3E)	2030 (Ongoing)
Consider tighter building regulations to support delivery of net zero ready buildings including a consultation on Part L regulations in 2024. Project Leaders: Welsh Government. AR: 1.21 (B.5.2)	2026
Develop and agree an approach and delivery plan for tackling owner-occupied retrofit. Review existing and explore new potential financial mechanisms to support owner-occupiers and building owners seeking to undertake energy efficiency retrofit works. Project Leaders: Welsh Government. AR: 1.22 (B.1.2)	2026
Identify procurement frameworks for renewable technologies which consider local and ethical sourcing of goods and services. Develop national procurement framework, learning from previous ECO 4 roll out and the Optimised Retrofit Programme, to deliver street-by-street retrofit. Project Leaders: Welsh Government. AR: 1.23 (E.4.1).	2026

Decarbonise the transport system

Action, Action Reference (AR) and Project Leader	Estimated Timeline
Support Ambition North Wales in developing and publishing a new Regional Transport Plan for North Wales by March 2025. Develop and implement sustainable transport plans, such as public transport, active travel and cycle routes. Project Leaders: Cyngor Gwynedd, Ambition North Wales. AR: 2.01	2026
Produce and publish a Council ULEV/ EV strategy by the end of 2024. Project Leaders: Cyngor Gwynedd. AR: 2.02	2026
Implement Cyngor Gwynedd's Green Fleet Plan to transition current fleet to EV and to explore any future developments for LGV's and HGV's (e.g. Hydrogen) Project Leaders: Cyngor Gwynedd. AR: 2.03	2030 (Ongoing)
Collaborate on opportunities to decarbonise the public sector fleet, public service vehicles, and commercial and industrial fleets and the co-ordination of associated infrastructure design and development across local authority boundaries. Project Leaders: Ambition North Wales, Welsh Government Energy Service. AR: 2.04	2030 (Ongoing)
Work together to deliver the most appropriate electric vehicle public charging infrastructure across the region, aligning with national work being undertaken through Transport for Wales Project Leaders: Ambition North Wales, Transport for Wales, SPEN . AR: 2.05 (AD)	2026

Action, Action Reference (AR) and Project Leader	Estimated Timeline
Support greater awareness raising of UK Government funding for development of electric vehicle charging infrastructure such as the on-street residential charging scheme. Project Leaders: Ambition North Wales. AR: 2.06 (4F)	2028
Continue to support organisations such as local community car clubs to deliver community-oriented, low-carbon transport infrastructure and services. Project Leaders: Ambition North Wales; Welsh Government Energy Service. AR: 2.07 (4G)	2030 (Ongoing)
Establish a Regional Transport Officer's Group that provides a forum for collaboration and alignment between local and national government in addition to Transport for Wales. Project Leaders: Ambition North Wales. AR: 2.08 (R4.1)	2026
Explore opportunities around bus franchising across the region. Project Leaders: Ambition North Wales. AR: 2.09 (R4.2)	2026
Produce the first Regional Transport Plan (RTP) in line with that Welsh Government statutory guidance. Project Leaders: Ambition North Wales. AR: 2.10 (R4.3)	2026
Develop a national procurement framework for EV infrastructure. Project Leaders: Welsh Government: AR 2.11 (T.2.40)	2026

Deployment of renewable energy generation

Action, Action Reference (AR), and Project Leader	Estimated Timeline
Supporting the Pioneer Places working group/partnership, and funding applications that can drive the development of Community Energy Services in Blaenau Ffestiniog and Bethesda. - Engage with and look for opportunities to partner with local organisations to accelerate renewable energy installations across Gwynedd. - Collaborate with Ambition North Wales, local grassroots organisations, and Ynni Cymru to further investigate innovative models (including CESCOs). Look for opportunities for feasibility studies or pilots using local sites as examples for decarbonisation. Project Leaders: Cyngor Gwynedd, Local Organisations, Ambition North Wales. AR: 3.01	2028
Work with local community energy organisations to explore further community owned delivery or investment in solar PV and small-scale renewables including hydroelectricity. Project Leaders: Cyngor Gwynedd. AR: 3.02	2030 (Ongoing)
Explore the development of an investment prospectus for renewable developments currently in the pipeline. Project Leaders: Ambition North Wales. AR: 3.03 (G)	2026
Engage with Welsh Government to identify and build on opportunities that Ynni Cymru could provide to North Wales. Project Leaders: Ynni Cymru, Ambition North Wales. AR: 3.04 (2A)	2030 (Ongoing)

Action, Action Reference (AR), and Project Leader	Estimated Timeline
Explore how to improve communication of available funding sources for the development and delivery of a range of low-carbon power generation projects AR: 3.05 (2B)	2026
Support workstreams in increasing local ownership of energy projects to be delivered in line with proposed guidance on local and shared ownership in Wales. Project Leaders: Ynni Cymru, Ambition North Wales. AR: 3.06 (2D)	2030 (Ongoing)
Explore the potential of establishing an advice hub to support regional decarbonisation / low carbon energy initiatives. Project Leaders: Ambition North Wales: AR: 3.07 (2E)	2026
Maximise opportunities for public procurement to support the acceleration of renewable energy generation and secure local economic and social value. - Ensure that public procurement strengthens local supply chains / local jobs (social value) - Ask the supply chain to deliver against public sector carbon ambitions through procurement frameworks. Project Leaders: Ambition North Wales: AR: 3.08 (2F)	2030 (Ongoing)
Maximise opportunities for community benefits funds from energy infrastructure projects (on the distribution network) to support local and regional decarbonisation initiatives, recognising the need	2030 (Ongoing)

