Carmarthenshire Local Area Energy Plan 2024



Introduction to the Document

This the primary report for the Carmarthenshire Local Area Energy Plan (LAEP), prepared by City Science for Carmarthenshire Council.

This LAEP was crafted through significant stakeholder engagement. It adheres to both the Energy Systems Catapult and Ofgem guidance. Earlier chapters summarise the findings from the LAEP process, providing a comprehensive overview of the current energy system in Carmarthenshire. Later chapters consider multiple prospective future energy scenarios and the nature of the potential energy system changes required, ultimately providing potential actionable steps, with the primary goal of achieving net zero by 2050.

The intention of this report is to serve as a dynamic resource, delivering technical insight in a format that is easily digestible. This document has been produced alongside detailed technical reporting that provides further details.



Provides an overview of the local context (such as demographic and socioeconomic factors), and the current energy system. The information provides a benchmark against which net zero progress can be measured. Presents a comprehensive vision for Carmarthenshire's future energy system, outlining the Net Zero Pathway, which was used to inform and support the interventions and the detailed Action Plan. Provides the potential interventions that can be applied across the energy system to reach net zero. It also identifies Focus Zones which are areas where an intervention is suitable on a large scale or could be prioritised. The Action Plan provides clear direction, channelling the broader focus on decarbonisation into a set of collective actions to guide and progress Carmarthenshire toward the targets in the Net Zero Pathway.



Mae'r adroddiad hwn ar gael yn y Gymraeg. This report is available in Welsh language.

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Acronym	Definition
ASHP	Air Source Heat Pump
BUS	Boiler Upgrade Scheme
CAPEX	Capital expenditure
CO ₂	Carbon dioxide
СРО	Charge Point Operator
DNO	Distribution Network Operator
EPC	Energy performance certificate
ESC	Energy Systems Catapult
EV	Electric vehicle
FES	Future energy scenarios
HGV	Heavy goods vehicle
KPI	Key performance indicator
LAEP	Local Area Energy Plan
LGV	Light goods vehicle
LSOA	Lower Layer Super Output Area
LULUCF	Land use, land use change and forestry
NGED	National Grid Electricity Distribution
NGET	National Grid Electricity Transmission
OS	Ordnance Survey
PPP	Public Private Partnerships
PV	Photovoltaic
RAG	Red, amber, green
RLCEA	Renewable and Low Carbon Energy Assessment
SIC	Standard Industrial Classification
SWIC	South Wales Industrial Cluster
WIMD	Welsh Index of Multiple Deprivation
WWU	Wales and West Utilities
ZEVIS	Zero Emission Vehicle Insight Study



Carmarthenshire's Local Area Energy Plan (LAEP) presents a comprehensive vision for Carmarthenshire's future energy system, delineating the essential characteristics it will need to achieve a net zero energy system by 2050. The objectives of the plan include:



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Promote cost-effective solutions for energy generation, distribution, and consumption whilst reducing carbon emissions

- Enhance the efficiency, security and resilience of the local energy system via sector-based interventions
- Enable the planning of energy infrastructure that aligns with the current and future needs of the community

Stimulate economic development and job creation through the growth of local clean/green energy industries

Address equity and social inclusion in the energy system to maximise well-being and other wider community benefits

What is a Local Area Energy Plan?

A LAEP is an evidenced, spatial plan that identifies the changes required to the local energy system and built environment to achieve a net zero energy system by 2050. The resulting Net Zero Pathway and Action Plan in the LAEP can be used to guide the area's long term strategic thinking, planning and investment but requires subsequent detailed design work to deliver the suggested actions and projects.



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

In 2021, the Welsh Government pledged to achieve net zero carbon emissions by 2050 and produced the Net Zero Wales Plan¹. This ambition is undeniably challenging yet is achievable with significant action and engagement from the regional local authorities, local communities and individual citizens. Despite the challenges, a net zero energy system can also offer immense economic opportunity and multiple co-benefits for the area, which are explored and illustrated through this LAEP.

Stakeholder Engagement

A comprehensive stakeholder engagement programme was embedded throughout each stage of the LAEP development. Local and regional sessions were held including interviews, technical validation meetings, workshops and focus groups to ensure the final outputs reflect the needs and ambition of local stakeholders.

Key Project Stakeholders

Wider Stakeholders

Subject experts

• High energy users

• Key industry

segmentsActive influencers

- Carmarthenshire Council
- Welsh Government Energy Service
- National Grid Electricity Distribution
- Wales and West Utilities
- Energy Systems Catapult

Local Context

Carmarthenshire County Council is in the South West Region of Wales and covers 12% of the total land in Wales². It has a low population density, half of that of the Welsh average, which is partly due to its rural nature.

It consists of 51 electoral wards and three of the largest towns and urban centres include Llanelli, Carmarthen and Ammanford. Due to its central geographical position, Carmarthenshire serves the needs of neighboring local authorities for retail aspects and some industrial and employment provision.



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Executive Summary

Policy Drivers

Carmarthenshire Council declared a climate emergency in 2019. A variety of policies drive the need for a net zero energy system.

Net Zero Wales Carbon Budget ³ Outlines national ambitions to be net zero by 2050, including a 37% reduction in emissions by 2025.	Llwybr Newydd - Wales Transport Strategy ⁴ The Wales Transport Strategy aims to create an accessible, sustainable and efficient transport system	South West Regional Energy Strategy ⁵ A regional strategy that outlines six priorities to deliver a 55% reduction in energy system emissions by 2035 to meet national and regional ambitions.	
Net Zero Carbon Plan ⁶	Emerging Local Development Plan ⁷	Moving Rural Carmarthenshire	
Commits the local authority to be net zero by 2030. Includes policies such as incorporating higher new build standards and delivering renewable energy.	A strong net zero focus through providing energy efficiency and climate change policies and outlining allocations for strategic renewable energy sites.	Forward [®] Includes a series of recommendations focused on increasing renewable energy development in rural areas.	

Baseline Energy System

The current energy system was analysed across sectors to understand emissions trajectories, key challenges and opportunities and to serve as a benchmark against which progress can be measured. The base year was chosen as 2019, as the latest available data unaffected by COVID-19.

Important note: The agricultural sector is a key part of Carmarthenshire's identity and produces 49% of the area's emissions. However, the LAEP only considers energy-related emissions, namely agricultural machinery and buildings (which contribute only 7% of emissions). Animal husbandry and land management (42% of Carmarthenshire's emissions) are not included in the LAEP and must be considered separately.

Historical Energy-Related Emissions (2005-2019)⁹



Historic carbon emissions have fallen, mainly due to the decarbonisation of the electricity grid since 2013. However, fossil fuels still make up the majority of energy consumption. Road transport and domestic housing are the two most energy intensive and polluting sectors.



