Local Area Energy Plan (LAEP)

Monmouthshire County

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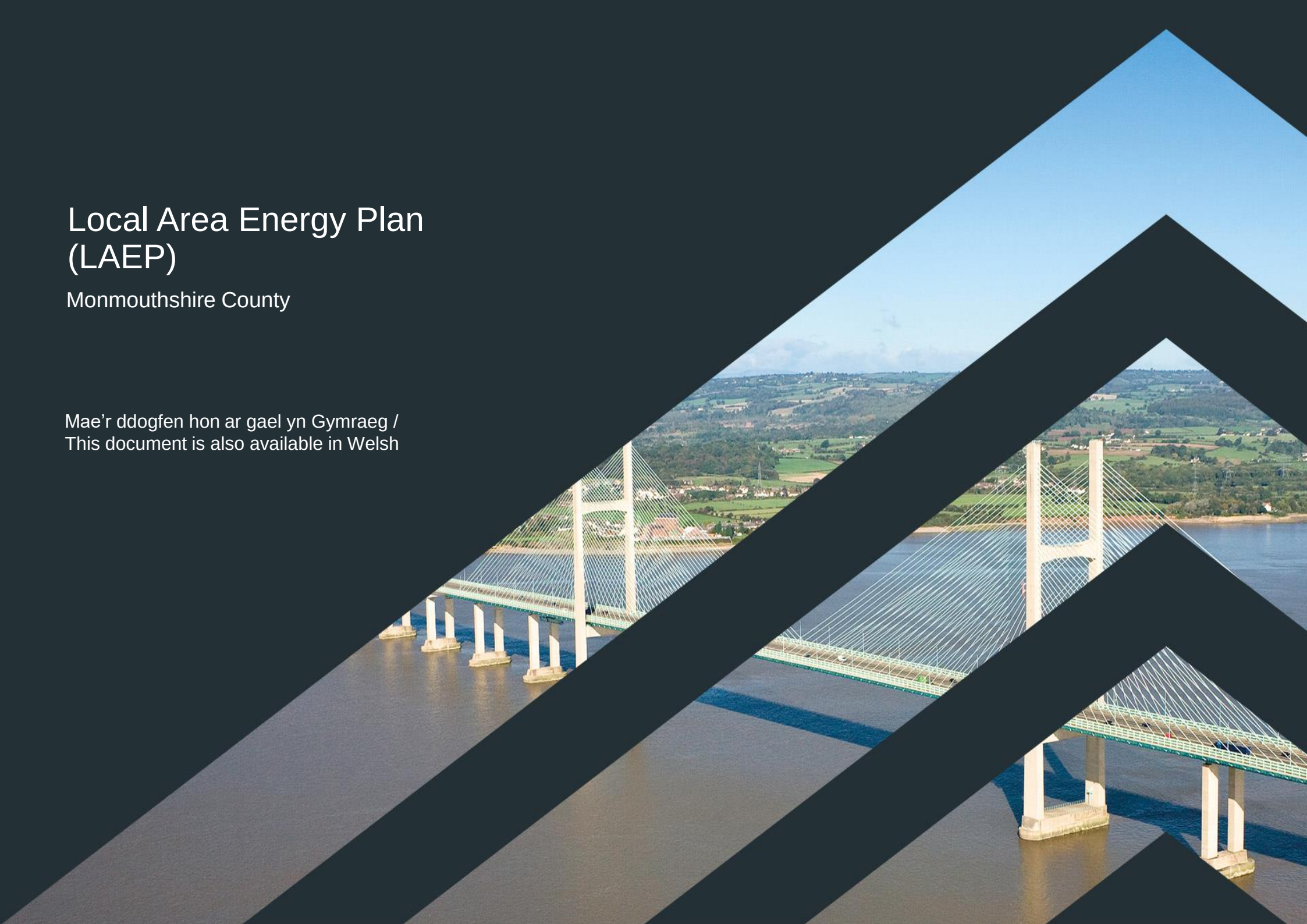
This document is also available in Welsh



Abbreviations

Acronym	Definition or meaning
ANW	Ambition North Wales
BEIS	Business, Energy and Industrial Strategy.
CAPEX	Capital Expenditure.
CCGT	Combined Cycle Gas Turbine.
CCR	Cardiff Capital Region
CCUS	Carbon Capture, Utilization and Storage.
CPO	Charge Point Operator.
COP	Coefficient of Performance.
DESNZ	Department for Energy Security and Net Zero.
DFES	Distribution Future Energy Scenarios.
DfT	Department for Transport.
DNO	Distribution Network Operator.
ECOFLEX	Flexible Eligibility Energy Company Obligation.
ECR	Embedded Capacity Register.
EfW	Energy from Waste.

Acronym	Definition or meaning
EGW	Energy Generation in Wales.
EPC	Energy performance certificate.
ESC	Energy Systems Catapult.
EV	Electric Vehicle.
FES	Future Energy Scenarios.
GDN	Gas Distribution Network.
GHG	Greenhouse Gas.
GIS	Geographic Information System.
HGV	Heavy Goods Vehicles.
LAEP	Local area energy planning or Local area energy plan.
LDP	Local Development Plan.
LGV	Light Goods Vehicles.

Abbreviations

Acronym	Definition or meaning
LSOA	Lower super output area, a 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, a medium-sized area classification in the UK designed to have a comparable population.
NAEI	National Atmospheric Emissions Inventory.
NGED	National Grid Electricity Distribution.
NZ	Net Zero.
NWTM	North Wales Transport Model.
NZIW	Net Zero Industry Wales.
OPEX	Operational Expenditure.
OS	Ordnance Survey.
PRI	Pressuring Regulating Installation.
RdSAP	Reduced data Standard Assessment Procedure.
REA	Renewable Energy Assessment.
REPD	Renewable Energy Planning Database.

Acronym	Definition or meaning
REPEX	Replacement Expenditure.
RFI	Request for Information.
RIIO	Revenue = Incentives + Innovation + Outputs, a regulatory framework used by the UK energy regulator, Ofgem.
RLCEA	Renewable and Low Carbon Energy Assessment.
RSP	Regional Skills Partnership.
RTP	Regional Transport Plan.
SAP	Standard Assessment Procedure.
SEWBCC	Southeast Wales Business Climate Coalition.
SEWTM	Southeast Wales Transport Model.
SDP	Strategic Development Plan.
SLES	Smart Local Energy System.
SPEN	SP Energy Networks.

Abbreviations

Acronym	Definition or meaning
SSE	Scottish and Southern Energy plc.
SWIC	South Wales Industrial Cluster.
TEC	Transmission Embedded Capacity.
TfW	Transport for Wales.
WIMD	Welsh Index of Multiple Deprivation.
WWU	Wales and West Utilities.

Sponsors: Delivery partners:

Contents

This Local Area Energy Plan was prepared by Arup, Carbon Trust and Afallen on behalf of Monmouthshire County and co-ordinated across the region by the Cardiff Capital Region. Energy Systems Catapult is the Technical Advisor for the LAEP Programme in Wales. The Plan's development was funded by the Welsh Government.

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Local Area Energy Plan outline

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

Overview

As part of this project, three 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 three documents are the:

1. **Local Area Energy Plan** *(this document)* contains the overarching plan, focusing on the Monmouthshire County'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 was taken. This report is available upon request.
3. **Renewable Investment Prospectus** highlights short-term, regional and local renewable energy opportunities that have the greatest potential for delivery across the Cardiff Capital Region (CCR).

Achieving the transformation that is needed for the energy system to reach net zero will not be easy and will need a collaborative approach.

The Council and the CCR have taken facilitating roles in developing this Local Area Energy Plan (LAEP), but will not deliver the ambition it sets out alone. The Plan has been developed with input from a range of stakeholders.

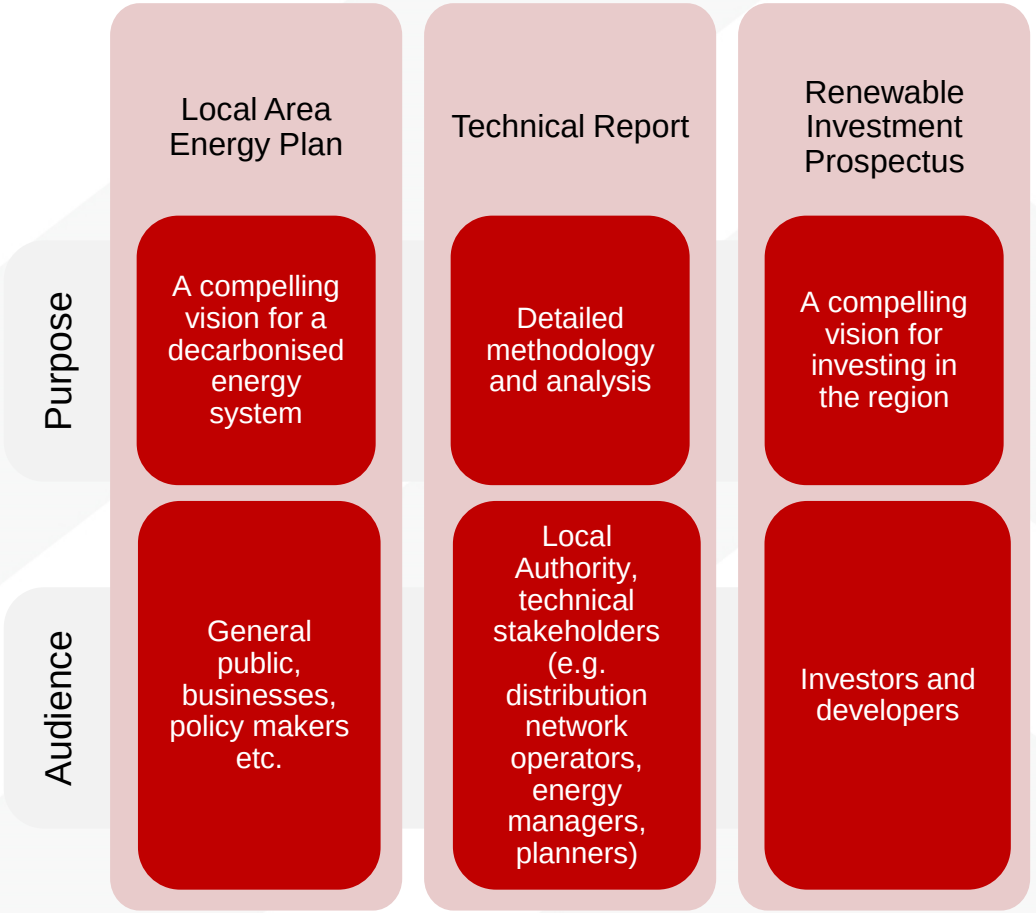

Figure 0.1: LAEP and support documents purpose and audience summary.

Sponsors: Delivery partners:

Executive summary

Monmouthshire County has a vision to transition the local energy system to net zero

Monmouthshire County's future local energy system **vision** is:

To become a zero carbon county, supporting well-being, health and dignity for everyone at every stage of life.

Monmouthshire County's **objectives** are collectively agreed and describe what needs to be done to create the enabling conditions needed to deliver this LAEP. The following objectives reflect the Monmouthshire County Council Corporate and Community Plan priorities:

1. Fair place to live where the effects of inequality and poverty have been reduced;

2. Green place to live and work with reduced carbon emissions, making a positive contribution to addressing the climate and nature emergency;

3. Thriving and ambitious place, full of hope and enterprise;

4. Safe place to live where people have a home where they feel secure in;

5. Connected place where people feel part of a community, are valued and connected to others;

6. Learning place where everybody has the opportunity to reach their potential.

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

Improve energy efficiency of existing buildings

Decarbonise transport

Generate green hydrogen for transport and industry

Deploy onshore renewables

Reinforce electricity networks

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Executive summary

Monmouthshire County's energy proposals in more detail

Improve energy efficiency of existing buildings

Enhance the energy efficiency of existing buildings through retrofitting measures aimed at reducing overall electricity and heating demand, whilst also transitioning away from fossil fuel-intensive heating systems to more efficient, low-carbon technologies.

Low-regret options:

- Fabric Retrofit
- Heat pumps
- Rooftop solar PV

Decarbonise transport

Reduce transport demand by improving active travel routes and expanding the public transport network. Increase the number of EV chargepoints and explore hydrogen for long-range vehicles.

Low-regret options:

- EV chargers

Generate green hydrogen for transport and industry

Engage with industry to support energy efficiency improvements to site processes. Furthermore, explore options to produce green hydrogen and assess its potential industrial and transport applications.

Low-regret options:

- Hydrogen

Deploy onshore renewables

Increase renewable energy output by reviewing and updating renewable energy generation targets. Proactively engage with local planners and developer to drive installation of generation assets.

Low-regret options:

- Ground-mounted solar PV

Reinforce electricity network

Support reinforcement of the electricity network to make sure future electricity demand can be met.

Low-regret options:

- Flexibility, storage technologies

Figure 0.2: Summary of energy propositions

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Executive summary

Monmouthshire County's local energy system will need to change significantly to achieve net zero by 2050

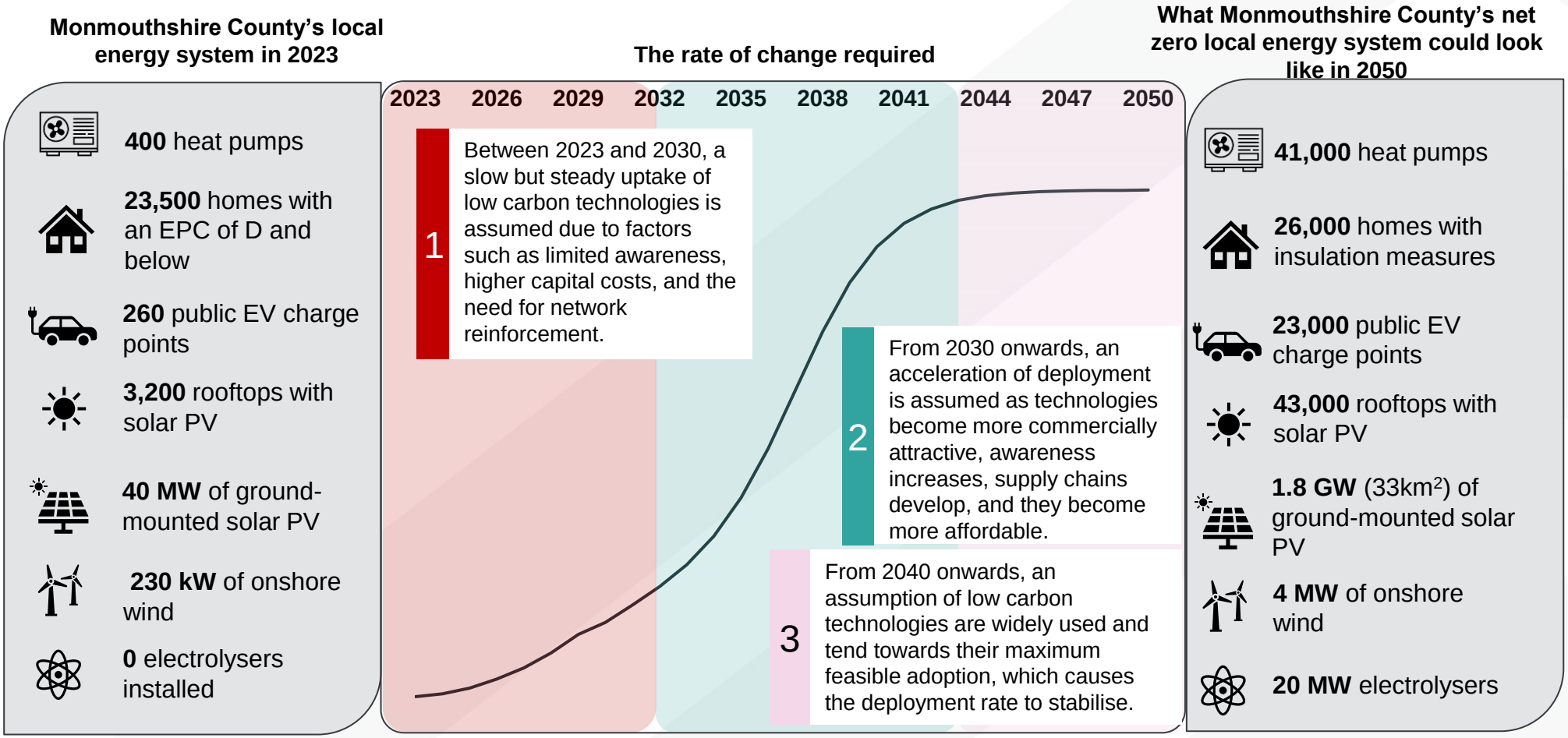


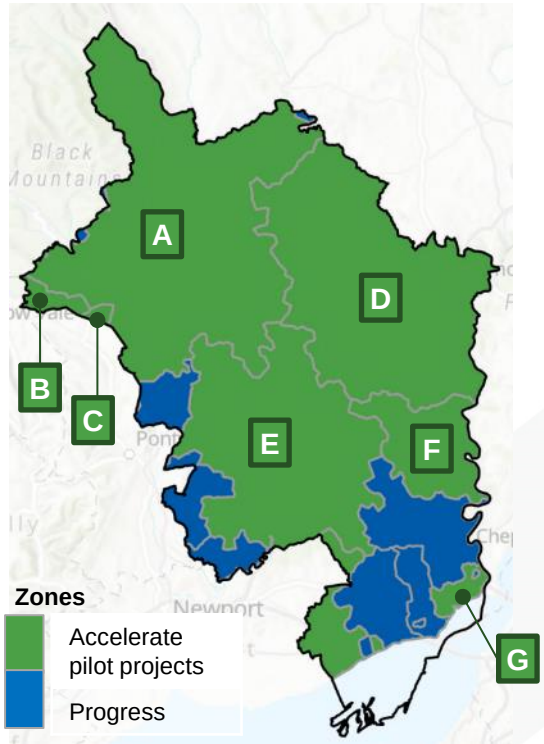
Figure 0.3: Summary of change required to the local energy system