Action, Action Reference (AR), and Project Leader	Estimated Timeline
to target those communities and areas most impacted by such developments. Project Leaders: Ambition North Wales: AR: 3.09 (2G)	
Explore the opportunities that Power Purchasing Agreements could provide to energy generation across the region. Project Leaders: Ambition North Wales: AR: 3.1 (R.2.1)	2026
Continue to explore the opportunities presented by solar canopies in car parking spaces and the enablers to scale the technology across the region. Leaders: Ambition North Wales, Welsh Government Energy Service: AR: 3.11 (R2.2)	2027
Identify and explore opportunities for the development of renewables on public sector owned land. Project Leaders: Welsh Government, Trydan Gwyrdd Cymru. AR: 3.12 (RN 4.1)	2030 (Ongoing)

Reinforce and transition the energy networks

Action, Action Reference (AR), and Project Leader	Estimated Timeline
Cyngor Gwynedd and SPEN to work collaboratively to understand future demands (electricity) and use this to influence ED3 Planning and investment from OFGEM. Hold regular meetings. Project Leaders: Cyngor Gwynedd, SPEN, WWU. AR: 4.01 (N.2.2; N.3.3)	2026

Action, Action Reference (AR), and Project Leader	Estimated Timeline
Co-ordinate Net Zero clinics for Local Authorities to discuss decarbonisation of heat, transport and renewables strategies, and willingly contribute to workshops organised by the Local Authorities for local small-medium enterprises (SMEs). Project Leaders: SPEN; <u>WWU. AR: 4.03</u> (N.2.5)	2030 (Ongoing)
Discuss and agree any strategic optimisation opportunities with each local authority to continue progressing decarbonisation and economic growth plans. Project Leaders: SPEN; <u>WWU. AR: 4.04</u> (N.2.6)	2030 (Ongoing)
Plan a method to consolidate the pipelines for all energy-related projects across the electricity and gas/hydrogen networks. This will consolidate all actions planned by electricity and gas/hydrogen networks within an area into one common database. As a starting point, set up ongoing engagement meetings with DataMapWales (6), NGED SPEN, and WWU to coordinate if and how DataMap Wales (6) may be an appropriate platform to consolidate this information. Project Leaders: SPEN; <u>WWU. AR: 4.05</u> (N.1.3)	2030 (Ongoing)
Inform local authorities about available data resources by providing access to the DFES report and the resulting Network Development Plan (NDP) via SPEN's Open Data Portal (51) as well as other datasets such as heat maps, network infrastructure & usage. Requests for additional, bespoke reports can also be made via the portal. Project Leaders: SPEN; <u>WWU. AR: 4.06</u> (N.2.1)	2030 (Ongoing)

Action, Action Reference (AR), and Project Leader	Estimated Timeline
Provide low carbon technology (LCT) optioneering services to Local Authorities to support them with site optioneering (cost and timescale) for EV charging, heat pump rollout and renewable generation infrastructure planning. Proposed Leaders: <u>SPEN</u> . AR: 4.07 (N2.4)	2029
Use all relevant outputs from the LAEPs to inform SPEN's DFES (Distribution Future Energy Scenario) Report (52), in turn SPEN will share the trends and highlights from the DFES with individual local authorities Project Leaders: <u>SPEN</u> . AR: 4.08 (N.2.3)	2026
Publish findings from North Wales Conceptual Plan for hydrogen infrastructure. Project Leaders: <u>WWU</u> . AR: 4.09	2026
Highlight gas infrastructure opportunities. Support Local Authorities in exploring new opportunities to develop the existing gas networks in advance of 100% transition to existing hydrogen network. Project Leaders: <u>WWU</u> . AR: 4.10 (N.3.1)	2030 (Ongoing)
Include new projects from the LAEP in strategic planning process. Project Leaders: <u>WWU</u> . AR: 4.11 (N.3.2)	2027
Make the network hydrogen ready. Deliver programme to convert remainder of gas network not covered by the REPEX programme to enable a 100% hydrogen conversion, WWUs sustainability strategy from 2023 identifies a desire to complete this between 2035-2040. Project Leaders: WWU. AR: 4.12 (N.3.5)	2030 (Ongoing)

Action, Action Reference (AR), and Project Leader	Estimated Timeline
Develop hydrogen and bio-methane projects. Project Leaders: WWU. AR: 4.13 (N.4.4)	2030 (Ongoing)
Develop a more detailed understanding of potential hydrogen transport demand and incorporate this demand within existing network demands. This action will be supported by WWU's innovation project HyDrive (53) Project Leaders: WWU. AR: 4.14 (N.4.5)	2026