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Executive Summary

Assessing Options for the Future

The potential 2050 energy system was modelled under a variety of technology and policy scenarios to understand the capacities of technologies required to reach net zero. This was extrapolated to a pathway, presenting a vision for how Carmarthenshire could progress to achieve decarbonisation. Two main narratives were tested and compared.

Widespread Engagement

- Incorporates a widespread uptake of heat pumps, increase in public transport and high electric vehicle (EV) adoption across all vehicles
- Industry relies on a mix of electrification and hydrogen
- Some technologies require consumers to embrace initial changes to behaviour

Widespread Hydrogen

- Change is driven from a topdown, system-wide approach with hydrogen infrastructure as a key driver for heating
- Hydrogen is the main fuel for industry and a key fuel for heavy vehicles
- Private transport is electrified and use of public transport increases

A 'Do Nothing' scenario was also used as a counterfactual, which assumes that nationally and locally, no further policies or action is taken. Analysis was carried out across multiple factors to determine a preferred pathway which balances the need to deliver carbon reductions with economic opportunity and improved quality of life for local people.



Major differences include a **7%** lower total system cost for Widespread Engagement and close to **50% savings** on consumer bills from using heat pumps rather than hydrogen boilers.





A Red Amber Green (RAG) analysis was carried out to demonstrate the impacts of each scenario. It was found that Widespread Engagement offers faster decarbonisation, at a lower overall cost, and with a reduced impact on consumer bills.



The Preferred Pathway

Overall, Widespread Engagement was selected by stakeholders as the preferred scenario. This is due to the cost savings, lower impact on consumer bills and generally lower risk associated with the electrification of heat versus widespread dependency on hydrogen. Both net zero scenarios, however, offered significant carbon emissions savings compared to the Do Nothing scenario.

The Widespread Engagement scenario transitions primarily to electricity, by increasing the rollout of heat pumps for both domestic and nondomestic buildings, and the adoption rate of EVs across all vehicle types. The overall energy consumption decreases as heat pumps and EVs are significantly more energy efficient than gas boilers and internal combustion engines. Hydrogen is still required in this scenario, which is used for a small number of heavy vehicles such as buses and Heavy Goods Vehicles (HGVs) and could be used for industrial processes.

The total system cost was estimated, which includes both fossil fuel and low carbon costs, between now and 2050 across both the private and public sectors. Overall, the Widespread Engagement scenario is estimated to cost an additional 22% relative to Do Nothing, to achieve the desired level of decarbonisation by 2050. This is equivalent to £5.3bn. In all scenarios, the transport sector has the highest cost due to the volume of new vehicles.



Widespread Engagement: Total Energy Consumption



Intervention Areas

Specific interventions required to achieve a net zero energy system under the Widespread Engagement Scenario were assessed across all sectors within the LAEP. These are presented in detail, including a spatial analysis of where they would be needed, which will support implementation programmes and identification of potential synergies from different actions.



The analysis from these intervention areas was combined with extensive stakeholder engagement to develop the final Action Plan.

Interventions were assessed across key factors for each sector, such as carbon emission savings, cost and energy reduction. This supports in determining the priority order of intervention and informs the local authority of the scale of cost required and the associated benefit.

Focus Zones were determined for areas where a given intervention is considered to be 'low regrets', i.e. it is recommended across all modelled scenarios. A summary of these Focus Zones is given on the following page, shown by the Plan on a Page. Interventions were chosen through engagement with stakeholders to determine the decarbonisation solutions that aligned with local policy and plans as well as supporting wider factors, such as alleviating fuel poverty. Some key findings across the intervention sectors are shown below.



Applying shallow (80%) and deep (20%) retrofitting can offer an 8% energy saving across all buildings.



The area will require 6,000 heat pumps by 2030.



Buses will make up 25% of the 2050 transport electricity demand, requiring strategic charging locations.



Renewable generation has the potential to increase 10-fold, and total generation in the area could exceed demand.



Over 80% of energy for industry could be supplied by hydrogen, benefiting from local infrastructure projects.



The 2050 electricity demand is estimated to be 2.4x the baseline, requiring network investment in Llanelli and many rural areas.

The Electrification Challenge

Net zero demands significant electrification, which will require increased capacity for both demand and generation on the electricity grid. The cost to increase capacity is substantial, with estimates of up to £200mn and £500mn for demand and generation respectively. Measures which reduce capacity needs, such as large energy storage and demand flexibility should be prioritised. A key focus after this LAEP will be to collaborate with National Grid Electricity Distribution (NGED) to forecast and plan for future demand and generation to enable efficient and timely grid upgrades.



Action Plan & Next Steps

The Action Plan provides the detail of 13 priority actions to achieve the milestone targets set out in the Net Zero Pathway, and support Carmarthenshire's journey to a net zero energy system. It acts as a catalyst for future initiatives, with an intention to inform upcoming projects, policies, and strategies. It provides clear, but intentionally flexible direction, channelling the broader decarbonisation focus into a set of collective actions. It is important to note that the selection of priority actions does not preclude support for initiatives beyond this list or those featured in other plans. The actions are categorised and outlined below.

Crosscutting Enabling Actions



Establish a Regional LAEP Steering Group
 Support a Long-Term Green Skills Programme
 Embed LAEP Learnings into Wider Processes & Communications

Building Efficiency, Retrofit & Heat Actions



4: Create a Retrofit & Low Carbon Heating Behaviour Change Campaign
5: Implement a Retrofit & Heat Bulk Purchasing Scheme for Social Housing
6: Develop a Retrofit & Low Carbon Heating Local Supply Chain

Transport Actions



7: Improve the Accessibility of EV Charging Infrastructure8: Facilitate Low & Zero Carbon Vehicle Public Fleet Uptake9: Enhance Active Travel & Public Transport

Generation & Networks Actions



10: Continue Collaboration with Electricity & Gas Network Operators11: Address Future Needs of Hydrogen-Fuelled Vehicles

Industry Actions



12: Establish an Industry Engagement Forum13: Support the Green Industries Investment Zone

Next Steps

To mobilise the actions, the following key next steps have been identified.

- **1. Regional Review:** A collaborative and thorough assessment of all four LAEPs in the region, leading to the identification of actions to be collectively advanced through a regional approach.
- 2. **Prioritisation:** Mobilise the establishment of a Regional LAEP Steering Group who will assess and develop a phased delivery plan to optimise impact and foster a holistic approach.
- **3. Collaboration:** The Regional LAEP Steering Group may take ownership of certain actions, however, not all actions will fall under its purview. Instead, it will delegate ownership to appropriate parties, via engagement with key stakeholders.
- 4. Funding & Resource: Once ownership has been identified, the next step is to assess the funding and resource required and develop a plan for each action.



The next page features an Action Roadmap which provides an overview of the sequential implementation of the priority actions







What is Local Area Energy Planning?