Note: The future energy system modelling sets out the scale of change required to reach net zero, however the trajectory is an illustration which is dependent on many factors, Certain factors, such as planning restrictions and network reinforcement, have not been considered.

Executive summary

To support transformation of the energy system, pilot projects may be useful. The map below highlights areas that could provide a useful focus for these pilots

Figure 0.4 identifies zones with particularly favourable conditions for specific energy components, making them ideal locations for pilot studies. The summary tables detail key figures for each zone by 2030: (i) pilot ambition, (ii) required investment for each pilot and (iii) total investment for all energy components and electricity network infrastructure interventions. Ranges show the minimum and maximum results from each future energy scenario modelled (see page 41 for more detail). Intervention should still be carried out in 'Progress' zones to transition the local area to Net Zero.



	(i)	(ii)	(iii)
Zone A			
	1,700 – 4,700 homes	£ 17 – 312 M	**Zone A total** £ 39 – 330 M
	400 – 500 chargers	£ 110 – 210 k	
Zone B			
	22 – 35 heat pumps	£ 110 – 160 k	**Zone B total** £ 950 k – 9.8 M
	68 – 177 homes	£ 570 k – 9.4 M	
Zone C			
	4 – 5 chargers	£14 – 18 k	**Zone C total** £ 14 – 18 k
Zone D			
	110 MW	£ 49 M	**Zone D total** £ 84 – 270 M

	(i)	(ii)	(iii)
Zone E			
	5 MW	£ 3.8 M	**Zone E total** £ 76 – 185 M
	151 MW	£ 60 M	
Zone F			
	230 – 420 homes	£ 2 – 42 M	**Zone F total** £6 – 46 M
Zone G			
	11 MW	£ 8.4 M	**Zone G total** £15 – 40 M

Suggested energy components to pilot in each zone (colour indicates the relevant proposition)

Heat pumps (P1)	EV charger (P3)
Insulation measures (P1)	Ground-mounted PV (P2)
Rooftop PV (P1)	Onshore Wind (P2)

Figure 0.4:' Monmouthshire County's spatial representation of opportunities, including 2030 ambition and investment (£).

Note: The proposals use modelling assumptions and do not reflect planning and other constraints.

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Executive summary

To deliver the LAEP, a series of actions and next steps have been developed

Action routemap

Although the exact form of the decarbonised energy system in 2050 is uncertain, there are actions that can be taken now with relative certainty that will help maintain the ability to meet the 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 to take collectively alongside stakeholders in the coming decade, with a particular focus on what can be achieved 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, there is an expectation that it to evolve over time and be regularly updated to make sure it stays relevant as set out in the LAEP guidance. Monmouthshire County's routemap can be found in Chapter 4: Action planning.

Next steps

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

Governance: Where possible, oversight of LAEP delivery will be integrated within existing governance structures.

Monitoring: CCR will work with local, regional and national partners to develop a monitoring framework which builds on existing processes and helps understand the progress Monmouthshire County is making towards the committed actions and ambitions set out in this plan.

Engagement & collaboration: Many stakeholders with an interest have influence over the local energy system came together to help shape this LAEP, and it is important that this collaboration continues throughout delivery of the plan.

Monmouthshire County

Chapter 1: Introduction

1. Introduction

What is Local Area Energy Planning (LAEP)?

Overview

Definition of a LAEP

A LAEP sets out the changes required to transition an area's energy system to net zero carbon 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[M01]. The process follows standardised guidance defined by ESC.

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[M01].

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 implementation[a].

Vision of a LAEP

A LAEP defines a long-term vision for an area. However, as set out in the LAEP guidance 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.

[a]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.

1. Introduction

What is Local Area Energy Planning (LAEP)?

Overview

Scope of a LAEP

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).

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

A LAEP provides a long-term plan to deliver net zero. A benefit of LAEP is the 'whole systems approach', aligned to the Wellbeing of Future Generations Act "way of working" on integration. This provides consideration to the most cost-effective solutions to future energy system at the right time 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.

1. Introduction

The energy transition across Wales

The Welsh Government's "Net Zero Wales" plan[M03] 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 LAEPs to all its local authorities. The programme is being coordinated through a regional approach, where LAEPs are being developed for local authorities in Mid Wales, South West 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 Figure 1.1.

To contribute to the Welsh Government's commitment of producing a "National Energy Plan", upon completion of the LAEP programme Energy Systems Catapult (ESC)[M04] 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[M05] platform. ESC is also providing technical advisory support to Welsh Government throughout the programme.

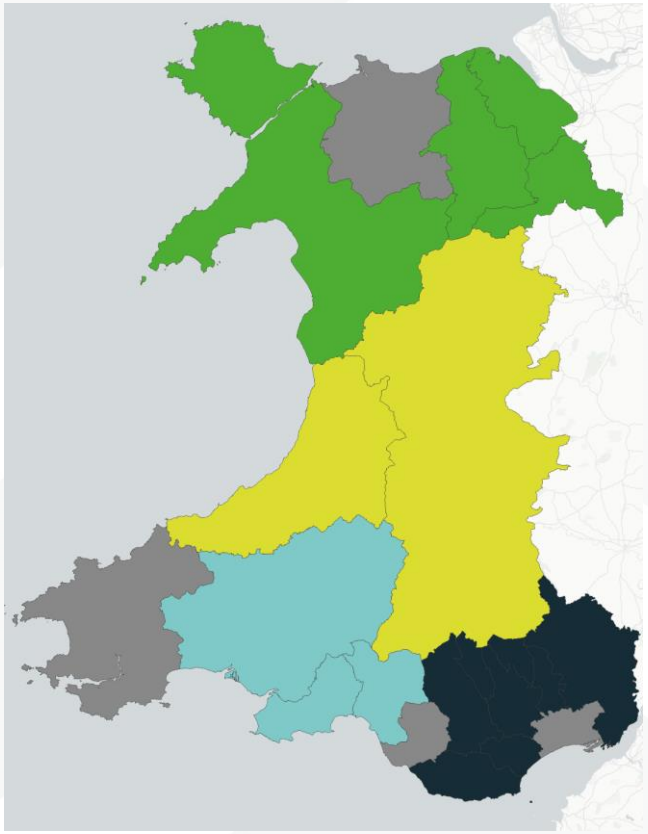


Figure 1.1: LAEP landscape across Wales

1. Introduction

Boundary and scope

Parts of the energy system analysed in a LAEP

This LAEP considers energy use, supply and generation within the Monmouthshire County boundary.

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. required for the energy system to operate.

Fuel for transport, heat and power in buildings and heat and power for industrial processes and other energy needs are considered together in the planning process to ensure that the interactions and dependencies between the generation and use of different energy sources across different sectors are fully considered. This can also help to identify where different systems can work better together to improve the overall resilience and flexibility of the energy system.

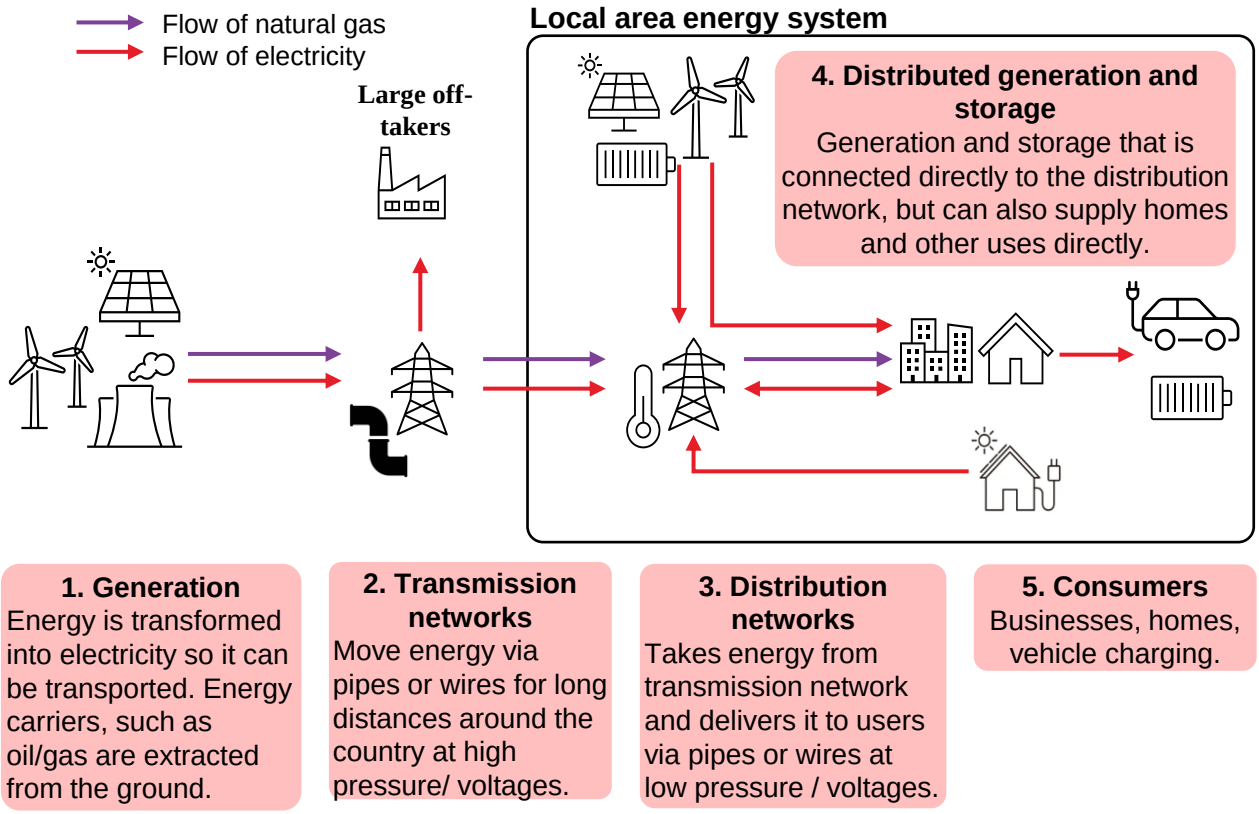


Figure 1.2: Schematic of electricity and gas transmission and distribution network and the system boundary for LAEP

1. Introduction

Boundary and scope - Definitions

Scope for the Welsh LAEPs

The diagram to the right indicate 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. [M01]

The geographic boundary for Monmouthshire County is used to set the boundary for the LAEP, which meant that any energy generating assets, energy use and infrastructure in that boundary were considered for inclusion in the LAEP.

Exclusions from the LAEP

LAEP does not consider aspects of the energy system which are expected to be overseen by central government, or any non-energy sources of greenhouse gas (GHG) emissions occurring within the Local Authority's governing boundary (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 (such as offshore wind, grid scale batteries, hydrogen production) are considered national assets and excluded from the modelling, however these may also play an important role in Monmouthshire County's decarbonisation journey.

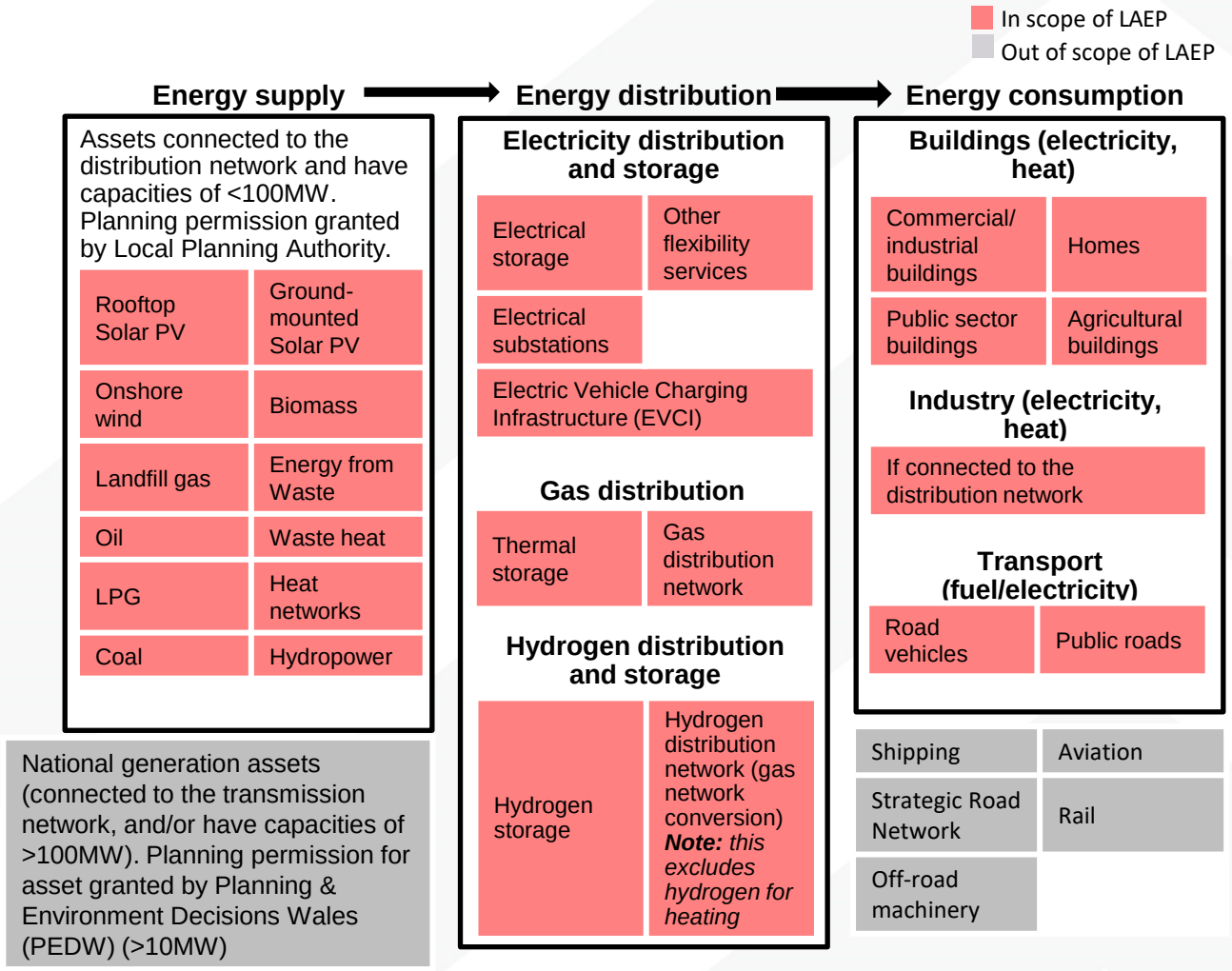


Figure 1.3: Schematic of the local system scope for LAEP.