Enabling actions

Action, Action Reference (AR), and Project Leader	Estimated Timeline
Develop an internal Gwynedd Officer working group with representatives across the council to support the update of the Local Development Plan. Ensure the LAEP and associated evidence supports the review (and update where necessary) of energy policy. Project Leaders: Cyngor Gwynedd. AR: 5.01	2028
Continue to engage with key stakeholders including through knowledge sharing and dissemination of good practice and case studies including Welsh and UK Government to ensure policy alignment and businesses and communities. Project Leaders: Cyngor Gwynedd. AR: 5.02	2030 (Ongoing)
Engage communities in understanding their electricity needs, retrofitting opportunities, transportation requirements, and heating needs across Gwynedd. Project Leaders: Cyngor Gwynedd. AR: 5.03	2030 (Ongoing)
Assess the feasibility of businesses adopting local generation and explore local energy market development, identifying necessary support. Project Leaders: Cyngor Gwynedd, Local Organisations. AR: 5.04	2030 (Ongoing)
Ensure effective alignment between local, regional and national energy strategies, plans and initiatives. Project Leaders: Cyngor Gwynedd, Local Organisations. AR: 5.05 (A)	2030 (Ongoing)

Action, Action Reference (AR), and Project Leader	Estimated Timeline
Provide regional support in the delivery of commitments made in the Climate Action Wales public engagement strategy (July 2023) to help citizens take action to reduce demand, improve energy efficiency and use energy in a way which supports our vision. Project Leaders: Ambition North Wales. AR: 5.06 (D)	2030 (Ongoing)
Continue to explore and support opportunities for smart local energy systems in the region. Using outputs from the LAEP, map smart local energy system opportunities and identify feasibility/demonstrator projects collaboratively with organisations across the region and engage with key stakeholders including community energy groups and general public. Explore/identify revenue and capital funding resources. Project Leaders: Ambition North Wales. AR: 5.07 (I.1.3; F)	2030 (Ongoing)
Ensure alignment between the scope and function of the new Regional Energy Strategic Planners (RESPs) with Ofgem's policy design. Consultation of the policy design will be published in the summer of 2024 with the RESPs in operation by late 2025/early 2026. Project Leaders: Ambition North Wales, Ynni Cymru, Welsh Government. AR: 5.08 (R1.1)	2030 (Ongoing)
Ambition North Wales to support the Race to Zero campaign and provide oversight on carbon emissions across the region. Project Leaders: Welsh Government, Ofgem, National Grid ESO. AR: 5.09 (R1.2)	2030 (Ongoing)
Lead on developing the skills requirements identified in the Regional Skills Partnership's (RSP's) Green Skills Report and Welsh Government's Net Zero Skills Action Plan. Map and identify skills	2030 (Ongoing)

Action, Action Reference (AR), and Project Leader	Estimated Timeline
and labour needs and gaps up to 2050 for retrofit and low carbon new builds; renewable deployment; decarbonised transport and business / industry decarbonisation. Project Leaders: Ambition North Wales. AR: 5.1 (E.3.1;C)	
Review and develop educational programmes to meet skills needed. Project Leaders: Regional Skills Partnership (RSP)/ Welsh Government. AR: 5.11 (E.3.2)	2030 (Ongoing)
Develop a communication strategy to educate, promote skills, training and the need for a supply chain Project Leaders: Welsh Government. AR: 5.12 (E.3.3)	2030 (Ongoing)
Work with Welsh Government to create a governance structure and performance management framework for the LAEPs to facilitate monitoring of progress and performance of the LAEPs across the Region. Project Leaders: Welsh Government Energy Services, Ambition North Wales. AR: 5.13 (R1.5)	2026
Using the outputs from the LAEPs and REPs, create a national plan which covers the gaps such as national and regional assets. Project Leaders: Welsh Government. AR: 5.14 (E, 2.2)	2026
Develop the first regional Strategic Development Plan (SDP). Include policies in the plan that support low carbon building practices and low carbon new builds Project Leaders: North Wales Corporate Joint Committee. AR: 5.15 (R1.3)	2028

Action, Action Reference (AR), and Project Leader	Estimated Timeline
Support the emerging hydrogen economy, taking account of proposed hydrogen projects across the region. Project Leaders: Ambition North Wales. AR: 5.16 (E)	2030 (Ongoing)
Publish a Welsh Gov carbon intensity standard for hydrogen production. This standard can be used as a basis for future NRW permitting. Project Leaders: Welsh Government, Natural Resources Wales. AR: 5.17 (N4.4)	2030 (Ongoing)

National Targets

Action	Timeline
Up to 1GW of electric hydrogen secured (2025) [UK] (54)	2025
Decision on hydrogen to heat buildings (2026) [UK] (55)	2025
Up to 10GW hydrogen capacity (50% electrolytic) [UK] (54)	Progressing towards 2030
Up to 50 GW of offshore wind capacity including up to 5GW of innovative floating wind (2030) [UK] (54)	Progressing towards 2030
Future Homes Standard consultation suggests all space heating and hot water demand be met through low carbon sources in new builds (2025) (56)	2025
All new social homes built to Welsh Development Quality Requirements 2021 without fossil fuel heating (from 2025) (57)	2025
All existing social homes to have a plan for minimising environmental impact and improving energy performance (2027) [Wales] (58)	2025
-37% GHG emissions by 2025 (rel. to 1990) [Wales] (59)	2025
-63% GHG emissions by 2030 (rel. to 1990) [Wales] (59)	Progressing towards 2030