Local Area Energy Plan (LAEP)

Sets out the changes required to transition an area's energy system to net zero carbon emissions, against a specified timeframe. This is achieved by exploring a range of technologies and scenarios through whole energy system modelling and analysis. By identifying the most cost-effective preferred pathway to net zero, additional benefits for the local area can be realised^{1,2}.

A LAEP results in an indicative costed spatial plan that identifies the change needed to the local energy system and built environment, detailing what changes are required, where, when and by whom. The level of detail for an area is equivalent to an outline design or master plan. Therefore, additional detailed design work is required for identified specific actions, projects, and programmes to progress to implementation. Rather than a detailed schematic, a LAEP proposes a sectorspecific action plan that sets out how each part of the area will be designed and built.

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, a full feasibility assessment by an appropriately qualified installation or design company, along with assessment of commercial viability and delivery mechanisms would be required.

Vision



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



Key Benefits of the Whole Systems Approach



Provides consideration of the most cost-effective solutions to the future energy system (e.g. 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 future plans, a LAEP is built on a common evidence base. The outputs can then be used reliably by all stakeholders knowing they are working towards a common goal built on strong foundations.

The Energy Transition Across Wales

The Welsh Government's "Net Zero Wales" plan establishes an increased level of ambition on decarbonisation, with a legally-binding target to reach net zero emissions by 2050³. It is the first national government to fund the roll-out of Local Area Energy Planning to all its local authorities. While four regions in Wales had earlier developed LAEPs, the present programme has extended LAEPs to all remaining areas through a coordinated regional approach. A number of suppliers have been selected to produce the LAEPs for each region, as detailed in the map.

The LAEPs will form the basis of the 'National Energy Plan' that Welsh Government have committed to produce in 2024. Upon completion of the LAEP programme, Energy Systems Catapult will aggregate the LAEPs into a national view. To support this task, they are working with the Welsh Government to create and import standardised LAEP outputs for aggregation into the DataMapWales platform. Energy Systems Catapult is also providing technical advisory support to the Welsh Government throughout the programme.



North Wales

Arup, Carbon Trust and Afallen

Mid Wales Energy Systems Catapult

South West Wales City Science



Cardiff Capital Region Arup, Carbon Trust and Afallen

Areas with existing LAEPs



Isle of Anglese

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Flintshire

Whilst the LAEPs are local, they have been developed using regional collaboration and themes aligned with the four Regional Energy Strategies.

Scope

The UK Government's 2021 Net Zero Strategy estimates that 82% of the UK's emissions are "within the scope of influence of local authorities"⁴. The scope of the LAEP considers current energy consumption (and associated greenhouse gas emissions), and projected consumption to 2050², based on the expected changes required to achieve a net zero energy system. Site-specific data is used where available, with remaining elements covered by national datasets.

The agricultural sector in Carmarthenshire produces 49% of the area's emissions, the majority of which is attributed to land management and animal husbandry, which are non-energy emissions (42% of total emissions). However, the scope of Local Area Energy Planning only

includes energy-related emissions, namely agricultural machinery and buildings. The LAEP alone therefore does not sufficiently cover the agricultural sector and it is vital for non-energy agricultural emissions to be addressed in separate workstreams.

In addition, LAEPs do not normally consider aspects of the energy system that are expected to be overseen by central government (such as shipping, aviation, rail, the strategic road network, and large electricity generators connected to the transmission network). In Carmarthenshire's case, the strategic road network is not included in emissions calculations; however, has been included for future energy demand forecasting. This is to inform the energy network and infrastructure investment required to support it.



Stakeholders

A stakeholder engagement programme was embedded throughout each stage of the LAEP's development. Local and regional sessions were held that included interviews, technical validation meetings, workshops and focus groups to ensure the final outputs reflect the needs and ambition of local stakeholders whilst providing regional alignment.

The two key workstreams included: Net Zero Pathway Development and Action Plan Development. Net Zero Pathway Development involved working with stakeholders to achieve a baseline understanding of the local energy system, explore and model "Futures Scenarios", and ultimately agree a net zero pathway. Action Plan Development engagement supported the understanding of the current delivery landscape and developed a long-list of actions that were prioritised and refined in close collaboration with a broad range of stakeholders. The diagram below illustrates how the key project and wider stakeholders informed the LAEP process, and how the engagements and their outputs influenced the process and directly fed into LAEP outputs. The stakeholders that were engaged are presented on the next page.



CARMARTHENSHIRE LAEP



Stakeholders



*The example organisations provided are not a complete list of stakeholders engaged throughout the LAEP development process.





Policy Ambitions

National

The Welsh⁶ and UK⁷ governments have a legallybinding target to reach net zero by 2050. Additional net zero targets include:



37% reduction in Welsh emissions by **2025**⁶



148,000 Welsh homes to be retrofitted by **2025**⁶



100% of Wales' electricity produced from renewables by **2035**⁸



Llwybr Newydd -The Wales Transport Strategy aims to create an accessible, sustainable and efficient transport system⁹



The Well-being of Future Generations (Wales) Act (2015) outlines seven goals to increase the well-being in Wales¹⁰



Regional

55% reduction in South West Wales' energy emissions by **2035**¹¹

South West Wales Energy Strategy (2022)¹¹ outlines six priorities to achieve this:



Energy Efficiency



Decarbonise Transport

Decarbonise Heat



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Regional Coordination

Smart & Flexible Systems

Electricity Generation

Ambitions to be a UK leader in renewable energy and the net zero economy $^{\rm 12}$



Local

2022 Nature emergency declared¹⁴



1st Welsh authority to publish a Net Zero Carbon Plan¹⁴:

Net zero Local Authority by **2030**

28 actions across key emissions sources

Local grid capacity severely constrained



3,080 fleet vehicles to zero emission by **2030**¹⁵



The emerging Local Development Plan includes a stronger net zero focus⁴



A strong focus on increasing renewable energy development in rural areas¹⁶

Existing Programmes

- •The Swansea Bay City Deal¹⁷ is an investment of up to £1.3bn in nine major programmes and projects across the Swansea Bay City Region, encompassing Carmarthenshire, Neath Port Talbot, Swansea and Pembrokeshire¹⁷.
- •The programme aims to boost the regional economy by at least £1.8bn whilst generating significant job opportunities. Net zero and energy system decarbonisation are key themes across the projects. The LAEP will seek to integrate and build on these initiatives to maximise impact and avoid duplication.

Swansea Bay City Deal

- •Since 2021, the college has trained over 500 people in practical net zero skills such as installing renewable energy technologies and EV infrastructure through the Green Skills Academy²⁰.
- •Building on this success, Coleg Sir Gâr has introduced an Introduction to Retrofit Course to support upskilling within the construction industry²⁰.