1. Introduction

Monmouthshire County's vision for their future local energy system

Future energy system vision and objectives

Monmouthshire County's vision

Monmouthshire County Council has produced the following vision statement that underpins our ambition for the future net zero energy system in Monmouthshire County:

Vision

To become a zero carbon county, supporting well-being, health and dignity for everyone at every stage of life.

Energy objectives

Monmouthshire County Council's Community and Corporate Plan priorities have been used to shape the LAEP. The proposed actions outlined in Section 4 of this plan are designed to implement changes that will facilitate Monmouthshire County in attaining these goals:

Community and Corporate Plan Objectives

Monmouthshire County will be a:

- Fair place to live where the effects of inequality and poverty have been reduced;
- Green place to live and work with reduced carbon emissions, making a positive contribution to addressing the climate and nature emergency;
- Thriving and ambitious place, full of hope and enterprise;
- Safe place to live where people have a home where they feel secure in;
- Connected place where people feel part of a community, are valued and connected to others;
- Learning place where everybody has the opportunity to reach their potential.

1. Introduction

LAEP contents

This LAEP presents a vision for a net zero local energy system for the whole Monmouthshire County area. It includes a route map to get there, and a set of recommended actions, whilst recognising the role of other key actors in government, the energy sector and across the community.

Plan structure

This plan is structured into three main topic areas:

1. The current energy system - description of Monmouthshire County's existing energy system and relevant policies and objectives.
2. The future energy system - presentation of future scenarios for a net zero local energy system, including risks and "low regrets" measures.
3. Actions planning - a route map and action plan to drive the local energy system transition in Monmouthshire County, including what needs to happen and what needs to be done.
4. Next steps – 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 1.4: Geographic boundary for Monmouthshire County LAEP

Monmouthshire County

Chapter 2: The current energy system

2. The current energy system

Policy context

Summary of policies

National Government Policy

- Both the UK and Welsh[M49] Governments have set net zero emissions targets for 2050[M74]. Welsh Government has also set a target for the Welsh public sector to be collectively net zero by 2030. [M54]
- Welsh Government has set its low carbon delivery plan for 2021-25 and is targeting a reduction of 44% against a 1990 baseline.[M03] It considers a just transition as key and sees decarbonisation as a means to deliver social and economic justice.
- **The Well-being of Future Generations (Wales) Act 2015[M06]** provides the legally binding framework for public sector activities to be in line with sustainable development principles in Wales, outlining seven goals for prosperity and sustainability.
- **Net Zero Wales[M03]**, published in 2021, sets out 123 policies and proposals to meet the second carbon budget (2021-25). Policy 20 of Net Zero Wales aims to de-risk and integrate investment in Wales through energy planning

Regional Policy

- **The CCR Energy Strategy (2021)[MC31]** objective is to develop a strategic pathway identifying key interventions that deliver on the region's ambitions for decarbonising its energy system. This regional strategy is comprised of a baseline energy assessment, results from future energy system modelling, an economic evaluation and outlines the subsequent steps for transitioning CCR's energy system.
- **The CCR Industrial and Economic Plan[MC35]** sets out a number of levers including: Green Technologies: Grow the green economy through innovation initiatives centred on green technologies and future skills. Net Zero Transition: Begin the transition of the regional transport network to net zero through the deployment of green technologies and infrastructure. Net Zero Energy Production: Support the development of net zero energy production facilities in the region to give greater energy security and reduce dependency on imported' energy.

Local policy

- In 2019, the Council declared a climate emergency, recognising the significant and imminent threat climate change impacts on current and future generations.
- **Climate and Nature Emergency Strategy (2024) [ML01]**outlines the council's response to the climate emergency declared in May 2019, the Motion for Rivers and Ocean declared in March 2022 and the nature emergency. This document also presents four objectives which form the framework of the Council's action plan. These objectives include Council Emissions, Nature Recovery, Rivers and Ocean and, Communities and Climate.
- **The Local Development Plan (LDP) (2011-2021) [ML02]** was adopted in 2014. Work on a Replacement Local Development Plan (RLDP) is currently underway.
- **Local Transport Strategy (LTP) (2024)[ML03]** sets outs actions that will facilitate the council in developing modern, accessible, integrated and sustainable transport system.
- **Well-Being Assessment (2022)[ML04]** is a document that consolidates key insights obtained from stakeholder engagement, datasets, reports and academic studies to provide a comprehensive overview of well-being in Monmouthshire County. The assessment covers the topics of social, environmental and cultural well-being as well as identifying emerging issues and future trends.

2. The current energy system

Monmouthire County's collaborative approach to developing and delivering the LAEP

Stakeholder engagement approach

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

Stakeholders were prioritised based on their level of local influence and / or knowledge of 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 emerged early in 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.

Stakeholders were engaged at different stages of the development process to make sure they could help shape the plan and key development milestones. Regional steering groups were held, attended by the regional and local authority leads, as well as bi-weekly meetings with the local authority leads. Three workshops were held regionally and involved primary stakeholders from across each local authority in the Cardiff Capital Region. 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	Social housing providers
Transport	TfW
Renewable energy generation	Energy project developers
Industry and private sector	Local industrial player
Community engagement	Community energy organisations
Networks	Distribution Network Operators, gas distribution networks
Public sector	Welsh Government

Table 2.1: Summary of stakeholders

2. How to read a Sankey

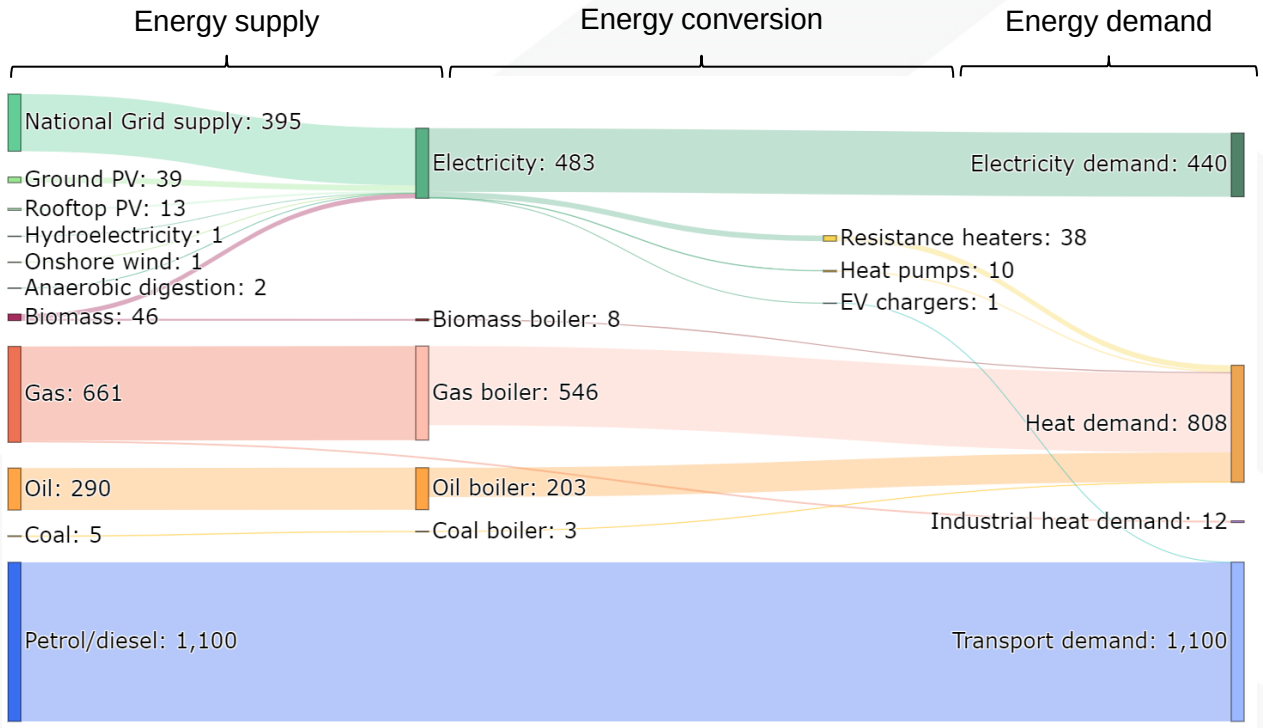
Monmouthshire County's energy baseline

How to read a Sankey diagram

Sankey diagrams are a way of showing energy flows from sources to demands via conversion technologies. They are read from left to right and show a snapshot of a scenario in time e.g., 2050 Energy transfers are drawn to scale and so are helpful to identify the size of each transfer and compare different scenarios.

Figure 2.2 presents Monmouthshire County's baseline Sankey diagram. It shows the import of electricity from National Grid to meet local demands for electricity, transportation, and heating. It also shows electricity is generated locally from rooftop solar, ground-mounted PV and hydroelectricity. Heat demand is primarily met by gas boilers supplemented by resistance heating (electric heaters), biomass, coal and oil boilers. Transport demand is predominantly being met by petrol/ diesel, with a small contribution from EV chargers. Results presented reflect Monmouthshire County's energy baseline in 2023, apart from the transport (2015) and industry data (2019).

The average Welsh home uses 3325 KWh/year of electricity, which is 0.003GWh for comparison with the scale on the Sankey. In terms of gas is 0.012GWh for comparison with scale on the Sankey.[M40]



1. Where the energy comes from
This side represents the different energy sources, including generation technologies and imports from the national grid.

2. How the energy is being converted

3. Where the energy is being used
This side represents the **final demands** for each energy vector: heat demand, electricity, demand, transport demand.

Figure 2.2: How to read a Sankey diagram (GWh/year).

2. The current energy system

Monmouthshire County's energy baseline

Energy demand

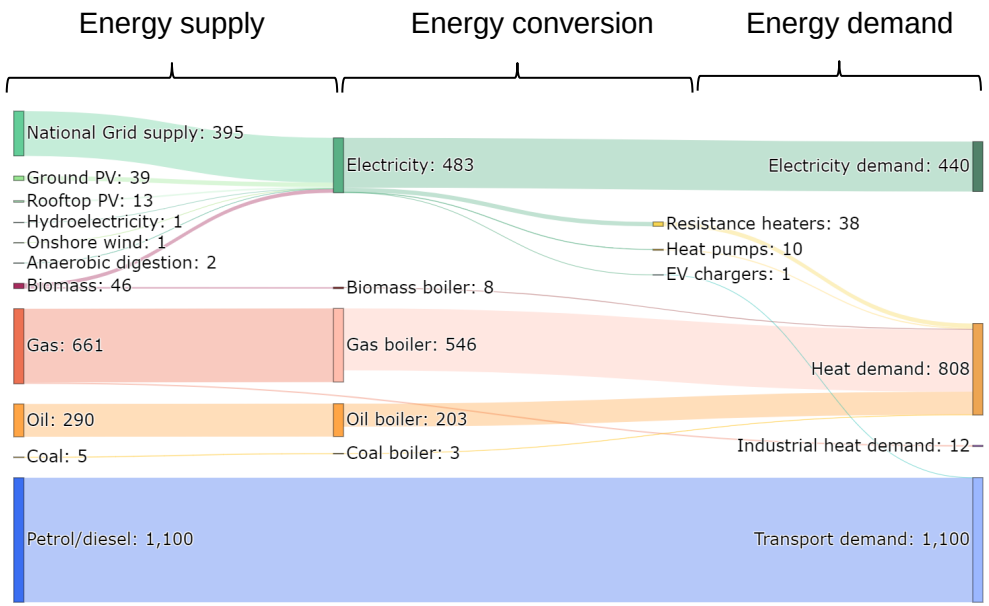


Figure 2.3: Sankey diagram showing energy input, conversion and output in Monmouthshire County (GWh/year).

Industry

In 2019, industry accounted for less than 1% (12 GWh) of the total energy demand.

Key industrial sites identified are the Magor Brewery and BAE Systems facility in Glascoed.

Transport

In 2015, transport accounted for the largest portion of total energy demand at 47% (1,100 GWh).

85% of households owned a car, with an average of 1.4 cars per household. M65

In 2019, 42 EV chargepoints installed. M43

Electricity

In 2023, electricity accounted for 19% (440 GWh) of the total energy demand.

6% (48 GWh) of heating demand was met by electricity, using resistance heater and heat pumps.

EV chargers catered to just 0.1% (1 GWh) of the total transport demand.

Heat

In 2023, heat accounted for 34% (808 GWh) of the total energy demand.

48% of properties achieved A-C EPC ratings.

25% of properties are not connected to the gas network and use electricity, oil, coal and biomass for heating.

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2. The current energy system

Monmouthshire County's energy baseline

Transport and building energy demand

In Figure 2.4, fossil fuel consumption (GWh) in Monmouthshire County is shown at the Lower Super Output Area (LSOA) level. Consumption is highest in the northern region and in the LSOA surrounding Usk. In rural areas, high fossil fuel consumption can often stem from a widespread distribution of amenities, causing longer journeys. Additionally, limited public transport options means there is a greater dependence on private vehicles.

Figure 2.5 presents Monmouthshire County's gas consumption at modelling zone level, which is delineated by primary substation service areas. The northern modelling zones are likely to have had a higher gas consumption because they encompass two of Monmouthshire County's more urban areas, Abergavenny and Monmouth.

According to DESNZ's National Atmospheric Emissions Inventory (NAEI) dataset, BAE Systems and the Magor Brewery were identified as major industrial sites in Monmouthshire County.

Note: The transport demand in Figure 2.5 only reflects trips originating within Monmouthshire County. It does not include vehicles that pass through an area without stopping.