Action	Timeline
Meet the equivalent of 100% of electricity needs from renewable sources by 2035 [Wales] (60)	Progressing towards 2035
1.5GW of renewable capacity to be locally owned (exc. Heat pumps) (2035) [Wales] (60)	Progressing towards 2030
580,000 heat pumps to be installed in Wales by 2035, contingent on scaled up support from the UK Government and reductions in the cost of technology (2035) [Wales] (60)	Progressing towards 2030
Minimum EPC E to rent out any property (from 2020 onwards) and EPC C from 2030 [UK] (61)	2024
1 public charge point for every 7 to 11 electric vehicles (2025) [Wales] (62)	2025
Rapid charging available every 20 miles on the strategic trunk road (2025) [Wales] (62)	2025
-10% car miles travelled/person (2030) [Wales] (4)	Progressing towards 2030
80% new cars and 70% new vans sold to be 0 emissions (2030) (ZEV mandate) [UK] (63)	Progressing towards 2030
100% new cars and vans sold to be 0 emissions (2035) (ZEV mandate) [UK] (63)	Progressing towards 2035
Net zero public sector by 2030 [Wales] (64)	Progressing towards 2030

5. Next Steps



Figure 44. Community Energy Action

Our LAEP in the context of programmes and projects

Our LAEP gives us a good understanding of the current state of our local energy system, and what it will take to decarbonise it. We have set out a plan of action for the next 5-6 years (to 2030), and intend on delivering this subject to sufficient political, and financial support.

We have assessed each proposition against the diagram to the right in terms of which stage of the development journey it is at. To take each proposition to delivery, programmes and projects will need to go through the entire journey.

Figure 45 shows how projects move from context and vision setting to procurement and project delivery.

Stage 0 Context setting: This stage involves understanding the context, key challenges, strategic objectives as well as our role to support delivery.

Stage 1 Delivery option assessment: This stage involves the initial options exploration with the defining of potential long list commercial options, an appropriate evaluation framework and initial market testing. **Stage 2 Detailed project development (including market testing):** Following the initial long listing exercise, detailed development of a shortlist of potential commercial options will be developed and tested with the market. This process will be iterative, as options will be refined based on feedback from the market as well as commercial and technical limitations

Stage 3 Procurement and project delivery: Stage will include selection of the commercial delivery option which best delivers the objectives and is commercially deliverable. This will be taken forward to procurement (if required) and subsequent delivery.

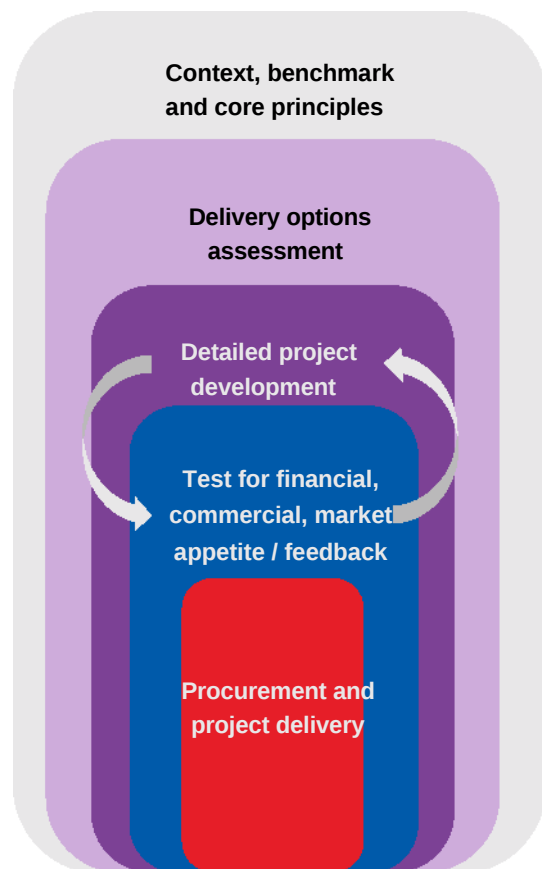


Figure 45. How programmes and projects develop stages 0-3.

During the LAEP process, we have developed the context and vision for four propositions. Whilst, for each of these, we have started work and delivered some projects, there is a need for a different scale of investment and change to reach net zero.

This means that, as well as continuing in delivering individual projects, we also take the first next step for each of our propositions in considering the delivery options.

Transition to low carbon buildings

For the transition to low carbon buildings, we have been supporting the delivery of this transition, with a focus on social housing and on our own council estate. There is still work for us to do here, and this will remain a focus for us. In order to deliver at scale across other tenures and building types, we know that we need to investigate new funding and financing mechanisms to support delivery. Ambition North Wales has committed to supporting this first next step for all the Local Authorities in North Wales.