Coleg Sir Gar's Green Academy Wales Project



- •Homes as Power Stations¹⁸ is part of the portfolio of projects set out within the Swansea Bay City Deal and aims to integrate energy efficiency design and renewable technologies into the development of new build homes alongside promoting public and private sector retrofit programmes.
- •A key ambition is to facilitate the uptake of renewable technologies in at least 10,300 properties (68% retrofit and 32% new build) within five years¹⁸.

Homes as Power Stations



- •The Swansea and Carmarthenshire Green Industries Investment Zone is integrated within the South West Wales Industrial Cluster and the Celtic Freeport and aims to connect the region's energy generation potential and industrial strengths to support long-term sustainable economic growth²¹.
- •Three potential investment zones are identified within Carmarthenshire: Llanelli Low Carbon Cluster, Nantycaws Circular Economy Park and Cross Hands Growth Zone²¹.

Green Industries Investment Zone



- •Pentre Awel is a 1,360 km² site in south Llanelli which will be the first development of its scope and size in Wales, offering a diverse mix of medical research and health care delivery as well as supporting and encouraging people to lead active and healthy lives¹⁹.
- •Part funded by the Swansea Bay City Deal (£40 mn), the project is being delivered by Carmarthenshire County Council in partnership with the Hywel Dda University Health Board, University and Colleges¹⁹.

Pentre Awel



- South Wales Industrial Cluster (SWIC) is the second largest emitting industrial cluster in the UK. As a result of the heavy industry presence, there is a significant amount of activity exploring the production, distribution and usage of hydrogen.
- •Wales & West Utilities (WWU) is exploring the feasibility of a dedicated hydrogen distribution pipeline, HyLine Cymru¹³, which would run from Milford Haven, through Carmarthenshire, over to Port Talbot.

HyLine Cymru



Greenhouse Gas Emissions

- Carmarthenshire's largest source of emissions is from agriculture at 49%. However, this LAEP only addresses the comparatively small volume of energy-related agricultural emissions (from buildings and machinery), at 7%. The more significant non-energy agricultural emissions (livestock, land use and soils) at 42% are outside of scope of the LAEP.
- The highest energy-related emissions in 2019 were produced by the domestic sector at 19%.
- Carmarthenshire's industrial and commercial sectors when combined contribute to 13% of total emissions.
- 7% of annual emissions are offset through Land Use, Land Use Change and Forestry (LULUCF).



Total Emissions (2019)²²: **Energy-Related Emissions** Historical Energy-Related Emissions (2005-2019)²² 1.652 kt CO₂e (2019)²²: 974 kt CO₂e²² 2%____ _3% 1,600 -7% 2% 4% 1,400 1,200 1,000 800 60 40 40 20 11% 12% 34% 16% 42% 19% 19% 29% 0 2005 2007 2009 2011 2013 2015 2017 2019 % = In Scope % = Out of scope ■LULUCF ■Agriculture (Non-Energy) ■Agriculture (Energy) ■Domestic ■Surface Transport ■Industry ■Commercial ■Public Sector ■All Waste

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Energy Demand



Energy Use (2019)²³



Carmarthenshire's highest energy demand comes from road transport and domestic buildings. Compared to other areas, Carmarthenshire also has a significant agricultural contribution, with relatively high energy use.

Transport

In 2019, fuel consumption by all vehicles totalled **1,680** GWh, at **36%** of total energy use. The highest fuel consumption (57%) occurred on A roads and 39% on minor roads with only 4% occurring on motorways²⁴.





Industrial & Commercial Energy Demand



Transport



Renewable Energy Installations





The Vision

The LAEP presents a comprehensive vision for Carmarthenshire's future energy system, delineating the essential characteristics it will need to achieve a net zero energy system by 2050. It outlines a potential pathway towards this goal, which is used to develop and support a detailed Action Plan. The objectives of the plan include:



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Promote cost-effective solutions for energy generation, distribution, and consumption whilst reducing carbon emissions

Enhance the efficiency, security and resilience of the local energy system via sector-based interventions

Enable the planning of energy infrastructure that aligns with the current and future needs of the community

Stimulate economic development and job creation through the growth of local clean/green energy industries

Address equity and social inclusion in the energy system to maximise well-being and other wider community benefits

A three-staged approach was adopted to develop these key actions and decarbonise Carmarthenshire's energy system.



2050 Energy System

The future energy system was modelled in the net zero year under different policy and technological scenarios. It explored the changes required to decarbonise under the area's major uncertainties, including capacity of technologies needed and total cost.



Net Zero Pathways

A Net Zero Pathway was developed for each scenario, depicting the potential routes to achieving net zero. The Net Zero Pathways informed the development of a series of interim targets and milestones to drive decarbonisation progress.



Action Plan

A delivery pipeline of key actions to achieve the milestone targets set in the Net Zero Pathway. This plan functions as a living document, providing a detailed blueprint that orchestrates the sequential implementation of key initiatives and measures.



Scenarios – Baseline & Net Zero Pathways

Three distinct primary scenarios were employed to explore the different pathways to meet net zero. The first scenario, "Do Nothing", served as a baseline, projecting the future energy system's trajectory without additional actions toward net zero beyond existing committed initiatives. Two alternative scenarios were also developed and modelled, delineating the potential routes and strategies needed to ensure Carmarthenshire achieves net zero. The National Grid Future Energy Scenarios (FES)¹ were a basis for modelling the trajectories.

In the Widespread Engagement scenario, a consumer-led, bottom-up transformation towards electrification was modelled, while the Widespread Hydrogen scenario envisioned a top-down transformation towards hydrogen.



This scenario serves as a baseline counterfactual, presenting the future energy system with only existing decarbonisation pledges (such as the ban on gas boilers from 2035).

It excludes policies which aren't tangible and, as such, does not guarantee the achievement of net zero.







- Incorporates a widespread uptake of heat pumps, increase in public transport and high EV adoption across all vehicles
- Industry relies on a mix of electrification and hydrogen
- Some technologies require consumers to embrace initial changes to behaviour

Similar to the FES Consumer Transformation scenario¹.



These scenarios were subsequently translated into Net Zero Pathways which identified the pace of change required, offering measurable steps and assessing the cost and wider infrastructure required to strategically deliver decarbonisation.

Throughout the process of developing the scenarios and pathways, a regional approach was applied across South West Wales. This ensured alignment and consistency between the three LAEPs being conducted in terms of narrative and assumptions, while also aligning with the scenarios previously modelled in Pembrokeshire's LAEP.





Widespread Hydrogen

- Change is driven from a top-down, system-wide approach with hydrogen infrastructure forming a key driver for heating
- Hydrogen is the main fuel for industry and a key fuel for heavy vehicles
- Private transport is electrified and use of public transport increases

Similar to the FES System Transformation scenario¹.