Transport

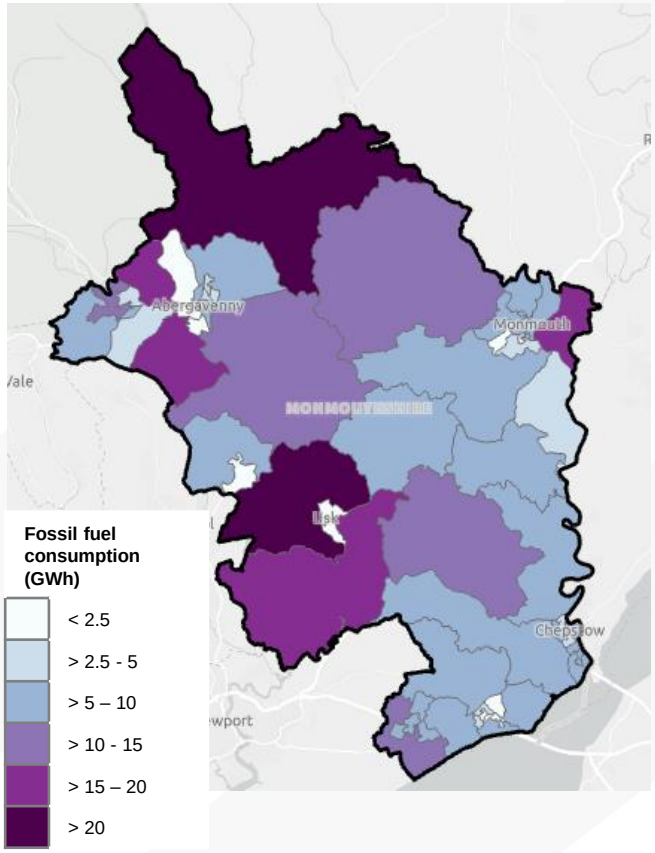


Figure 2.4: Transport energy consumption (combined total across cars, light goods vehicles (LGV) and heavy goods vehicles (HGV) by LSOA (2015)

Gas Consumption & Industrial Loads

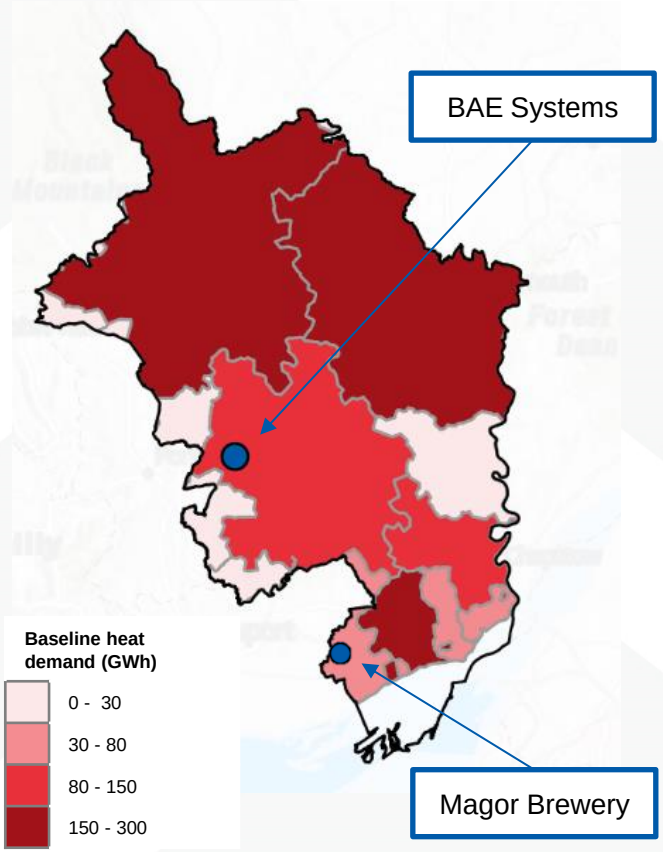


Figure 2.5: Baseline heat demand (2023) by modelling zone and major industrial loads (2019) in Monmouthshire County.

2. The current energy system

Monmouthshire County's energy baseline

Energy generation

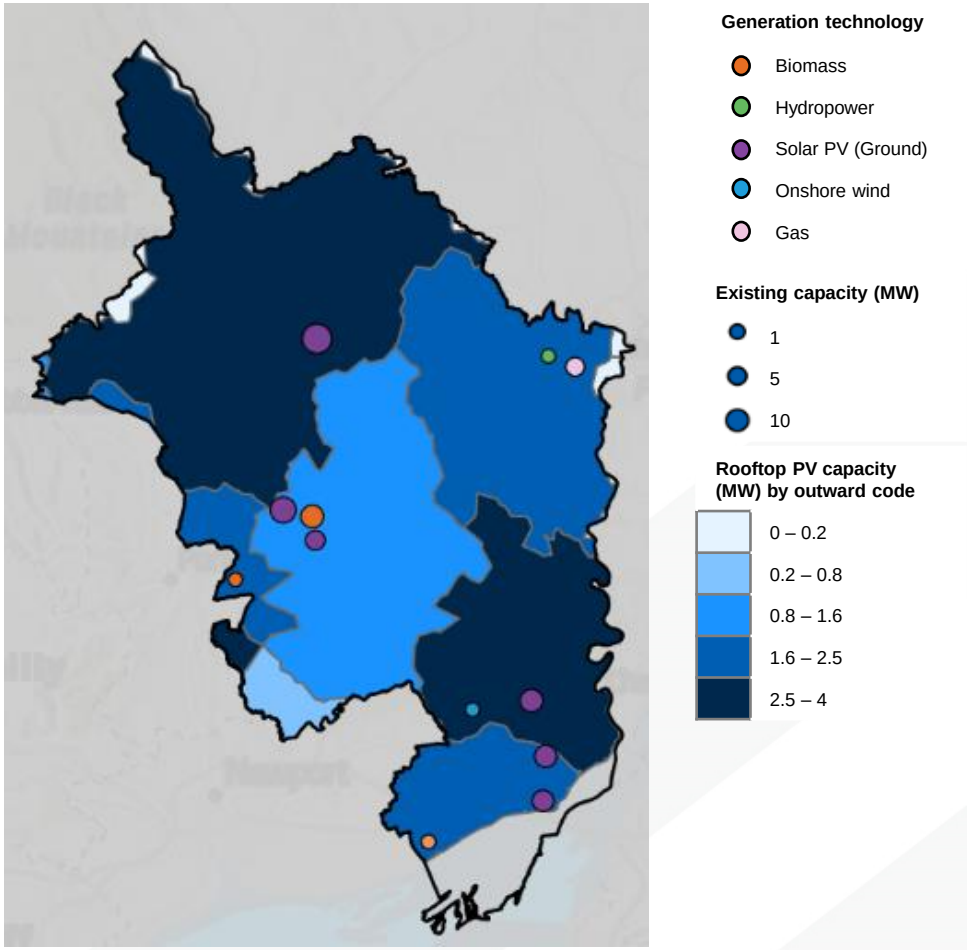


Figure 2.6: Local energy generators and their respective capacities (MW) and domestic and non-domestic rooftop solar PV (MW) by outward code (2023)

Electricity generation

In 2023, generators had a total installed capacity of 50 MW.

Solar PV farms had the largest total installed capacity at 40 MW, predominantly comprised of ground-mount systems (39 MW). The largest asset in size (10 MW) is the Manor Farm solar farm, near Llanvapley, Abergavenny.

Other renewable generators included a biomass, anaerobic digestors, hydropower and an onshore wind turbine which had a capacity of 6 MW, 0.36MW, 0.15 MW, 225 kW, respectively.

There was one 3.2 MW fossil fuel powered generator.

Heat generation

The primary source that served Monmouthshire County's heating demand was natural gas, distributed to consumers through the Wales and West Utilities distribution network.

Monmouthshire County currently does not have any heat networks. It is a predominantly rural area and therefore has lower building densities, making it challenging to identify suitable locations for heat networks.

A previous study, conducted by Sustainable Energy in 2021, set out to identify the opportunity for heat networks in Monmouthshire County. The findings concluded that out of a potential eight sites, only one was recommended for future investigation.

2. The current energy system

Monmouthshire County's energy baseline

Networks and infrastructure

Figures 2.8 and 2.9 displays primary substation supply and demand headroom across Monmouthshire County, providing an insight to the network capacity in 2019. This metric offers an overview of the electricity network's capacity, highlighting areas where constraints may be present.

In 2023, substation headroom was lower in Monmouthshire County's main settlements, such Abergavenny, Monmouth and Chepstow. The higher concentration of buildings in these urban areas leads to an increased demand for electricity, which in turn could result in reduced substation capacity.

Headroom provides insights into the distribution networks (11 kV) capacity however, constraints can occur upstream (at transmission network level) and downstream (at lower voltage network level) of primary substations. It is therefore important to note that Figures 2.8 and 2.9 may not show the full extent of Monmouthshire County's electricity network constraints.

Note: Headroom is an indicative measure of a primary substation's capacity. In more general terms, it's the ability of that substation to handle the total flow of electricity through it.

Supply headroom

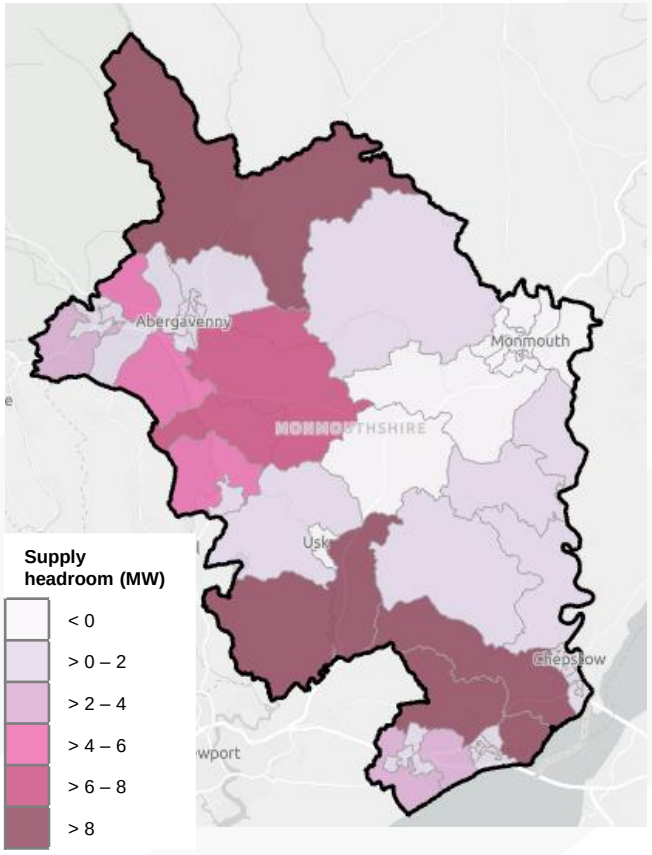


Figure 2.7: Electricity supply headroom by LSOA

Demand headroom

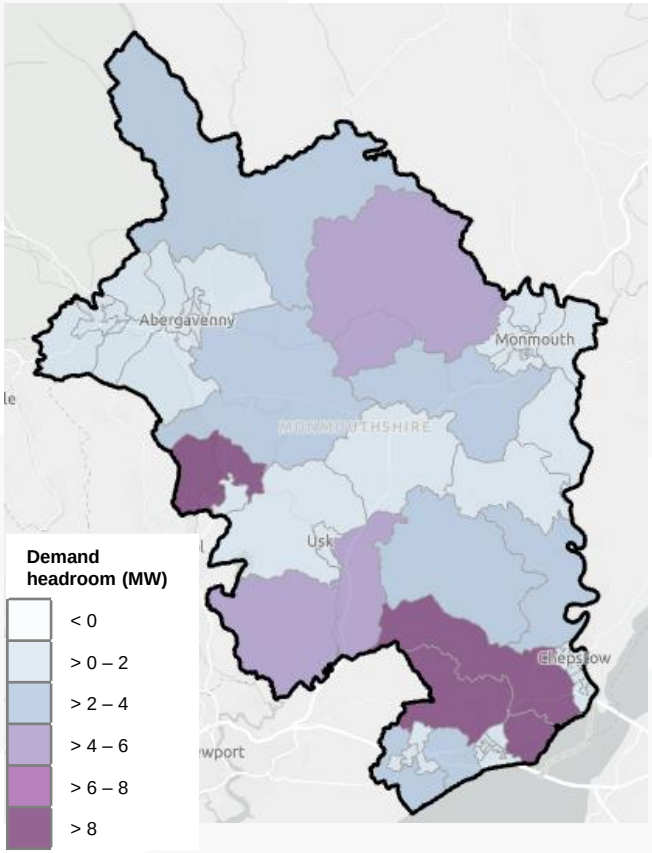


Figure 2.8: Electricity demand headroom by LSOA

2. The current energy system

Monmouthshire County's energy baseline

Local environmental, social and economic factors that influence energy

Land

Monmouthshire County is located in the southeastern region of Wales, sharing borders with the southwestern part of England and the Midlands. There are six main settlements in Monmouthshire County; Abergavenny, Caldicot, Chepstow, Magor, Monmouth, and Usk.

The landscape in Monmouthshire County is predominantly rural. Internationally and nationally designated areas include the Wye Valley Area of Outstanding Natural Beauty and the Brecon Beacons National Park. Monmouthshire County is also home to the Gwent Levels which is a Sites of Special Scientific Interest due to its high conservation value.

Demographics

In 2021, Monmouthshire County's population stood at 92,961. This represents a growth of 1.8% over the decade from 2011 to 2021. Interestingly, this growth rate is slightly higher than the overall population increase of 1.4% observed across Wales during the same period[ML05].

Monmouthshire County had the eighth lowest population density of all 22 local authorities[ML05].

The average age of the population was 49 years in 2021. This constitutes an increase of four years from 2011 to 2021. Monmouthshire County has the joint second-highest average age alongside Conwy[ML06].

Socio-economics

According to the Welsh Index of Multiple Deprivation (WIMD) 2019[ML05], Monmouthshire County had no areas in the most deprived 10%.

Monmouthshire County has a diverse economy covering a range of sectors. In 2020, the sectors with the largest number of enterprises were 'professional, scientific and technical' (17.5% of all enterprises) and 'agriculture, forestry and fishing' (15.3% of all enterprises) [ML09].

In 2021, the unemployment rate was 1.9%, down from 3% in 2011[ML06].

Tourism is an important sector in Monmouthshire County's economy. In 2022, 2.34 million tourists generated £285 million for the local economy, supporting 3,356 jobs[ML07].

GHG Emissions

In 2021, greenhouse gas emissions totalled at 6.7tCO_{2e} per capita, which was higher than the UK average of 4.8t$CO_{2e.}$ Transport was the largest emitter in 2021, accounting for ~50% of Monmouthshire County's total emissions[ML08].

Net carbon emissions decreased by 32%, from 924ktCO_2 to 625ktCO_2 between 2005 and 2021. This trend mirrors the national decrease in emissions, which can be attributed to the shift away from coal-fired power generation towards increased renewable energy generation.

2. The current energy system

Monmouthshire County Council's energy baseline

Progress to date

Since declaring a climate emergency in 2019, Monmouthshire Council has worked to reduce its organisational GHG emissions, and to provide the means for the wider community to do the same, as the county transitions to a net zero energy system.

Monmouthshire County Council's Climate and Nature Emergency Strategy and action plans are particularly noteworthy, as they provides a list of actions grouped by key decarbonisation themes. Monmouthshire County Council review and publish monitoring reports that show progress against actions in this plan. The updated Strategy and Action Plan has been considered by Scrutiny and was taken to Cabinet in May 2024.

There has been a variety of projects aimed at implementing net zero solutions in Monmouthshire Council. One example is a council-wide decarbonisation project led by Monmouthshire County Council, in partnership with SSE Energy Solutions. In 2022, 22 council-owned buildings had been retrofitted and a further 14 schools had been identified to have measures installed. The initiative was expected to save up to 1.7 GWh.

It important to highlight that Monmouthshire County Council's commitments to decarbonisation predates 2019. For example, the Oak Grove Solar farm was developed by the Council in 2017.