Decarbonise the transport system

As with the rest of the UK, transport emissions in Gwynedd remain significant, and as a rural area, large parts of our population are reliant on the car. We have developed a plan to decarbonise our own council fleet and have been supporting the roll out of EV charging facilities, as well as community organisations, such as car clubs. However, we have a long way to go to scale up to deliver the scale of change needed. This will largely be done at a regional level, recognising the Regional Transport Plan that is being developed over the next year.

Increase renewable energy generation

We already have over 100MW of renewable energy generation being produced across the county. We will continue to support renewable development, especially at a community scale, recognising the wider benefits that this can bring. However, we recognise that overall, we will need to enable over 200 MW more renewables, and so we need to deliver at all scales to deliver the change we want to see.

Reinforce and transition the energy networks (gas and electricity network)

As a highly rural area, we only have half of the properties in our area connected to the gas network. This means that within our other propositions, we need to consider opportunities for smart local energy systems to minimise reinforcement needs. SPEN and WWU have both been engaged in the development of this LAEP and have committed to continue to working across Gwynedd to support the energy transition.

Governance

Progressing through energy propositions

Gwynedd's LAEP gives us a good understanding of the current state of our local energy system, and what it will take to decarbonise it. We have set out a plan of action for the next five-six years (until 2030) and will aim to deliver this collectively subject to sufficient political, and financial support.

We recognise that this will involve building on the opportunities identified in this LAEP to scope viable projects and programmes that take us closer to our energy system vision. Some of our programmes and projects will require further development, and so we will prioritise any further research or studies needed before moving ahead with implementation. Any research or feasibility studies will include financial modelling. We will work with Ambition North Wales, Welsh Government and stakeholders to identify funding opportunities, and we will encourage relevant local organisations and/or groups to undertake development activities to progress towards delivery (such as feasibility studies, detailed technical and commercial development, business case and procurement).

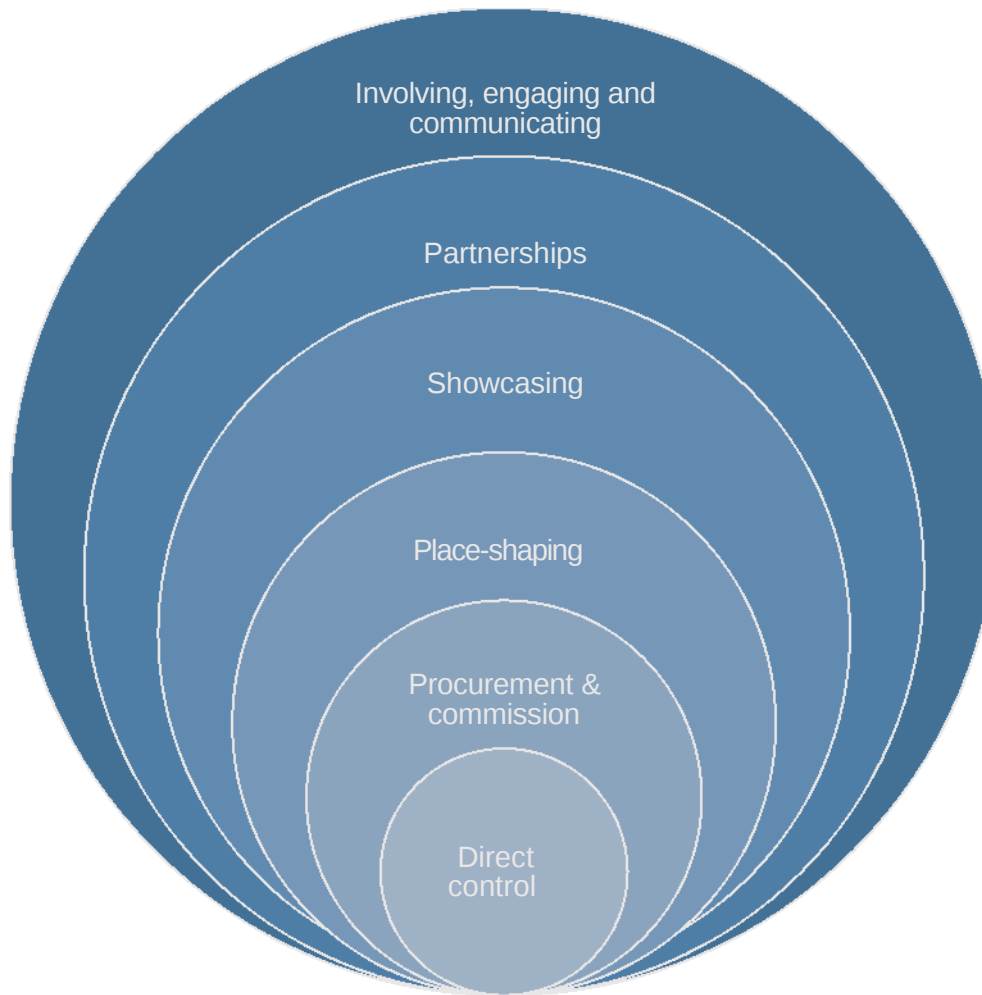


Figure 46. Local Authority roles and level of influence to control (descending)

Governance

We want to make sure that there is a well-defined governance structure for managing the delivery of the LAEP. As an area-wide plan it is the responsibility of all who live and operate in the area to support its delivery, and the chosen governance framework will need to reflect this. As a Council, will seek to bring the delivery of our LAEP into alignment with our plans for delivering our Climate and Nature Emergency Plan and other plans where activities are mutually beneficial for addressing the climate emergency and meeting our climate change targets. We intend to align governance arrangements for the LAEP with those for our Climate and Nature Emergency Plan. Both would be subject to oversight by the council's Climate and Nature Board which in turn is answerable to the council's Cabinet and Communities Scrutiny Committee.