Scenarios – Sensitivity Analysis

In addition to the primary scenarios focused on achieving net zero emissions, a secondary scenario set was modelled to assess the sensitivity of the grid to electricity demand peaks. These scenarios serve as a vital tool for stress testing the electricity grid, exploring the potential maximum and minimum demand scenarios that may emerge in 2050. The intention behind this modelling is not to predict a likely pathway to net zero but to provide a comprehensive understanding of the potential range of future electricity demand.

Given the inevitable uptake of electrification, reinforcing the electricity

network will be a critical enabler for a successful net zero transition. The scenarios, by delineating the upper and lower bounds of electricity demand, allow for a robust evaluation of the system's resilience. This stress testing feeds into reinforcement required for the electricity network to withstand a spectrum of future uncertainties, thereby enhancing its adaptability and reliability.

Ultimately, these scenarios do not represent the likely pathway to net zero; instead, they function as a tool for risk mitigation and contribute to the development of a robust energy system.



Net Zero Pathways – Methodology

To inform the development of a pipeline of priority projects, a Net Zero Pathway analysis and techno-economic model were developed to determine the preferred pathway for Carmarthenshire. The themes below were evaluated.

Carbon Emissions: The annual carbon emissions were projected to 2050 to compare the carbon savings.

System Cost: The overall cost of transforming and decarbonising the energy system was modelled to identify the most cost-effective scenario.

Health: The effect on air quality was modelled to evaluate the impact on health and well-being.

Job Creation: The net number of temporary and permanent jobs was modelled to highlight potential opportunities for employment.

Consume costs wer system ch individua

Consumer Bills: Energy bills and upfront costs were modelled. This relates the wider system changes onto the impact on an individual's finances and fuel poverty risk.



Electric Vehicles Uptake



Current heat pump and EV uptake is low (dashed lines) and will need to increase to meet the pathway. The rate of change required to meet net zero is very ambitious and will require extensive planning by local authorities, as well as governmental support to be achievable.

Net Zero Pathways – Energy Mix

Highlights



Heat pumps and heat networks are the most prevalent technologies for heating in Widespread Engagement, replacing gas boilers and leading to high levels of electrification.



The high energy efficiency of heat pumps significantly reduces the overall energy demand of the system.



Hydrogen boilers are the most prevalent technology for heating in Widespread Hydrogen, with heat pumps and heat networks still forming a part of the mix.



Some hydrogen will form part of the energy mix in both scenarios for high temperature industrial processes.





Widespread Hydrogen – Total Energy Consumption



Net Zero Pathways – Carbon Analysis

Highlights



Net Zero is not met under the 'Do Nothing' Scenario.



Decarbonisation occurs slower under the Widespread Hydrogen scenario, as hydrogen technologies are not yet commercially available.

kt CO₂e Compared to 'Do Nothing': **8,500** are avoided **Widespread kt CO**₂e under **Widespread kt CO**₂e **Widespread Hydrogen**



Decarbonisation is dependent on the Grid Carbon Intensity, which decreases as fossil fuel power plants are superseded by renewable energy.



Widespread Hydrogen assumes green hydrogen is readily available and produced via electrolysis from grid electricity.

Total Annual Carbon Emissions



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Net Zero Pathways – Cost Analysis



Highlights

Transport is the most significant expense, due to the large cost associated with purchasing new vehicles.

"Do Nothing" still has high transport cost as the transition to EVs is largely consumer-driven.

Secondary markets for EVs would significantly decrease this cost over time.

The 'Do Nothing' scenario has lower costs as new technologies are currently more expensive than existing ones.



The domestic and nondomestic cost for Widespread Engagement is less than Widespread Hydrogen, as hydrogen is more expensive than electricity.

Widespread Engagement and Hydrogen scenarios are similar in overall system cost (this does not include cost for upgrading electrical grid or decommissioning gas network).


Net Zero Pathways – Health Analysis

Highlights



The costs represent the damages on human health, productivity, well-being, and the environment caused by burning fuels.



The domestic sector has the largest impact due to the large number of gas and oil boilers already in use in Carmarthenshire.



All scenarios transition away from petrol and diesel vehicles as this transition is being consumer-led.



The transition away from fossil fuel heating towards heat pumps or hydrogen boilers leads to a substantial improvement in air quality.



Under 'Do Nothing', the lower uptake of low-carbon heating systems results in higher levels of air pollution.



Under Widespread Engagement, air quality damages are:

36% lower than "Do Nothing" (~£100 million).





Domestic Buildings Transport Agricultural Machinery Non-domestic Buildings Industry

Net Zero Pathways – Job Creation Analysis

Highlights



Installations of heating technologies are the largest temporary job creator, followed by retrofit installations.



The large initial number of temporary jobs in the net zero scenarios is due to the deep retrofit of council-owned buildings, which finishes around 2030, depending on external financing.



Hydrogen retrofit and installations are only expected to begin from 2030.



The increase in skilled workers needed in the retrofit and renewable sectors would benefit from training at colleges and investment into apprenticeships.



Permanent Jobs (Maintenance) - All Net Zero Scenarios



Net Zero Pathways – Consumer Bills Analysis



Highlights



Shallow retrofit includes measures such as loft and cavity wall insulation. The payback is greater for heat pumps (due to higher fuel cost relative to gas boilers), showing the synergy between heat pumps and retrofit.



Hydrogen boilers increase expenses over 40% compared to Air Source Heat Pumps (ASHPs), due to the high running cost of hydrogen and initial installation.

Over a 30-year period, consumers who invest in an ASHP, rooftop PV, and shallow retrofit will save more money than those who only have a gas boiler.



ASHPs and batteries have potential to reduce energy bills, although as relatively new technologies they have a high capital expenditure (CAPEX). As production increases, these costs are anticipated to fall.

Net Zero Pathways – Summary

The Widespread Engagement pathway has significant advantages over Widespread Hydrogen, including:

- Over 1,200 kt CO₂e additional carbon savings
- 7% lower system cost
- £11mn savings in air quality damages
- Considerable consumer bill savings using heat pumps instead of hydrogen boilers

The key difference between the two scenarios is the use of hydrogen for heating, with some smaller differences in hydrogen's use for transport and in industry.

The interventions (in the next section) have therefore been predominately based on the Widespread Engagement scenario. However, hydrogen's future role in heating is uncertain and will be a governmental decision. This has been considered and accounted for during the development of interventions and the Action Plan.



Electrification of heating is the main recommendation, however developments around the government guidance for hydrogen should be monitored.

Electrification also has significant uncertainties and challenges concerning electricity grid capacity, connection delays and the costs of gas grid decommissioning.



Hydrogen has high uncertainty around future cost, availability, and carbon emissions, making it difficult to justify as the key energy vector for buildings and transport.

However, hydrogen will have an important role where electrification is less suitable, such as high temperature industry. The LAEP's Action Plan reflects this.