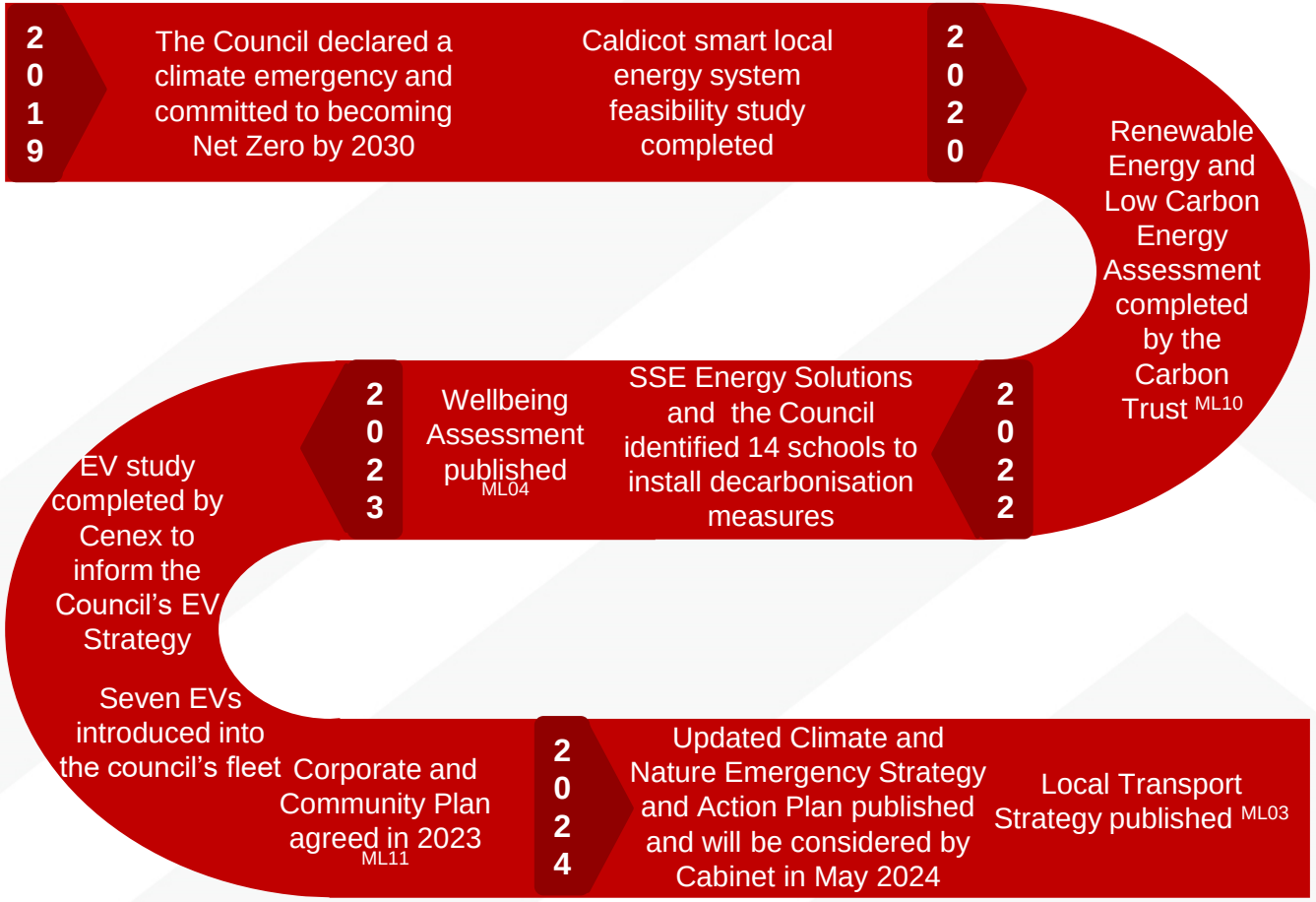


Figure 2.9: Summary of activities to date that have contributed to decarbonising the local energy system

2. The current energy system

Monmouthshire County's energy baseline

Plans for the future

Renewable generation

Monmouthshire County already has a large amount of renewable energy generation, with significant potential for more. A Renewable Energy Assessment undertaken by Carbon Trust in 2022 highlighted large amounts of land which had theoretical potential for renewables. Further refinement of this assessment will be undertaken to account for further factors.

Since the Council declared and Climate Emergency in 2019, various solar systems have been installed (40 MW), with additional projects currently in the pipeline. For example, in 2022, rooftop solar panels were installed on 14 schools. The energy produced by these panels is used directly on-site, significantly reducing the overall energy demand.

Going forward, the RLDP will establish policy to support and enable renewable energy generation. However, unlocking the full potential of renewable energy in Monmouthshire County is challenging. Welsh Government's national policy to safeguard Wales's Best and Most Versatile (BMV) agricultural land (grades 1, 2 and 3a) from development, makes securing planning permissions for renewable development difficult. Grid constraints and the public acceptance are also contributing factors limiting the amount of development in the county.

Reducing energy demand

Monmouthshire County Council has already made significant progress towards reducing local energy demand. To accommodate the growing number of EVs in the area, the Council has invested in EV charging infrastructure, installing fast EV chargers for public use at 17 car parks.

The Council is also planning to continue investment in enhancing public transport infrastructure and active travel routes. One example is the Council's work with the Burns Delivery Unit to promote the delivery of a new Walkway Station in Magor. This station will be designed so people can walk, cycle or use public transport to reach the station. These schemes offer residents efficient and sustainable commuting alternatives, reducing reliance on private vehicles.

Beyond the Council's initiatives, the Magor Brewery in Caldicot represents a significant opportunity for decarbonisation, impacting both the site and Monmouthshire County as a whole. The Magor Brewery, in partnership with Protium, has produced a proposal to develop a zero-emission Hydrogen Production Facility, which will use onsite renewable energy sources for power generation. This initiative has the potential to reduce dependence on fossil fuels across Monmouthshire County if excess hydrogen produced at this site can be used by heavy good vehicles (HGVs).

Monmouthshire County

Chapter 3: The future energy system

3. The future energy system

Overview

Monmouthshire County's Vision

To become a zero-carbon county, supporting well-being, health and dignity for everyone at every stage of life.

Objectives of the plan

The LAEP's objectives reflect the priorities set out in Monmouthshire County Council's Community and Corporate plan:

- Fair place to live where the effects of inequality and poverty have been reduced;
- Green place to live and work with reduced carbon emissions, making a positive contribution to addressing the climate and nature emergency;
- Thriving and ambitious place, full of hope and enterprise;
- Safe place to live where people have a home where they feel secure in;
- Connected place where people feel part of a community, are valued and connected to others;
- Learning place where everybody has the opportunity to reach their potential.

Understanding the future energy system

To transition Monmouthshire County's energy system to net zero by 2050, there are multiple plausible and attractive future energy systems for the area, depending on a range of factors.

This includes how innovation might impact on the cost of technologies over time, as well as wider policy decisions that will be made by Welsh and UK Governments.

Scenario analysis

To inform the plan, scenario analysis was used 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. Four future energy scenarios were modelled which were the most cost- and carbon-effective way to meet demand in each one. Through doing this, technologies were identified 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.

Deployment modelling

Looking 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 to define a suitable level of ambition, and bring all this evidence together into an action plan.

3. The future energy system

Overview

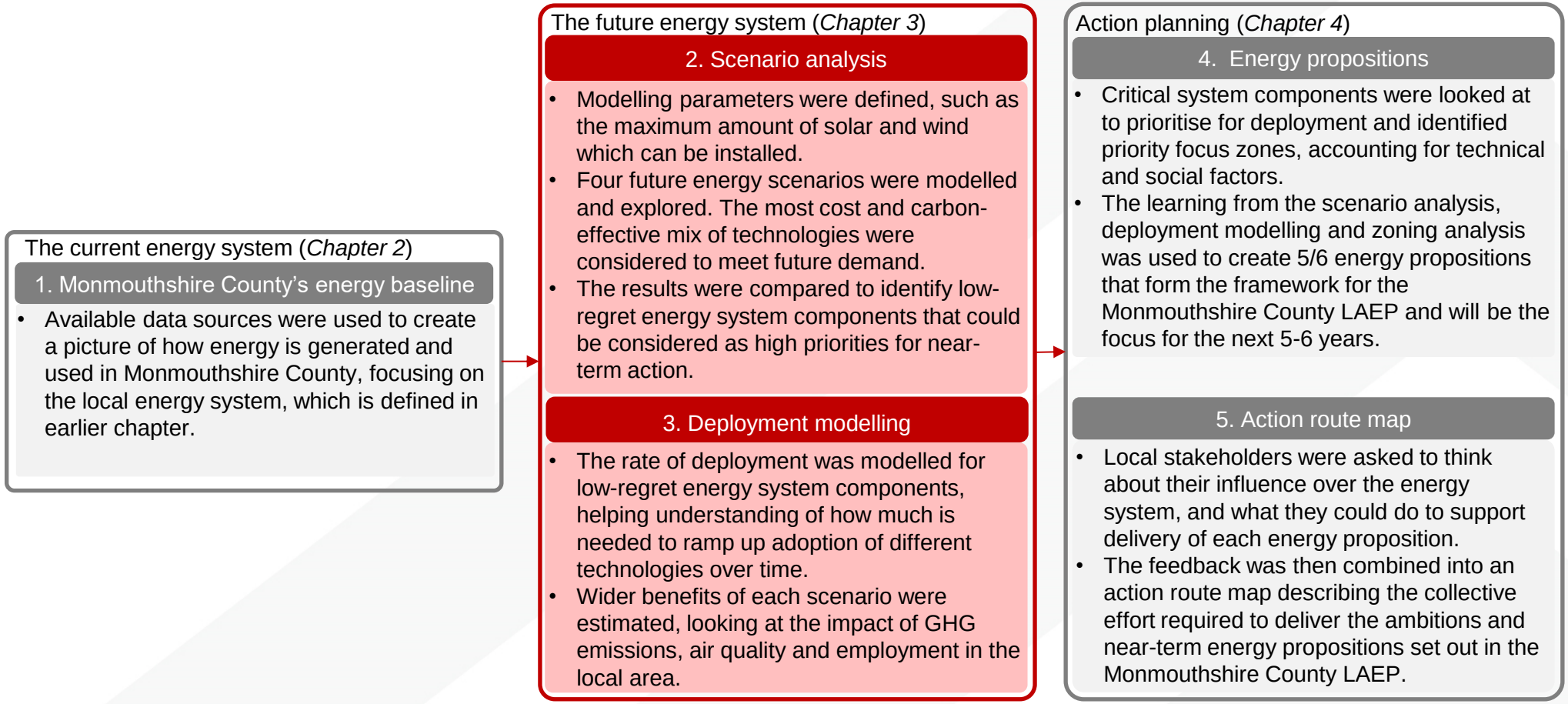


Figure 3.1: Summary of steps taken to produce the LAEP

3. The future energy system

Scenario analysis

Summary of future energy scenarios

A scenario is used in modelling to test a range of potential futures. The scenarios shown in Figure 3.2 have been used to envision the energy system in 2050, testing how changes in demand might impact the local energy mix and the adoption of low-carbon technologies required for a transition towards net zero. In the National Net Zero, Low Demand, High Demand scenarios, the energy system is assumed to reach net zero by 2050. In contrast, the Do Nothing scenario portrays a future where net zero is not achieved by 2050.

Do Nothing	•A scenario for comparison which considers committed activities and assumes that current and consulted upon policy goes forward and remains consistent. •This scenario provides a cost counterfactual. •There is no decarbonisation target for this scenario, and it is not used it in optimisation modelling.
National Net Zero	•Uses the lowest cost and carbon combination of technologies to meet Wales' 2050 net zero target. •Assumes a moderate level of energy demand reduction across the system. •Model is allowed to import and export to the electricity grid, this assumes that the electricity grid is decarbonised and reinforced to allow for the demands, likely to be a combination of offshore wind, hydrogen CCGT, grid level battery storage, nuclear (these are considered as national assets and outside the scope of the LAEP).
Low Demand	•Considers the lowest future energy demand across different sectors. •Explores the impact of energy-reducing initiatives (home fabric improvements) and uptake of active travel and public transport use. •Model finds the lowest cost and carbon combination of technologies to meet predicted future energy demand. •Import and export of electricity as National Net Zero
High Demand	•Considers the highest future energy demand across sectors. •Model finds the lowest cost and carbon combination of technologies to meet predicted future energy demand. •Import and export of electricity as National Net Zero
High Hydrogen	•*Explores impact of energy-reducing initiatives such as home fabric improvements and uptake of active travel and public transport use.* •*Considers hydrogen for heavy goods vehicles.*

Figure 3.2: Summary of future energy scenarios

The future local energy system

Scenario analysis

National Net Zero scenario - Energy flows (GWh, 2050)

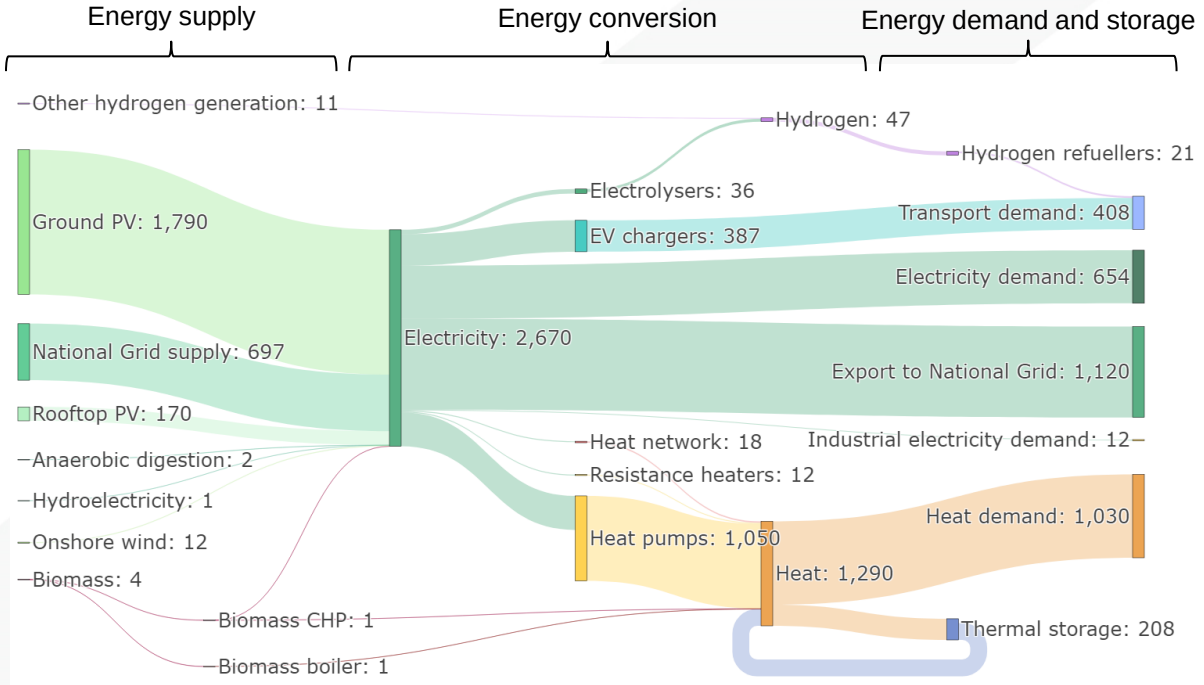
Figure 3.3 is an output from the modelling and shows a potential future energy system for Monmouthshire County under the National Net Zero scenario. This energy system results from modelling to create the most cost and carbon optimal system. Four scenarios were modelled to support the decision making. This optimisation modelling informs the deployment pathways as well as the action plan. The National Net Zero scenario (shown below) aligns with High Demand, Low Demand and High Hydrogen scenario trends, as shown in Figure 3.4 on page 43. Note that this Sankey diagram does not present the final plan for the Monmouthshire County's future energy system.

Hydrogen imports and hydrogen generated from electrolysis could serve transport demand.

Significant increase in renewable energy generation, especially ground-mounted PV (45x higher than baseline).

Electricity supplied by the National Grid increased by 1.7x compared to the baseline.

Smaller contribution from biomass, which serves both electricity and heat demand.



Annual electricity use is 5.5x greater than the baseline.

Majority of transport demand could be met by electricity supplied through EV chargers. Hydrogen refuellers meet 5% of demand.

Significant portion (40%) of the generated electricity is surplus and is subsequently exported.