Roles and responsibilities

The Council's role in each action will vary. Some actions call for Council action in the delivery of programmes, whilst other actions involve the Council as a convener, or co-ordinator between multiple organisations.

Planning Authority:

Preparing planning policies and allocating land in our Local Development Plan (LDP).

Development management – taking decisions on planning applications submitted to the local planning authority for development; as well as preparing Environmental Impact Assessments for schemes determined by the Infrastructure Planning Commission

Place-maker:

- Taking action at a Council wide level to achieve a low carbon economy.
- Taking forward wider community action and communicating the need to increase the uptake of renewable energy.

For this delivery of the LAEP and our own Climate and Nature Emergency Plan to be successful, we will require a collective, co-ordinated effort from many different stakeholders, which means closer collaboration between the Council and our partners, and building relationships with key stakeholders that hold influence over different parts of the energy system. We will leverage our existing partnerships to do this, such as the Public Sector Board (PSB), Public Sector Decarbonisation Group and others.

Regional role

Developing this LAEP in close collaboration with other local authorities in Wales recognises that a consistent, co-ordinated plan for the energy system in North Wales can bring wider benefits, ensure decisions are made effectively whilst minimising any knock-on effects in other areas. Taking this approach recognises the environmental, economic and social dependencies between different local areas and local energy systems. Ambition North Wales, a regional representative in national discussions on energy, as well as responsible for coordinating North Wales' Energy Action Plan and managing the North Wales Growth Deal, recognises its critical role in endorsing this way of working, and how it might support this approach where it is most effective:

- Act as a regional resource to support local authorities to deliver their LAEPs.
- Ensure effective alignment between each LAEP, North Wales Regional Energy Strategy and the emerging National Energy Plan.
- Develop the skills requirements identified in the Regional Skills Partnership's Green Skills Report and Welsh Government's Net Zero Skills Action Plan.
- Encourage, facilitate and support a joined-up approach to delivering local actions that are common across the region to be efficient, effective and consistent (e.g. cross-border collaboration on funding applications).
- Facilitate engagement between local authorities and regional stakeholders e.g. continue to facilitate forums like the Regional Steering Group, where updates and support can be shared regionally between local authorities, networks and other local and regional stakeholders.

- Provide regional support in the delivery of commitments made in the Climate Action Wales public engagement strategy (published July 2023) to help citizens take action to reduce demand, improve energy efficiency and use energy in a way which supports our vision.

National perspective

Welsh Government has committed to achieving net zero emissions in Wales by 2050 and recognises that a significant part of this will depend on transforming the energy system to enable the reduction and decarbonisation of energy generation and use in Wales. From a national perspective, the LAEPs will help Welsh Government to:

- Understand local energy needs and priorities and how this might influence national energy infrastructure planning
- Gauge the level of ambition and engagement from Local Authorities and what policy and/or institutional support might be needed to empower Local Authorities to drive energy innovation at a local level.

Having a Local Area Energy Plans (LAEP) for every Local Authority in Wales presents a unique opportunity for Welsh Government to develop a national energy plan that is coherent with local energy priorities and needs and identifies ways to accelerate the transition at pace and scale. Wales's national energy plan will bring this all together and provide clarity on the most cost-effective route to net zero. Its delivery will only be a success if there are suitable governance frameworks in place and allocated powers for Local Authorities and regional organisations to take a leading role in delivery.

Finance

For those actions that relate directly to our statutory duties as a local council and align with our immediate priorities, we will develop an investment plan to support the delivery of a Local Authority programme of works to enable the delivery of the LAEP. This may be from

usual capital markets or through more innovative financing mechanisms such as community municipal investments, Pay as you Save or net-metering. Innovative finance options to be explored for individual energy consumers such as green mortgages.

For actions that are best delivered by other local, regional or national organisations, partnering and engaging with these organisations will be critical for discussing Gwynedd's ambitions and how to make them investable.

Monitoring and review

This plan sets out key actions that will be taken by various stakeholders across Gwynedd for the first five-six years (until 2030) to set the local area on a journey to achieve a net zero energy system. The plan needs to be flexible to adapt to changes in the future.

We will work with regional and national partners to develop a monitoring framework which builds on existing data and processes and helps us understand the progress the county is making towards its committed actions and ambitions set out in this plan.