Interventions & Focus Zones

This section provides technical detail for each intervention area that has been covered in this LAEP, under the Widespread Engagement scenario. This includes exploring key assessment factors on these recommended interventions areas. Clusters of interventions within the same area, were grouped and identified as "Focus Zones", which are priority areas for intervention. The results of this analysis has directly informed the development of some of the final actions within the Action Plan.

Intervention Areas



Throughout this section, mapped intervention requirements have been presented for the described primary substation zones. Where relevant, this has been supplemented with further spatial information to provide insight to each zone.



The intervention findings have then been further developed to suggest potential Focus Zones (areas where a particular intervention is highly recommended or consider 'low regrets'), based on the detailed analysis. The Focus Zones have been purposefully selected to be applicable for either scenario to ensure they are 'low regret' regardless of additional external factors. Whilst specific areas are suggested, wider considerations will be needed before the Council finalises any zone for prioritisation. Depending on data suitability and type of zone, Focus Zones have either been represented on a Lower Layer Super Output Area (LSOA) level (for ease of spatial referencing) or as indicative point locations. For renewables, areas with high potential have been deliberately indicated at a high level. Further analysis and stakeholder engagement would be required to provide more specific locations.

Wider factors to be included in the selection of a Focus Zone are:

- Extent of fuel poverty or socio-economic vulnerability
- Alignment with existing or proposed programmes of work across the public sector
- Eligibility for funding which should be capitalised
- Opportunity for strategic roll out due to specific characteristics such as types of building
- Support from wider stakeholders such as areas which could be impacted by HyLine Cymru

The following page presents the Plan on a Page. This is a combination of all Focus Zones across Carmarthenshire, across all sectors. This gives a spatial representation of some of the priority actions which need to occur and how they interconnect.



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Energy Efficiency in Domestic Buildings – Overview

Fabric Retrofit has several benefits such as lower energy bills, reducing carbon and demand on the grid, and improving comfort, health and well-being.

For the purposes of the LAEP, retrofit has been split into two categories across both domestic and non-domestic buildings:

Shallow:

Measures which payback within 10 years. (e.g. loft insulation and cavity wall insulation)

Recommended as a minimum for all of Carmarthenshire's building stock, where suitable.



Recommended for 20% of buildings: All public sector and some privately owned buildings.

Deep retrofit can require significant investment and isn't always required. Technological developments mean newer air source heat pumps can operate effectively in some buildings without extensive retrofit¹. Additional insulation can improve a heat pump's efficiency, depending on factors such as the age, type of building and if it has underfloor heating. This investment to bill saving ratio should be considered.

Assessment for a shallow, more financially accessible retrofit is recommended for all buildings, while a deeper retrofit is recommended for specific cases, such as those who are most vulnerable. Retrofit suitability should be assessed on an individual building basis as standard measures are not appropriate for all build types and ages. Correct assessment is needed to avoid issues such as damp and poor ventilation.



TOTAL COST Shall

Shallow: £11.0mn

Deep: £61.6mn

Challenges

- Lack of necessary skills and reliance on supply chain to deliver at pace and scale.
- High upfront costs including significant funding gap for council and social housing.

Opportunities

- Boosting the local economy and stimulating growth across the region.
- Funding schemes can support local authorities and social housing landlords with delivery.

Outcome

- Creating a long-term skills programme.
- Signposting funding and innovative financing mechanisms and ensuring consumers are well educated on the options available.

Energy Efficiency in Non-Domestic Buildings – Overview

Fabric retrofit for non-domestic buildings can be slightly more complex due to the more varied nature of their construction types. For the purposes of this analysis, the type of retrofit, the cost and the efficiency improvement has been defined based on the building use type, such as offices, industrial, and community, arts and leisure.

The LAEP has split the types of measures into shallow and deep, as described below.

Shallow:

Measures which payback within three years. (e.g. carbon and energy management systems, lighting improvements, upgrading of small appliances)

Deep:

Longer payback, higher upfront investment. (e.g. upgrading building fabric or air conditioning, improving ventilation)

Recommended as a minimum for all of Carmarthenshire's non-domestic building stock, where suitable Recommended for 20% of nondomestic buildings: All public sector and some privately owned buildings

Number of Non-Domestic Buildings by Type





Impact of Retrofitting Non-domestic Properties

Non-domestic retrofit measures tend to cover efficiency improvements to electricity use and cooling as well as heating.

Building design is very varied, with properties having complex systems and functionalities tailored to their specific purpose. Measures may need to be more bespoke due to specialised ventilation or cooling set-ups which require higher expertise to upgrade without disrupting ongoing operations. The scale of changes tends to be bigger due to the size of buildings, causing higher investment costs and requiring more extensive planning.

Data on building fabric of existing non-domestic buildings tends to be poor and estimated in most cases. The recommended measures are approximate and more representative of the building stock as a whole, but has less accuracy when broken down to individual buildings. Therefore, all results for non-domestic buildings are aggregated and indicative and specific Focus Zones have not been created.



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Energy Efficiency in Buildings – Focus Zones

Focus Zones for building energy efficiency could include areas with 'no regrets' or a priority need for action. This could be identified by areas with a high risk of fuel poverty, housing with particularly low EPC scores or areas with a high density need for retrofit which could benefit from a mass roll-out scheme.

Further analysis was carried out to determine potential Focus Zones. Data used included the Welsh Index of Multiple Deprivation (WIMD) ranking of areas, the density of homes with the lowest EPC (F or G) and areas with a high density of social housing². The Focus Zones have been presented

on an LSOA level for reference but the area of impact may be smaller and should be reviewed on an individual zonal level.

This combination of data suggests areas where poor energy efficiency could be impacting deprivation, particularly through fuel poverty. Intervention in these areas could benefit from mass planning, including spatially strategic roll-out of implementation to achieve economies of scale, or bulk purchasing of materials for efficient and effective impact.



Domestic Heating – Overview

Carmarthenshire will require the mass replacement of current heating technologies in domestic properties (mainly gas and oil boilers) with decarbonised alternatives to reach net zero. Four main heating options were considered for buildings and the final split in 2050 is shown below.

Split of Heating Technologies in 2050 for Domestic Properties





Up to £47mn available through the Boiler Upgrade Scheme (BUS) grant in 2025



Air Source Heat Pump

This is the most suitable and lowest cost solution across most buildings. Heat pumps are proven to work in many building types with only moderate retrofitting³.

Although one the cheapest low carbon options, heat pumps are likely to be more expensive than gas boilers to run and have a higher initial CAPEX. Future reforms of energy pricing may reduce this gap, but price is currently driving concerns around uptake and the potential impact on fuel poverty. Heat pump efficiency increases with building energy efficiency, reducing bills. Therefore, retrofit and heat pump roll-out should be targeted simultaneously.