Heat supply could predominately be met by heat pumps (81%) , with smaller contributions from heat networks (1%) , resistance heaters (1%), biomass boilers (0.2%).

Figure 3.3: Annotated Sankey diagram showing energy flows under the National Net Zero scenario (GWh in 2050)

The future local energy system

Scenario analysis

Energy system components

Figure 3.5 summarises Monmouthshire County's optimisation modelling results. Key findings include:

- **Generation:** Electricity generated from ground-mounted solar and rooftop PV increases significantly across all scenarios. Onshore wind generation also increases but to a lesser degree. Biomass use for electricity generation decreases as to reach Net Zero by 2050, Monmouthshire County's electricity system will be more dependent on lower cost renewables such as wind and solar.
- **Demand:** Transport decarbonises across all scenarios due to the roll out of EVs displacing petrol and diesel vehicles. Heat demand decarbonises primarily through the roll out of heat pumps. Whilst other heating technologies, such as heat networks and resistance heaters also contribute, their usage is comparatively smaller.

It's important to emphasise that these scenarios are hypothetical and used as a guide to inform the LAEPs action plan. Common trends across the scenarios help shape the direction our strategy should take. In practice, factors such as site availability, suitability and competing land uses will need to be considered. The figures shown in Figure 3.4 therefore represent maximum values.

Key: **Increase** in use of technology ↑ | **Decrease** in use of technology ↓

Energy components	Baseline	National Net Zero	High Demand	Low Demand	High Hydrogen
Ground-mount PV	39 GWh	↑ to 1,790	↑ to 1,790	↑ to 1,790	↑ to 1,790
Rooftop PV	13 GWh	↑ to 170	↑ to 170	↑ to 170	↑ to 170
Onshore wind	1 GWh	↑ to 12	↑ to 12	↑ to 12	↑ to 12
Biomass	46 GWh	↓ to 4	↓ to 4	↓ to 3	↓ to 4
Anaerobic digestion	2 GWh	= no change	= no change	= no change	= no change
Hydrogen import	0 GWh	↑ to 11	↑ to 11	↑ to 10	↑ to 40
Electrolyser	0 GWh	↑ to 36	↑ to 35	↑ to 37	↑ to 116
Import from Grid	395 GWh	↑ to 697	↑ to 705	↑ to 500	↑ to 691
EV chargers	1 GWh	↑ to 387	↑ to 403	↑ to 387	↑ to 312
Refuellers	0 GWh	↑ to 21	↑ to 21	↑ to 21	↑ to 70
Heat pumps	10 GWh	↑ to 1,050	↑ to 1,050	↑ to 642	↑ to 1,050
Heat networks	0 GWh	↑ to 18	↑ to 18	↑ to 18	↑ to 18
Resistance heaters	38 GWh	↑ to 12	↑ to 12	↑ to 6	↑ to 12
Biomass boilers	8 GWh	↓ to 1	↓ to 1	↓ to 1	↓ to 1

Figure 3.4: Scenario results comparison showing annual electricity generation (GWh) in 2050

Connected. Competitive. Resilient.

3. The future energy system

Deployment modelling

Impact on energy demand

The projected changes in energy consumption across various sectors for 2023, 2030, and 2050 are shown in Figure 3.5. Key trends and insights include:

- **Overall energy demand** in the National Net Zero, High Demand and High Hydrogen scenario increases marginally by 2050 due to only moderate interventions aimed at improving energy efficiency. In the Low Demand scenarios, overall energy demand significantly reduces as it is assumed that initiatives focused on retrofitting buildings, promoting public transport, and encouraging active travel are ramped up.
- **Heat demand** increases significantly between 2023 and 2050 in both and National Net Zero, High Demand and High Hydrogen scenarios, primarily due to a rise in new developments across the county. In the Low Demand scenarios, the increase in heat demand is less significant, due to the higher rates of building retrofit.
- **Transport demand** from road vehicles declines from 2023 to 2050 across all scenarios. This reduction is driven by the assumption that uptake of active travel and use of public transport services increases. In reality,this decrease may be limited by factors such as the availability of affordable, frequent, reliable public transport needed to enable citizen behaviour change in rural areas.
- **Industrial demand** remains low but consistent between 2023 and 2050 across all scenarios. However, it is important to note that industrial demands shown are lower as this analysis only considers major loads. Smaller industrial sites energy demands will be accounted for under buildings.

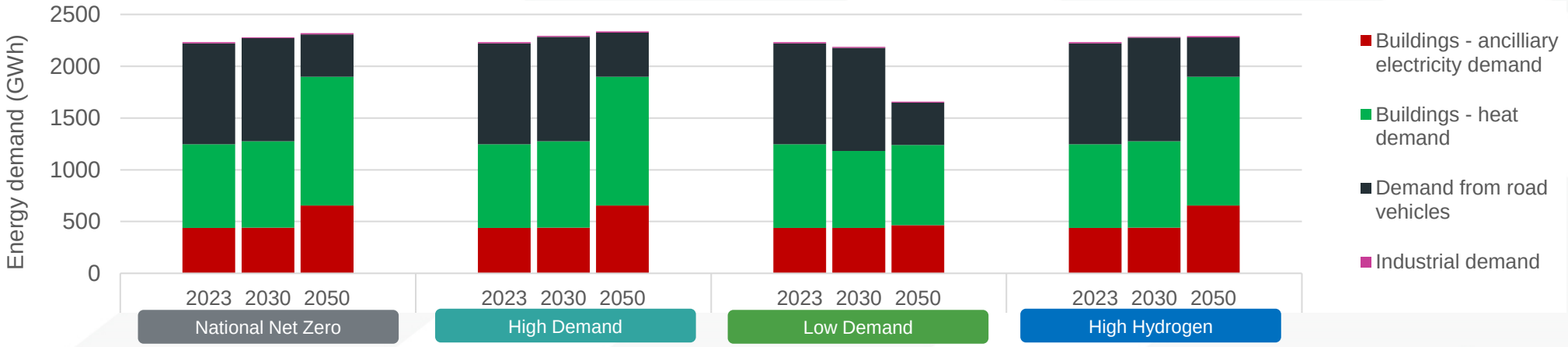


Figure 3.5:' Monmouthshire County's energy demand (GWh) over time for each scenario in 2023, 2030 and 2050.

3. The future energy system

Deployment modelling

Impact on GHG emissions

Figure 3.6 shows GHG from now until 2050 for the Do Nothing and modelled scenarios. In the Do Nothing scenario, the rate of change is based on current deployment rates and policy levers. The other modelled scenarios show trajectories that align with the optimisation models results. The difference in emissions between the Do Nothing and modelled scenarios in 2050 highlight the step-change in policy and behaviour required to reach Net Zero.

These pathways have been developed through deployment modelling, which involves forecasting the installation rates of various energy interventions required to reach the future energy system by 2050. For instance, deployment modelling can be used to determine how rapidly rooftop solar PV installations must occur between now and 2050 to reach the required future capacity. Modelling compares these rates against a counterfactual pathway, reflecting current trends and targets. This comparison helps recognise how quickly acceleration of the adoption of these technologies is required. It also shows the impact on emissions over time for different future energy system scenarios. This insight can guide actions over the next five years to ensure adoption of these technologies at a rate necessary to reach the proposed energy system.

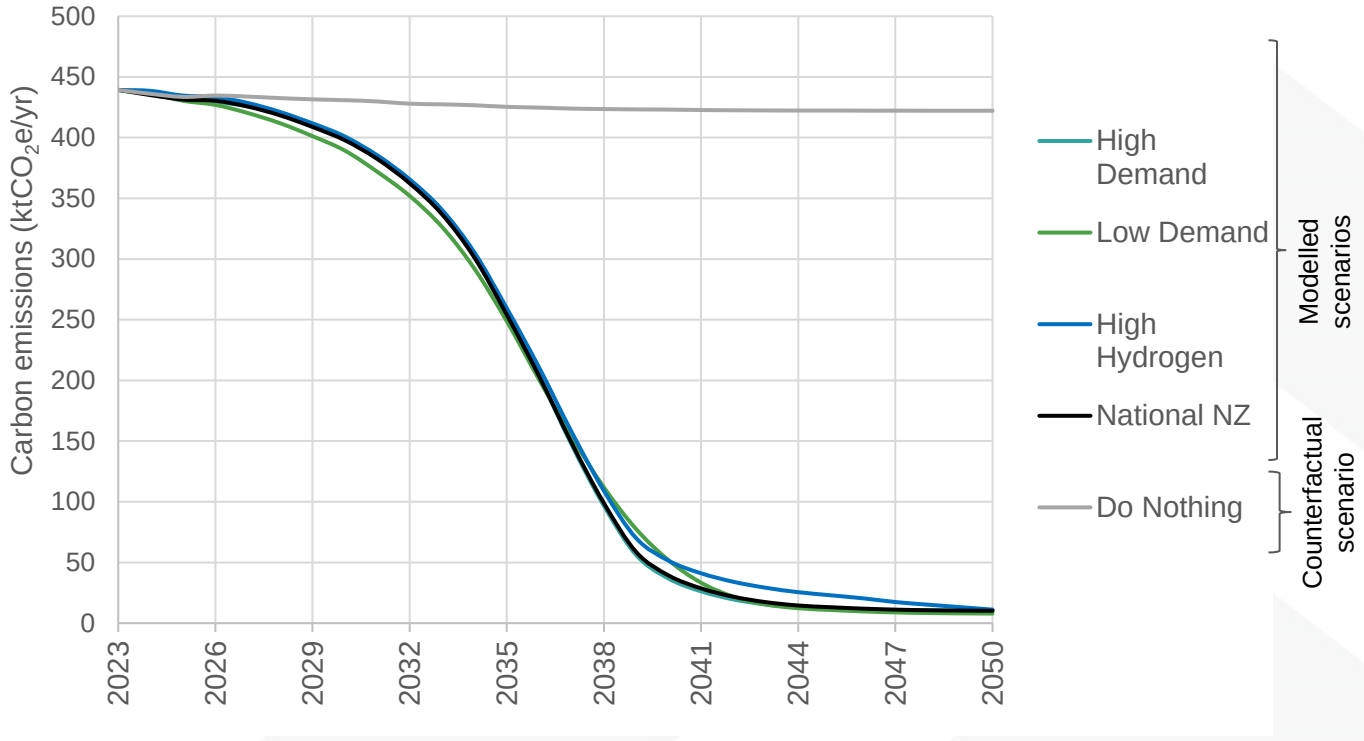


Figure 3.6: Monmouthshire County's greenhouse gas emissions over time for each scenario

Note (1) The National Net Zero, High Demand, Low Demand and High Hydrogen scenario where modelled to achieve net zero emissions. The Do Nothing scenario does not have a decarbonisation target and is based on current committed activities. **(2)** Residual emissions associated with the electricity grid and biomass means emission don't reach zero by 2050. **(3)** An assumption has been made that only green hydrogen is imported.

3. The future energy system

Deployment modelling

Socio-economic impacts

Reducing the amount of energy used 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.

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 3.1 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.

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 as well as associated supply chain and multiplier effects[M42].

Metric	Do Nothing	National Net Zero	High Demand	Low Demand	High Hydrogen
Difference in energy demand between 2023-2050 (GWh)	No change between 2023 and 2050	Energy demand **increases by 86 GWh**	Energy demand **increases by 100 GWh**	Energy demand **decreases by 570 GWh**	Energy demand **increases by 57 GWh**
Cumulative air quality activity costs between 2023-2050 (£'million) (2022 prices)	£466 M	£226 M **52% less** than the Do Nothing scenario	£224 M **52% less** than the Do Nothing scenario	£225 M **52% less** than the Do Nothing scenario	£232 M **50% less** than the Do Nothing scenario
Jobs added between 2023-2050 (FTE)	520	3,100 **2,580 FTEs more** than the Do Nothing scenario	3,200 **2,680 FTEs more** than the Do Nothing scenario	4,100 **3,580 FTEs more** than the Do Nothing scenario	3,400 **2,880 FTEs** more than the Do Nothing scenario

Table 3.1: Summary of economic impacts for each scenario: employment impacts and air quality activity costs. Figures shown relate to the period 2023 – 2050. Air quality activity costs are presented using 2022 prices and are not discounted

.

3. The future energy system

Deployment modelling

Socio-economic impacts

The number of new jobs that will be created in Monmouthshire County has been forecast across the four future energy scenarios. Referring to the example projection for the National Net Zero scenario shown in Figure 3.7:

1. Gradual increase (Now to 2030): Job numbers rise steadily as deployment progresses, reflecting installation rates and technology adoption.
2. Acceleration (2030 to 2040): The pace quickens, driven by increased uptake and technological advancements.
3. Plateau (2040 to 2050): Job growth stabilises as the market reaches saturation.

The installation of renewable energy assets will create job opportunities, mainly during the construction phase. However, due to the generator's longer lifespan and lower maintenance requirements, these jobs are less permanent. On the other hand, energy efficiency retrofitting and heat pumps involve a higher frequency of installations, ongoing maintenance, and have a shorter lifecycle, resulting in a larger number of available jobs.

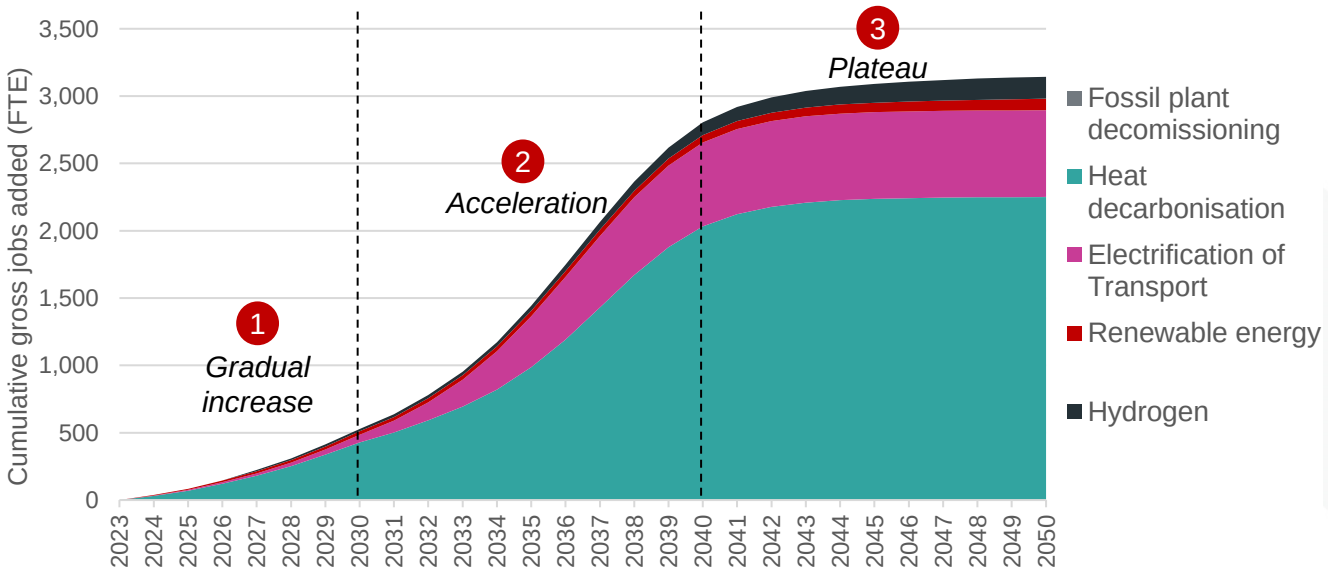


Figure 3.7: Cumulative gross jobs added (full-time equivalent) in the National Net Zero scenario from 2023-2050

Sector	Gross jobs added (FTE) by 2050 – scenario average
Heat decarbonisation (incl. EE retrofit)	2,500
Electrification of transport	600
Hydrogen	250
Renewable energy	90