We will make use of publicly available datasets such as the Energy Performance Certificate Register (65), the Micro Generation Certification Scheme (66), the Renewable Energy Planning Database and publications such as Renewable Generation in Wales report (45) (67). We will also track GHG emissions reduction, building on our existing submissions to Welsh Government for Public Sector Reporting as a starting point. We recognise that available data will lag a few years behind.

Our action routemap has been developed as a dynamic plan that recognises the influence that wider contextual changes at national and local level will have on the way we choose to transition to a net zero energy system, such as national regulation, policy and strategic plans. As a result, we expect to regularly review and update our routemap based on these dependencies.

The whole plan will be updated at least every five - six years to take account of key factors, including policy changes at a UK and Welsh Government level, changes in costs and the effectiveness of technologies.

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Glossary

Term	Definition or meaning
Action	The process of doing something – a specific action assigned to a responsible person preferably with a date to be completed.
Anaerobic Digestion	Processes biomass (plant material) into biogas (methane) that can be used for heating and generating electricity.
Baseline	The baseline is the data showing the current energy system, containing the 2019 data sets provided by the LA and publicly available data.
Batteries	Devices that store electrical energy to be used at a later time.
Biomass boiler	A boiler which burns wood-based fuel (e.g. logs, pellets, chippings) to generate heat and electricity.
Carbon Capture and Storage (CCS)	The process of capturing and then storing carbon emissions before they enter the atmosphere.
Certainties	A fact that is definitely true or an event that is definitely going to take place. In terms of a local energy system, uncertainties include funded projects, etc.

Term	Definition or meaning
Demand	Local energy demand that the local energy system needs to meet.
Demand headroom	The difference between the electrical capacity of a substation, and the electricity demand at the substation at the time of peak demand.
Deployment modelling	A model investigating rates by which to deploy specific technologies between the baseline year and 2050 to achieve the end state developed by the optimisation model for each scenario. The model considers broader plan objectives and local, regional, and national strategic priorities, policies, and targets to help us to define a suitable level of ambition and inform an action plan.
Dispatchable energy generation	Energy generation that can turn on and off (i.e. isn't controlled by the weather) – this is likely to be gas turbines of some sort.
Distribution network	Takes energy from transmission network and delivers it to users via pipes or wires at low pressure / voltages.
Electricity network	Interconnected infrastructure which consists of power stations, electrical substations, distribution lines and transmission lines. The network delivers electricity from the producers to consumers.
Electrolyser	A piece of equipment that uses electricity to split water into hydrogen and oxygen.

Term	Definition or meaning
Energy Proposition	A proposition is an energy component with a scale and a timescale. For instance, X MW of wind turbine to be built in 5 years, 10,000 buildings to retrofit with XX by 2030, or a pilot project such as hydrogen storage innovation. These are typically near term, low regrets energy components that are needed in future energy systems (it is likely that these appear in all scenarios).
Focus zone	A modelling zone which has been identified as an area in which to target near-term installation, upgrade, retrofit, or other activities related to a specific energy system component.
Generation	Local generation – size below 100MW.
Grid electricity	Electricity that is supplied by the electricity network.
Grid substation	The physical equipment comprising a substation with a 132kV-33kV transformer(s) connecting the grid-level, extra high voltage electricity lines to the primary-level, high voltage electricity lines. The grid substation facilitates connection with the national grid.
Heat network	A distribution system of insulated pipes that takes heat from a central source and delivers it to a number of domestic or non-domestic buildings.

Term	Definition or meaning
Heat pump	A piece of equipment that uses a heat exchange system to take heat from air, ground or water and increases the temperature to heat buildings.
Hydrogen	A flammable gas that can be burned, like natural gas, to generate heat or power vehicles. The by-product is water only, no carbon.
Hydrogen Combined Cycle Gas Turbine (CCGT)	Hydrogen is combusted and the heat produced is recovered to produce steam. This steam is used to drive a steam turbine which turns a generator to produce electricity.
Infrastructure	Local energy distribution infrastructure, includes storage assets if these are at grid level.
Landfill gas	Gases such as methane that are produced by micro-organisms in a landfill site that can be used as a source of energy.
Lever	We use the term policy levers to refer to the 'governing instruments' (Kooiman, 2003) which the state has at its disposal to direct, manage and shape change in public services.
Local energy system	The distribution level energy system, excludes the transmission and national assets.
Longer-term options	The likely outcome of these is less certain and dependent upon actions and decisions being made that are not under our control, e.g. a national policy or the capability / availability of a technology.

Term	Definition or meaning
Major industrial load	The power demand of industrial sites in the 2019 NAEI Point Sources data are large enough to be classified as major industrial loads. Sites that aren't included in this database are likely too small to have a significant impact on the energy system singlehandedly.
Methane reformation	Process of producing hydrogen by heating methane from natural gas and steam, usually with a catalyst. Produces carbon dioxide as a by product.
Microgeneration	Small-scale generation of heat and electricity by individuals, households, communities or small businesses for their own use.
Modelling zone	A specified area in our modelling which is the smallest level of granularity for analysis. The zones are used through energy modelling, deployment modelling, and mapping. Zones were created by intersecting the Local Authority boundary with the primary substation service area boundary, as described in the "Methodology - electricity and gas network infrastructure" section of the Technical Report. May also be called "zone" or "substation zone" in the reports.
National Asset	National infrastructure (can be supply or demand and the accompanying transmission / distribution infrastructure) – defined as over 100 MW, unless it produces heat which can only be used locally this is generally excluded from LAEP particularly the modelling.