ASHPs, the most widely suitable heat pump, are not the only recommendation. Building suitability will need to be considered on a case-by-case basis for other options such as ground source or water source heat pumps.

Biomass Boiler

(4)

Buildings which currently have biomass boilers are assumed to mostly retain them as these are already considered to be low carbon. However, the high impact on local air quality should be considered.



] Direct Electric

Direct electric heating can be appropriate for properties which have limited space for an air source heat pump or retrofitting is challenging. However, it can be expensive due to the relatively lower efficiency than heat pumps and higher cost of electricity compared to gas. Therefore, it is recommended in only certain cases.

Non-Domestic Heating – Overview

Carmarthenshire will require the mass replacement of current heating technologies (mainly gas and oil boilers) with decarbonised alternatives to reach net zero. Four main heating options were considered for buildings and the final split in 2050 is





Heat networks are best in areas of high heat density and therefore are recommended for some of Carmarthenshire's urban and industrial areas and are most suitable for non-domestic properties. The main potential opportunities exist around Carmarthen and the industrial and commercial areas in Llanelli.

Heat networks have a very high upfront cost due to the infrastructure required and therefore ensuring financial viability is key.

Specific heat sources for heat networks have not been modelled in this LAEP and further feasibility studies would be needed.

ASHPs can be highly suitable for non-domestic properties due to the ability of some models to provide both heating and cooling. They can have similar or reduced spatial needs compared to conventional heating and are easily scalable and easy to integrate with solar panels or thermal storage.

Direct heating can be suitable in non-domestic buildings which have low, or irregular heating demand where a simple and flexible system is required without extensive infrastructure or complex control systems. They can also provide precise control of temperatures across different parts of the building.



Values presented are totals of the respective primary substation zones.

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Domestic Heating – Focus Zones

Various factors impact the suitability of a low carbon heat technology and the deployment strategy for domestic properties in a given area. Considering these different factors can enable the development of Focus Zones. For example, technologies such as biomass boilers are restricted to specific areas, whereas others such as air source heat pumps can benefit from mass roll-out.

ASHPs are suitable in any location and for almost all building types. However, due to the uncertainty around hydrogen for heat and the typically higher carbon heating sources for off-gas grid homes, it can make sense to prioritise rural, off-gas grid areas for initial targeting. Suitable Focus Zones show LSOAs for off-gas grid heat pump targeting are shown on the above map.

The wards of Cenarth and Llangeler have the largest numbers of recommended heat pumps for an off-gas grid area, with 3,000 heat pumps projected across the towns and surrounding area. It could be recommended as a priority area for early engagement programmes with building owners to understand the benefits and funding opportunities for heat pumps.

Priority

Actions

Decarbonisation of off-gas grid, oil boilers



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Non-Domestic Heating – Focus Zones

For non-domestic properties in particular, heat networks could be a key factor in heating decarbonisation in Wales and by design are suitable for only certain areas where buildings have sufficiently high density and heat demand. This has been found around central Llanelli and Carmarthen which are slightly denser urban areas and could connect up to ~650 and ~440 properties respectively. Other areas show some potential for heat networks, although these would be small networks with just a few buildings. This is expected as much of Carmarthenshire is sparsely populated.

Following identification of high heat demand density, low carbon heat sources must be located. This could be from waste heat sources (such as industrial sites or incinerators) or from low carbon heat sources. Typical sources include bodies of water, rivers, sewer networks or geothermal heat. Low temperature heat sources would be increased using heat pumps, supplying buildings with space heating and hot water at high efficiencies.

Heat networks have a high upfront cost due to the scale of infrastructure development required and therefore most networks are reliant on 'anchor loads' to have a sufficiently high heat demand to payback the high costs at a suitable rate for investors. These are typically buildings with a large heat demand and preferably are public sector buildings; this provides a more reliable stakeholder and gives confidence in future connection, although private sector connections can be equally suitable.

For all clusters identified it is recommended to carry out a further review of any which show adequate potential to be developed further through a feasibility study.

Priority

Actions

Create Behaviour Change Campaign to Increase Uptake of Retrofit and Low Carbon Heating



Road Transport – Overview

The continuing policy priority under any future pathway will be to reduce the need to travel, above encouraging walking, cycling and public transport. Low carbon vehicles, whilst important, will sit below an emphasis on "mode shift" within the sustainable transport hierarchy (right)⁴.

Support to improve public transport will reduce the number of cars and improve congestion in major urban areas. However private vehicle use will still be significant. Adequate electric chargepoint infrastructure will still be crucial to support and continue the rapid growth, with owners requiring confidence in both battery range and accessibility of charging everywhere they travel.

Total Cost of Low Carbon Transport 2020-2050*





100% of homes will need access to an EV charger

Carmarthenshire will require 59,390 EV chargers by 2030⁵

45% of journeys to be made by walking, cycling or public transport by 2045⁴

Carbon Emissions from Transport



While cars, vans and motorbikes are expected to move to 100% electric, hydrogen could be an alternative for heavier vehicles such as buses and HGVs. Carmarthenshire Council has collaborated with Pembrokeshire Council to explore the potential for hydrogen-fuelled vehicles, conducting a two-week hydrogen bus trial along the route between Haverfordwest and Carmarthen. However, as there is high uncertainty around the viability and cost, hydrogen vehicles are not being prioritised in Carmarthenshire for local fleets. The Council will continue to engage in the developing need for hydrogen infrastructure for their strategic road network, and therefore the LAEP has identified the future key heavy vehicle refuelling points.





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Road Transport – Focus Zones

To boost the uptake of EVs sufficiently to achieve 100% market penetration by 2050, the main barriers to adoption need to be addressed: cost of vehicles, capability of the technology (particularly the mileage range of an EV), and extensive and accessible charging. EV technology is developing rapidly to provide a range which is competitive with internal combustion engine vehicles. Vehicles will become increasingly more affordable as the cost of new products fall and the second-hand market establishes itself.

Non-domestic charging infrastructure needs to be planned strategically for high-traffic areas. This includes 'destination' locations such as town

integrated with car parking, and through-traffic hotspots, which are key points along the strategic road network such as service stations. These have been indicated with High Electric Charging Demand Focus Zones.

It is also important to ensure access for rural communities by installing chargers in key public areas and car parks. Public awareness and engagement campaigns will support the installation of domestic charging where off-street parking is available, and would be recommended in more rural areas where there are fewer public or workplace chargers available.



Generation – Overview

Although Carmarthenshire is already a leader in renewable generation for Wales, it has potential for significantly more renewable installations. However, Carmarthenshire is not reliant on renewables for decarbonisation and therefore these values should be seen as an ambition not a target. Any renewable installation must be of benefit to the local area and, importantly, the farming community. It is possible for renewables to coexist with the agricultural, rural nature of the area but careful planning and engagement with the local community is key.