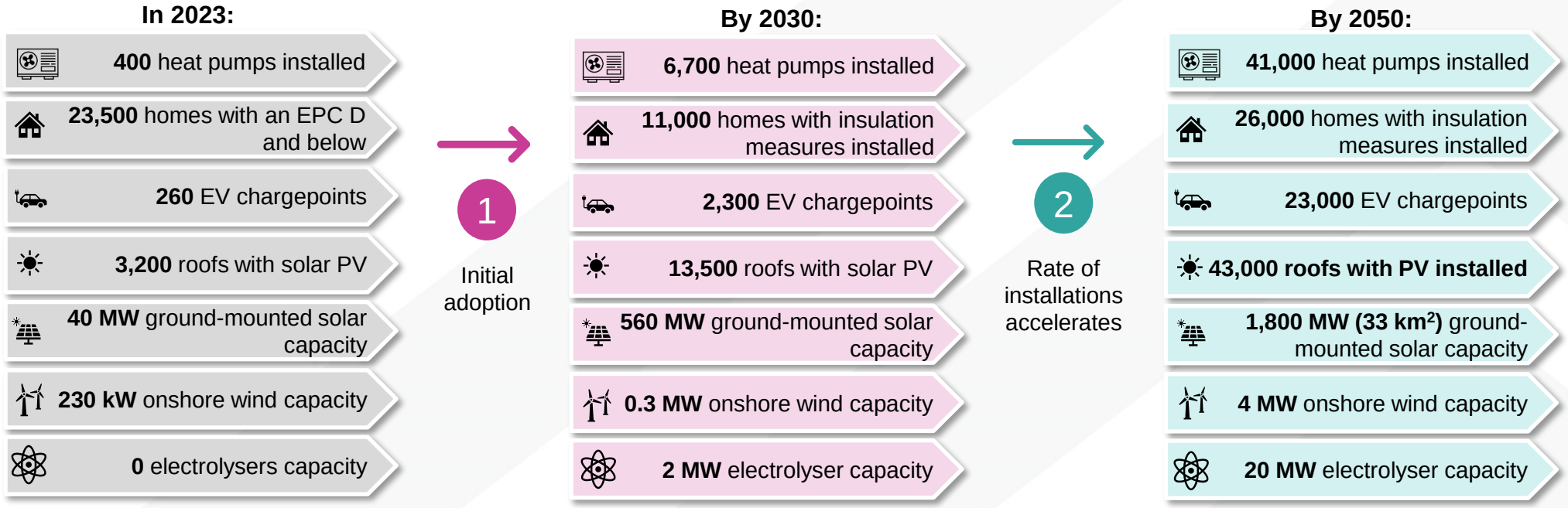
Table 3.2: Jobs added per sector by 2050. Note this is an average taken from results across all modelled scenarios.

3. The future energy system

Deployment modelling

Summary of deployment

Figure 3.8 provides a breakdown of the energy components and interventions required for achieving a net zero energy system by 2050. These values were derived from an average deployment rate taken across the modelled scenarios. The deployment model helps to show where the County is now and where it needs to get to, providing a starting point to frame the challenge and the requirement for more detailed analysis. Theoretical pathways have been included which have a high degree of uncertainty as there are many variable factors and unknowns. Some of the factors that are not considered in our modelling but still impact deployment are (i) technological advance and innovation, (ii) supply chains and how they develop and (iii) large scale activity to decarbonise infrastructure at other levels: regional, UK and beyond.



1 Between 2023 and 2030, new technologies continue to enter the market, but their adoption rate is more gradual. The slower adoption during the initial years can be due to factors such as limited awareness, higher costs, and the need for infrastructure reinforcement. The adoption of more developed technologies increases at a steadier rate from 2023 to 2050.

2 The installation rate accelerates between 2030 and 2050 as barriers to adoption diminish. Factors that can contribute to higher installation rates include increased awareness of the technologies and economies of scale which lead to reduced installation costs.

Figure 3.8: Monmouthshire County's energy system component deployment rates

Monmouthshire County

Chapter 4: Actions planning

4. Action planning

Energy propositions

The learning from exploring different energy futures and deployment pathways was shared with stakeholders and discussed with them what key drivers will be critical for the transition to net zero. The feedback, the strategic vision and objectives were considered and the energy propositions were agreed to act as the framework for Monmouthshire County LAEP. There are numerous interdependencies and interactions between these propositions, as shown here, and this highlights the importance of a whole system approach with a co-ordinated programme of delivery to meet the net zero target by 2050.

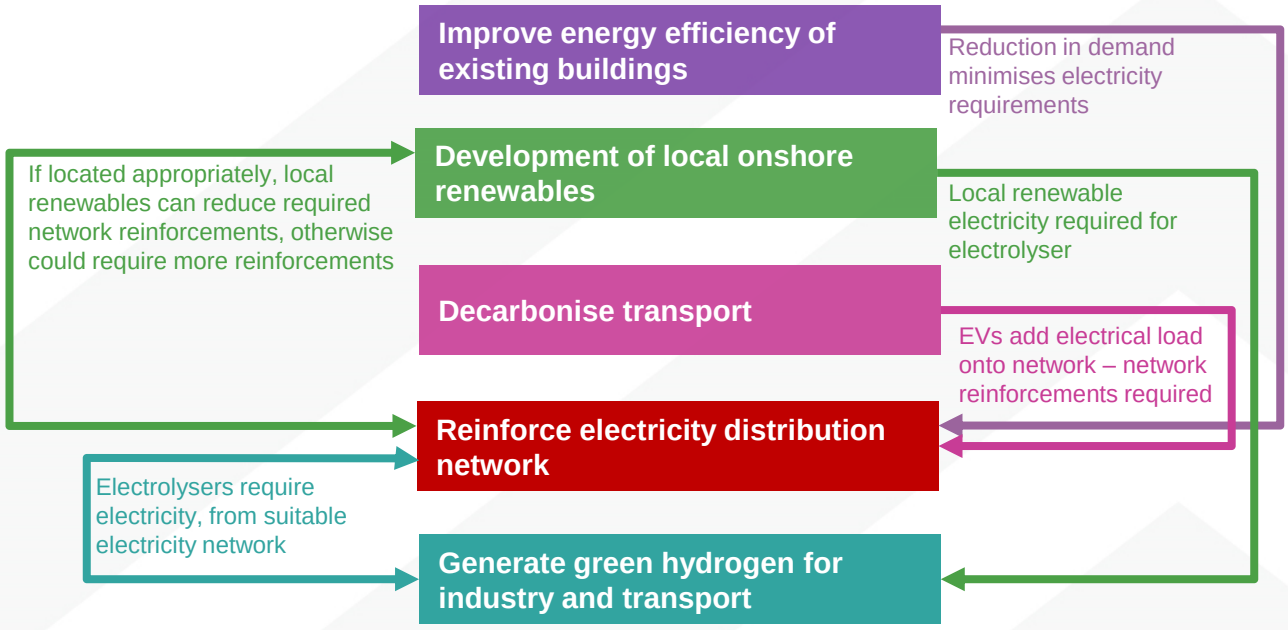


Figure 4.1: Summary of energy propositions and their inter-dependencies

Sponsors: Delivery partners:

4. Action planning

Energy propositions

Energy propositions in more detail

1. Improve energy efficiency of existing buildings

Ambition: Enhance the energy efficiency of buildings through retrofitting measures aimed at reducing electricity and heating demand, whilst also transitioning away from fossil fuel-intensive heating systems to more efficient, low-carbon technologies. The following interventions will be considered under this proposals:

- Improving building fabric
- Installing heat pumps and rooftop PV

CAPEX required to deliver: £550 – 3,800 M

2. Deploy onshore renewables

Ambition: Increase renewable energy output by reviewing and updating renewable energy generation targets and using the Regional Spatial Plan. Proactively engage with local planners and developers to drive installation of generation assets. The implementation of these interventions will need to consider existing policy constraints. The following interventions will be considered under this proposals:

- Deployment of ground-mounted solar PV

CAPEX required to deliver: £760 M

3. Decarbonise transport

Ambition: Reduce transport demand by improving active travel routes and expanding the public transport network. Increase the number EV chargepoints and explore hydrogen for long-range vehicles. The interventions being considered under this proposition are:

- Installation of EV chargepoints
- Improving active travel routes and the public transport network
- Piloting hydrogen for transport

CAPEX required to deliver: £60 – 77 M

4. Generate green hydrogen for transport and industry

Ambition: Explore options to produce green hydrogen and assess its potential industrial and transport applications. Note that hydrogen for heating homes is not included in this proposition.

The following interventions will be considered under this proposition:

- Investigating the potential for green hydrogen generation

CAPEX required to deliver: £7 – 23 M

5. Reinforce the electricity network

Ambition: Make upgrades to the electricity network that are required to ensure increasing electricity demand can be met. This is key to ensuring the success of propositions (1), (2), (3). The following interventions will be considered under this proposition:

- Upgrading the electricity network

The CAPEX on this page is the amount (£ M) of investment required to meet the 2050 modelled figures. The CAPEX ranges show the minimum and maximum results from each future energy scenario. The CAPEX does not represent the total amount that Monmouthshire County Council needs to spend in order to implement the local actions. The actors are set out on pages 48-53.

*This CAPEX figure only includes the cost to install EV chargepoints. It does not include investment required to improve active travel routes and public transport networks.
Note: CAPEX required to deliver has not been calculated for proposition 5 due to the high uncertainty associated with these propositions.

4. Actions planning

Energy propositions

Identifying priority focus zones and an action routemap

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

Spatial representation of opportunities

As a starting point, our spatial representation of opportunities, shown in Figure 4.2 on the next page, indicates the location and scale of recommended near-term changes required across Monmouthshire County. The map highlights seven modelling zones identified as priority focus zones for the low-regret energy system components included in the energy propositions: heat pumps, EV chargers, rooftop PV, ground-mounted PV, onshore wind, and insulation retrofits. To prioritise where each low-regret energy system component should be deployed, each modelling zone was ranked using various technical and social factors such as the available capacity at each substation, Welsh Index of Multiple Deprivation.

Action routemap

Our energy propositions describe where our priorities lie based on the evidence presented thus far. Our action routemap takes each energy proposition and outlines critical, enabling actions that can be taken collectively with stakeholders in the coming decade, with a particular focus on what can be achieved in the next 5-7 years. The action route map recognises the interdependencies of national and local legislation and policies and the resulting impact on the transition journey. The routemap is therefore a snapshot based on the prevailing conditions and will need to be reviewed to reflect changing circumstances.

Each action will require six key elements to be successful:

- Mobilising finance
- Strong and consistent policy frameworks
- Identifying delivery owners
- Community engagement
- Planning consent (when required)
- Grid capacity

Monmouthshire council's role in delivering each energy proposition will vary. Some actions call for council 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, it was identified that some of the actions are best delivered collaboratively through the regional partnership. This is because there are economies of scale, and it would be more efficient to have joined up and focused public resources. The regional actions will require detailed design work, to create projects and programmes, to progress them to implementation stage - with an initial focus on the tried and tested. The council will take an active role in supporting the CCR going forward.

The following section provides further detail on each of the actions that will be undertaken under each energy proposition, as well as the key asks of others. Due to the relative uncertainty of longer-term actions, detailed scoping of these in this report is not included and instead, focus on actions intended to be delivered in the short-term, subject to appropriate support.

For more details on the methodology and the, action plan, please see the Technical Report.

4. Action Planning

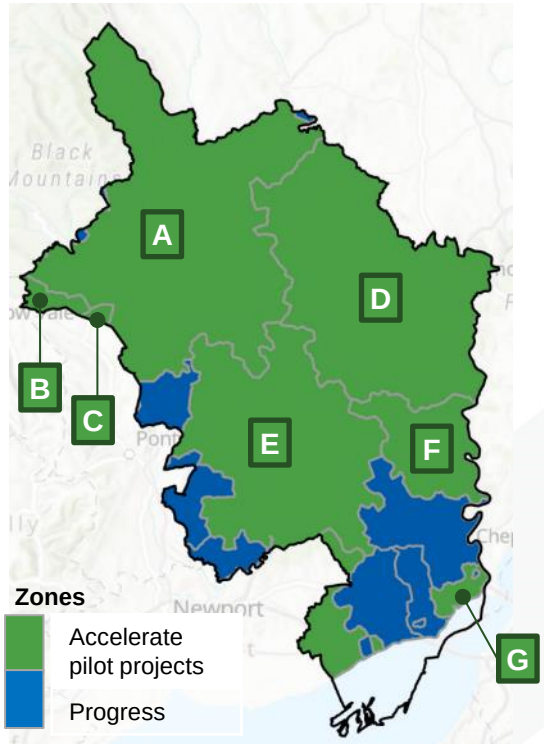
Spatial representation of opportunities

Priority zones

Suggested energy components to pilot in each zone (colour indicates the relevant proposition)

Heat pumps (P1)	EV charger (P3)
Insulation measures (P1)	Onshore wind (P2)
Rooftop PV (P1)	Ground-mounted PV (P2)

Figure 4.2 identifies zones with particularly favourable conditions for specific energy components, making them ideal locations for pilot studies. The summary tables detail key figures for each zone by 2030: (i) pilot ambition, (ii) required investment for each pilot and (iii) total investment for all energy components and electricity network infrastructure interventions. Ranges show the minimum and maximum results from each future energy scenario modelled. Note: intervention should still be carried out in 'Progress' zones to transition the local area to Net Zero.



	(i)	(ii)	(iii)
Zone A			
	1,700 – 4,700 homes	£ 17 – 312 M	**Zone A total** £ 39 – 330 M
	400 – 500 chargers	£ 110 – 210 k	
Zone B			
	22 – 35 heat pumps	£ 110 – 160 k	**Zone B total** £ 950 k – 9.8 M
	68 – 177 homes	£ 570 k – 9.4 M	
Zone C			
	4 – 5 chargers	£14 – 18 k	**Zone C total** £ 14 – 18 k
Zone D			
	110 MW	£ 49 M	**Zone D total** £ 84 – 270 M

	(i)	(ii)	(iii)
Zone E			
	5 MW	£ 3.8 M	**Zone E total** £ 76 – 185 M
	151 MW	£ 60 M	
Zone F			
	230 – 420 homes	£ 2 – 42 M	**Zone F total** £6 – 46 M
Zone G			
	11 MW	£ 8.4 M	**Zone G total** £15 – 40 M

Note: The proposals use modelling assumptions and do not reflect planning and other constraints.

Figure 4.2: Monmouthshire County's spatial representation of opportunities, including 2030 ambition and investment (million £) Zone boundaries are defined by modelling zone.