Term	Definition or meaning
National Net Zero	The National Net Zero modelled in the LAEP. Details of assumptions are in the methodology section.
Natural Heritage	This includes features which are of ecological, geological, geomorphological, hydrological or visual amenity importance within the landscape, and which form an essential part of the functioning of the natural environment and natural assets of RCT.
Net Zero	Net Zero when used in this LAEP is the energy Net Zero as it does not include all emissions, only energy emissions.
No regrets/ low regrets	Options which are common to all scenarios, cost-effective, provide relatively large benefits, and are very likely to be important parts of the future energy system, regardless of future uncertainty.
Optimisation modelling	Modelling to create the most cost and carbon optimal system.
Outward code	The first part of a postcode i.e. BS1.
Pathway	A pathway is how we get from the current energy system, to the most likely Net Zero end point. The pathway will consider what is needed from across the scenarios, the supply chain, number of installers etc. The propositions will make up the more certain part of the pathway, whereas the longer-term energy components will need further definition in the future.

Term	Definition or meaning
Power purchase agreement (PPA)	A contract between two parties where one produces and sells electricity and the other purchases electricity.
Primary substation	The physical equipment comprising a substation with a 33kV-11kV transformer(s) connecting the primary-level, high voltage electricity lines to the consumer-level, low voltage electricity lines.
Primary substation service area	The area bounding the buildings or other electricity demands which are served by a primary substation (or, in ANW, a group of primary substations acting together to serve one area).
Programme	A series of projects, usually with a theme, that is run collectively.
Project	Strategic scale projects being implemented or planned for implementation in the local energy system that will significantly affect local demand or local supply.
Quick win projects	Very short-term actions, certain as no major blockers.
Resistance heating/ heater	Generates heat by passing electrical currents through wires.

Term	Definition or meaning
Scenario	A scenario is a set of assumptions for a particular end point (usually 2050) which are modelled in our optimisation model. We modelled 5 different scenarios to see what was common across the scenarios and therefore is a “no regrets” measure, and what changed between the modelled scenarios.
Sensitivities	Sensitivities of a specific scenario can be tested – for instance to test the impact of increasing electricity/hydrogen prices on the scenario. Testing a sensitivity is when you change one thing multiple times to assess the impact on the cost/carbon.
Sewage gas	A mixture of gases generated in sewer systems, used in a reciprocating gas engine to produce heat and electricity.
Solar PV	Convert solar radiation into electricity using photovoltaic (PV) cells.
Super Grid Transformer (SGT)	A transformer found at electricity substations that step up/down the voltage for onward distribution.
Strategic objective	Strategic objectives are purpose statements that help create an overall vision and set goals and measurable steps to achieve the desired outcome. A strategic objective is most effective when it is quantifiable either by statistical results or observable data. Strategic objectives further the vision, align goals and drive decisions that impact change.

Term	Definition or meaning
Strategic options	Strategic options are longer-term changes to demand, generation and infrastructure that will lead onto decarbonisation of the local energy system - and the key variables that determine scenarios.

Units of Measure

Unit	Definition or meaning
°C	Degree(s) Celsius – a unit of temperature on the Celsius scale.
GWh	Gigawatt hour(s) – a unit of energy representing 1 billion watt-hours.
kgCO ₂ e	Kilogram(s) of carbon dioxide equivalents – a unit of measurement for greenhouse gas warming potential, expressing the equivalent weight of carbon dioxide with the same global warming potential.
ktCO ₂ e	Kilotonne(s) of carbon dioxide equivalents - a unit of measurement for greenhouse gas warming potential, expressing the equivalent weight of carbon dioxide with the same global warming potential. Represents 1 million kgCO ₂ e.
kV	Kilovolt(s) – a unit of potential energy of a unit charge in a point of a circuit relative to a reference (ground) representing 1000 volts.
kW	Kilowatt(s) – a metric unit of power measuring rate of energy consumption or production representing 1000 watts.
kWh	Kilowatt hour(s) - a unit of energy representing 1000 watt-hours.
kWp	Peak kilowatt(s) – the maximum power rating possible produced by an energy generation source (i.e., amount of power produced in ideal generation conditions).

Unit	Definition or meaning
MW	Megawatt(s) – a metric unit of power measuring rate of energy consumption or production representing 1 million watts.
MWe	Megawatt(s) electric – a unit of electric power output from a generation source representing 1 million watts electric.
MWth	Megawatt(s) thermal – a unit of thermal power output from a generation source representing 1 million watts thermal.
MWh	Megawatt hour(s) - a unit of energy representing 1 million watt-hours.
tCO₂ per capita	Tonne(s) of carbon dioxide per capita – a unit of mass of carbon dioxide emitted per member of a population per year. Represents 1000 kgCO ₂ per capita.

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