Sponsors: Delivery partners:

4. Action planning

Action routemap

National policies and targets

	Action	2024	2025	2026	2027	2028	2029	2030
National targets	• Up to 1GW of electrolytic hydrogen secured (2025) [UK][M44]							
	• Decision on hydrogen to heat buildings (2026) [UK][M45]							
	• Up to 10GW hydrogen capacity (50% electrolytic) [UK][M44]	Progressing towards 2030						
	• Up to 50GW of offshore wind capacity including up to 5GW of innovative floating wind (2030) [UK][M44]	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) [M46]							
	• All new social homes built to Welsh Development Quality Requirements 2021 without fossil fuel heating (from 2025)[M47]							
	• All existing social homes to have a plan for minimising environmental impact and improving energy performance (2027) [Wales][M48]							
	• -37% GHG emissions by 2025 (rel. to 1990) [Wales][M49]							
	• -63% GHG emissions by 2030 (rel. to 1990) [Wales] [M49]	Progressing towards 2030						
	• Meet the equivalent of 100% of electricity needs from renewable sources by 2035 [Wales][M26]	Progressing towards 2035						
	• 1.5GW of renewable capacity to be locally owned (exc. Heat pumps) (2035) [Wales] [M26]							
	• 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[x] (2035) [Wales] [M26]							
	• Minimum EPC E to rent out any property (from 2020 onwards) and EPC C from 2030 [UK][M51]							
	• 1 public charge point for every 7 to 11 electric vehicles (2025) [Wales][M23]							
	• Rapid charging available every 20 miles on the strategic trunk road (2025) [Wales] [M23]							
	• -10% car miles travelled/person (2030) [Wales] [M03]	Progressing towards 2030						
	• 80% new cars and 70% new vans sold to be 0 emissions (2030) (ZEV mandate) [UK] [M53]	Progressing towards 2030						
	• 100% new cars and vans sold to be 0 emissions (2035) (ZEV mandate) [UK] [M53]	Progressing towards 2035						
	• Net zero public sector by 2030 [Wales][M23]	Progressing towards 2030						

4. Action planning

Action routemap

Enabling actions

L Action will be implemented at a local scale, across Monmouthshire County

Timescale for the action is ongoing

	Action	2024	2025	2026	2027	2028	2029	2030	Proposed lead(s)
Enabling actions	E.1.1: Develop MCC procurement procedures to include requirements for carbon management plans or practices from suppliers								L
	E.1.2: Continue to deliver an accredited Carbon Literacy programme for businesses, residents and community leaders to empower change								L
	E.1.3:Promote and support delivery of Surple scheme to provide Net Zero training, tools and support to businesses in Monmouthshire County.								L

4. Action planning

Action routemap

Transition to low carbon buildings

L Action will be implemented at a local scale, across Monmouthshire County

Timescale for the action is ongoing

	Action	2024	2025	2026	2027	2028	2029	2030	Proposed lead(s)
Transition to low carbon buildings	B.1.1: All new homes required to be net zero carbon following the adoption of the new RLDP							↻	L
	B.1.2: Develop and implement an Energy Strategy for Council occupied buildings to reduce consumption demand and support behavioural change								L
	B.1.3: Develop costed decarbonisation plans for MCC's built estate. Interventions to be prioritised and actioned in line with available resource								L
	B.1.4: Develop a low carbon heat strategy and action plan for MCC's estate								L
	B.1.5: Continue to implement a rolling programme of Re:fit energy saving and decarbonisation phases across all MCC operational estate							↻	L
	B.2.1: Develop a targeted campaign in collaboration with ABUHB and Public Health to, promoting ECO4 Flex to those eligible via Route 3.								L

4. Action planning

Action routemap

Deploy renewables

L Action will be implemented at a local scale, across Monmouthshire County

Timescale for the action is ongoing

	Action	2024	2025	2026	2027	2028	2029	2030	Proposed lead(s)
Deploy onshore renewables	R.1.1: Review and update renewables guidance in RLDP as Regional / National policy directions and targets emerge								L
	R.1.2: Investigate and identify opportunities to increase local offtake and demand offset from Monmouthshire Council local generation assets								L
	R.1.3: Identify and implement options for encouraging uptake of retrofit domestic renewable energy / energy measures among private residents.								L

4. Action planning

Action routemap

Decarbonise transport

L Action will be implemented at a local scale, across Monmouthshire County

Timescale for the action is ongoing

	Action	2024	2025	2026	2027	2028	2029	2030	Proposed lead(s)
Decarbonise transport	T.1.1: Adopt and implement a Monmouthshire County EVCI strategy and action plan, promoting social parity and equitable access for those without off-street parking		■	■					L
	T.1.2: Partner with industry to identify opportunities for destination and hub charging along main arterial routes			■	■	■	■	■	L
	T.1.3: Develop and implement a fleet transition plan to convert the Council's operational fleet to ULEV alternative			■	■	■	■	■	L
	T.1.4: Introduce an EV / Hybrid pool car fleet to reduce business mileage emissions of MCC operations	■	■						L
	T.1.5: Develop and promote salary sacrifice schemes and site travel plans to reduce commuting emissions	■	■	■	■	■	■	■	L
	T.1.6: Promote the use of public transport, cycling and walking to school and encourage schools to produce their own school travel plans, supported by MCC active travel team			■	■				L
	T.1.7: Continue to work on active travel routes funded by Welsh Government	■	■	■	■	■	■	■	L
	T.1.8: Undertake collaboration with Marches Forward Partnership to develop a Marches Regional Area Energy Plan	■	■						L
	T.1.9: Promote car lift share opportunities	■	■	■	■	■	■		L

4. Action planning

Action routemap

Generate green hydrogen for transport and industry

L Action will be implemented at a local scale, across Monmouthshire County

Timescale for the action is ongoing

	Action	2024	2025	2026	2027	2028	2029	2030	Proposed lead(s)
Generate green hydrogen for transport and industry	I.1.1: Identify Monmouthshire council's fleet hydrogen requirements and undertake feasibility study / business case for producing and supplying green hydrogen								L

Sponsors: monmouthshire sir fynwy; Llywodraeth Cymru Welsh Government

Delivery partners: ARUP; CARBON TRUST; Prifddinas Ranbarth Caerdydd Cardiff Capital Region

4. Action planning

Action routemap

Energy networks

Action will be implemented by Wales and West Utilities (WWU)

Action will be implemented at a local scale, across Monmouthshire County

Action will be implemented by National Grid Distribution Network (NGED)

Timescale for the action is ongoing

	Action	2024	2025	2026	2027	2028	2029	2030	Proposed lead(s)
Energy networks	N.1.1: Hold regular engagement meetings between Monmouthshire council, NGED and WWU		Every six months						L
	N.1.2: Consolidate project pipelines across electricity and gas networks								nationalgrid
	N.2.1: Inform local authorities about our available data resources		Ongoing						nationalgrid
	N.2.2: Engage with DFES and respond to consultations in support of required investment at RIIO-ED3 and RIIO-GD3		Ongoing						L
	N.2.3: Include new projects from the LAEP in strategic planning process								nationalgrid
	N.3.1: Highlight gas infrastructure opportunities		Ongoing						
	N.3.2: Include new projects from the LAEP in strategic planning process								
	N.3.3: Support RIIO-GD3 Planning through attending stakeholder events and responding to consultations								L
	N.3.4: Continue our iron mains replacement programme which will support the gas network to be hydrogen ready								
	N.4.1: Develop hydrogen and bio-methane projects								
	N.4.2: Investigate hydrogen transport demand								

Connected. Competitive. Resilient.

Monmouthshire County

Chapter 5: Next steps

5. Next steps

The LAEP in the context of programmes and projects

The LAEP gives a good understanding of the current state of the local energy system, and what it will take to decarbonise it. The ambitions and supporting actions have been set out, the delivery of which will be dependent on national policies, resources and funding.

Each proposition has been accessed 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 5.1 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: This 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.

Update diagrams

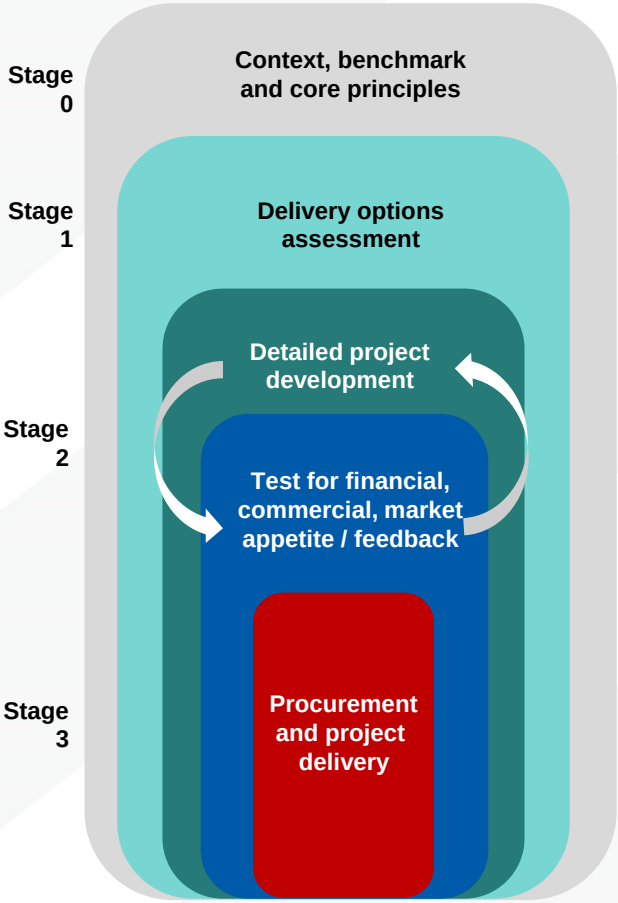


Figure 5.1: How programmes and projects develop

5. Next steps

Enabling conditions for success

Governance

Delivery of the LAEP will be overseen by Monmouthshire County Council and the CCR.

Recognising the number of different stakeholders who play an important role in delivering the change that will be required to meet the objectives and actions set out in this plan, Monmouthshire Council will work with the CCR and partners across different sectors. The CCR will lead on developing and setting up a governance structure that will enable wider input to the plan.

To deliver this, Monmouthshire County Council will decarbonise assets within direct control, such as council buildings and the council transport fleet. Further, the council will drive and influence the decarbonisation of the wider area through showcasing, collaborating and engaging the community.

The sphere of influence might include:

- Budget and finance
- Defining and helping to achieve the project outcomes
- Identifying the priorities
- Identifying potential risks and monitoring risks
- Monitoring timelines
- Monitoring the quality of the project as it develops

The council is involved in a range of projects, initiatives and partnerships with different levels of control. Some of these examples are shown on page 53.

Across the CCR, there are synergies in terms of the propositions chosen. Therefore there may be efficiencies in undertaking many of the programmes and projects forward regionally and/or nationally.

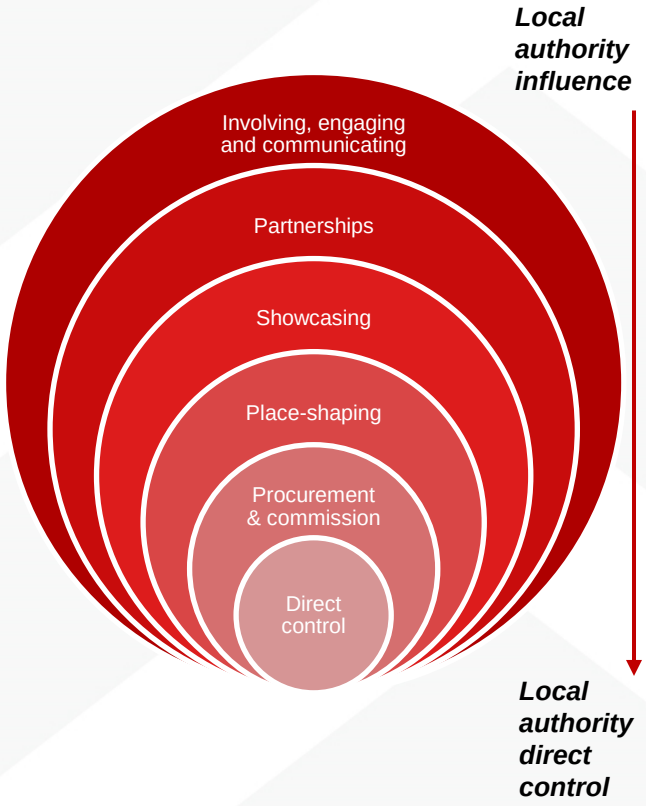


Figure 5.2: Local Authority roles and level of influence

5. Next steps

Enabling conditions for success

Monitoring and review

This plan sets out the key actions for the next six years to support the area to achieve the ambitions in our longer-term routemap. The plan needs to be flexible to adapt to changes in the future.

Working across the region, the Cardiff Capital Region will develop a consistent performance management framework and facilitate monitoring and review of the LAEPs across the region. An annual monitoring report will be produced, building on the Welsh Government's Energy Generation[M61] in Wales reports, which will describe the progress against the actions set out in this plan.

To monitor these metrics, CCR will make use of publicly available datasets such as the DFES reports undertaken by NGED [MC70], Energy Performance Certificate Register [M72], the Micro Generation Certification Scheme[M73] and the Renewable Energy Planning Database.[M62]

CCR will develop a baseline understanding of these metrics based on existing data and monitor changes annually.

GHG emission reduction for the area will be tracked as part of the annual reporting process which will be in addition to the Welsh Government public sector reporting that is undertaken by local authorities. Available data may lag a few years behind.

Monmouthshire County

Appendix

Glossary of terms

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.
Cardiff Capital Region	The Cardiff Capital Region, that covers the 10 local authority areas covering South East Wales -Blaenau Gwent; Bridgend; Caerphilly; Cardiff; Merthyr Tydfil; Monmouthshire; Newport; Rhondda Cynon Taf; Torfaen and Vale of Glamorgan.
Certainties	A fact that is definitely true or an event that is definitely going to take place. In terms of a local energy system, certainties include funded projects, etc.
Demand	Local energy demand that the local energy system needs to meet.

Glossary of terms

Term	Definition or meaning
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 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.
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).
Energy System Component	A term used to describe anything that can have a direct impact on energy demand and/or the way energy is supplied. E.g. installing retrofit measures can reduce overall heating demand, increasing solar PV capacity can change the supply mix and the way that the energy system operates.
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.

Glossary of terms

Term	Definition or meaning
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.
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.
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	The term policy levers is used 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.

Glossary of terms

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 100MW, unless it produces heat which can only be used locally this is generally excluded from LAEP particularly the modelling.
National grid	A generic term used in the reports referring to the electricity network serving Wales, including both the transmission and distribution networks and facilitating the flow of electricity between neighbouring areas or regions. *May also be called generically "grid" in the reports.*
National Net Zero	The National Net Zero modelled in the LAEP. Details of assumptions are in the methodology section.
National 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.

Glossary of terms

Term	Definition or meaning
Net Zero	Check preference with LA and note down in the table in Glossary of terms.docx . 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.
	A term used to describe ways that a particular objective can be achieved. In the context of this LAEP, an option could be deploying a particular energy system component.
Outward code	The first part of a postcode i.e. BS1.
Pathway	A pathway is how to 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.
Power factor	The ratio between useful power (kW) and apparent power (kVA) consumed or transformed by electrical equipment.
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.

Glossary of terms

Term	Definition or meaning
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.
Renewable Energy Guarantees of Origin (REGO) Agreement	A scheme that tells consumers what proportion of their electricity comes from renewable sources.
Resistance heating/ heater	Generate heat by passing electrical currents through wires.
Scenario	A scenario is a set of assumptions for a particular end point (usually 2050) which are modelled in our optimisation model. 5 different scenarios were modelled 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.
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.

Glossary of terms

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.
Substation upgrades	Interventions at an existing primary substation designed to increase the capacity of the substation, such as upgrading an existing primary substation or installing a new primary substation. *May also be called 'substation interventions' in the reports.*
Supply	Energy supply options – this is how energy is delivered from the point of source – so a supply option would be solar PV.
Supply/ generation headroom	The difference between the electrical capacity of a substation, and the power being supplied to the substation at a given time.
TfW zone	An area used by the Transport for Wales (TfW) as a point of origin or departure for vehicle trips. M*ay also be called "transport zone" within the reports.*
Transmission network	Move energy via pipes or wires for long distances around the country at high pressure/ voltages.
Uncertainties	Uncertainty results from lack of information or from disagreement about what is known or even knowable.
Wind power	Harnessing the kinetic energy of wind to turn a turbine to generate electricity.

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.
kgCO2e	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.
ktCO2e	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 kgCO2e.
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).
MVA	Mega volt amp(s) – a metric unit of apparent power measuring rate of energy consumption or production and considering the efficiency by which electrical power is converted into useful output. It is related to MW by the power factor of the system or equipment.

Units of measure

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.
tCO_2 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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