Carmarthenshire could achieve up to an estimated 2,900 GWh/year of annual renewable generation. This vastly outweighs its future energy demand (2,000 GWh/year), even despite high demand from electrification. This includes the consideration of wider factors which will influence the final uptake of renewables, such as land use and ownership, planning and grid constraints. It assumes build-out of ground-mount PV and onshore wind will be 5% and 75% of their theoretical potential, respectively.

Total Renewables Capacity (MW)



These figures are ambitious; there will likely be impeding factors such as grid constraints which may make them more challenging to achieve.

Although not a necessity for decarbonisation, localised energy generation could offer a faster pathway to net zero, additional energy security and a major source of income for local supply chain, developers, building and landowners.

Emissions Savings from Local Renewables



Ambition for Demand vs Generation in 2050





Generation – Focus Zones

Evaluation of Focus Zones for renewable generation has been based on the LAEP renewable potential analysis and the Renewable and Low Carbon Energy Assessment (RLCEA) renewables priority areas⁶. These Focus Zones are not defining areas for renewable development, they identify areas where engagement with the local community and landowners should be sought to understand the shared benefits and opportunities that renewables could offer and require further analysis. When implemented correctly, installation of solar and wind farms can work side-by-side with agricultural land, but it is imperative that this is understood by the local farming community and the opportunity harnessed by them.

Grid connection delays will be a major factor in the overall renewable

development by 2050. This is a UK-wide challenge and continued engagement with NGED to understand solutions will be key.

Carmarthen

Rooftop PV is assumed to be viable on 25% of properties, utilising space which is currently an unused, valuable asset. Engagement with building owners, both domestic and non-domestic, in areas with high PV potential should be prioritised. This includes informing people of how to access surveys, funding and support as well as the potential benefits of infrastructure.

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Priority Actions

Continue Collaboration with Electricity and Gas Network Operators to Foster a Robust Future Energy System

Key Focus Zones

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- Priority renewables study area for onshore wind and ground mount PV
- Existing onshore wind
- Existing ground-mount PV

Priority rooftop PV engagement

The Welsh Government aims to accelerate community-owned renewable energy projects. Such projects are currently being progressed by community energy organisations (with support from Community Energy Wales) and could have a significant contribution to increasing generation within the county.

Industry (inc. Agriculture) – Overview

The decarbonisation of heavy industry and agricultural machinery is challenging, both technically and economically. Alternative, low carbon technologies for industry (particularly for high temperature processes) are expensive, and the supply chains are less well developed than other sectors. The cost and timelines of grid connections can also impede electrification.

Agriculture also faces high costs for low carbon technology. The transition will be reliant on the development of viable and affordable, alternative machinery. Whilst this LAEP only considers energy demand, the wider emissions surrounding livestock and land use should also be recognised.

Industry

Industry is assumed to be split between electrification (low temperature processes) and hydrogen fuel (high temperature processes). The transition is predicted to be slower than other sectors due to the lack of formal targets and anticipation of unique challenges across the sector.

The costs of replacing industrial equipment and machinery for low carbon equivalents has not been included as they are both bespoke and uncertain. This will of course be led by the private sector although the Council will ensure to support industry where possible. Advances in low carbon agricultural machinery are slower than other technologies, with the expectation of a shift towards electrification and alternative, sustainable fuels. As neither options are currently commercially ready, agriculture is assumed to be one of the later sectors to transition.

Agricultural Machinery

Hydrogen and biofuel could both be alternative fuels. However, due to the uncertainty around price, availability and safety of hydrogen on farms, it has not been considered in this analysis.

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The transition of individual industrial sites to either electrification or hydrogen is highly uncertain and this LAEP provides estimates based on high level knowledge of processes. Therefore, opportunities for both decarbonisation routes should be explored.

Carbon Emissions from Industry



Carbon Emissions from Agricultural Machinery



Cost and Fuel use for Agricultural Machinery





Industry (inc. Agriculture) – Focus Zones

Industrial Focus Zones are mainly based around the Green Industry Investment Zones, which include Llanelli Low Carbon Cluster, Nantycaws Circular Economy Park and Cross Hands Growth Zone⁷. These are not exhaustive opportunities, as there are many more industrial areas in the local authority. However, these could be key zones to support and provide exemplar learnings.

Focus Zones to decarbonise energy used for agriculture are based around areas with high agricultural machinery activities. These could be key initial zones for engagement to explore opportunities for decarbonisation or potential pilot projects.

Priority Actions

Establish an Industry Engagement Forum to Identify and Progress Energy-Related Opportunities

Support the Green Industries Investment Zone Project to Encourage the Decarbonisation of Industry

Key Focus Zones

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Agricultural Focus Zone

Potential Industrial Hydrogen Use

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Green Industries Investment Zones



The use and production of hydrogen should be planned strategically. The opportunity around the development of HyLine Cymru could provide a valuable source of hydrogen and easy distribution to Carmarthenshire. Plans around HyLine Cymru and further developments of the potential for hydrogen's use across industry, transport and agriculture should be drawn together to understand how shared infrastructure could be developed.

Networks – Focus Zones – Demand Capacity

The resiliency of the electricity grid will be paramount to decarbonisation, to be able to support the considerable increase in electricity demand as many sectors electrify. In some areas, the future demand will exceed the current grid capacity and upgrades will be required.

Distribution Network Operators manage the delivery of electricity to endusers through the low and medium voltage portions of the network, which deliver from primary substations down to building level customers. Therefore they are responsible for upgrades, maintenance and expansion of the distribution networks within the modelled zones.

Advanced planning of upgrades across multiple projects and sectors will reduce delays and can help to reduce and spread costs by considering the demand holistically, instead of for individual applications. The 2050 electricity demand is 2.4x current demand

The modelled hourly electricity consumption for each sector was analysed to estimate the overall peak electricity demand in 2050 for each primary substation area. The peaks were compared to the current estimated capacity of each primary substation, as per NGED's data. This gave an indication of where future demand may exceed current capacity.

This modelling is highly indicative and uncertain as the reality of network modelling and connections is highly complex. Therefore, this analysis was performed as a Red Amber Green (RAG) assessment to identify areas with a high (red), moderate (amber) or low (green) risk of needing an upgrade.

Areas denoted as high risk have been selected as network Focus Zonesareas which will require planning and engagement with stakeholders to support development and decarbonisation. Three primary substations were identified to have significant demand capacity restrictions, with estimates of network upgrades required costing in the range of £100 - 200mn. The peak demand data accounts for demand reduction measures such as flexibility services, retrofitting of buildings and distributed energy resources. However further alternative solutions could be cheaper than grid upgrades, such as aggregation of flexibility and peak shaving services; smart grid technologies; and grid level storage. Although grid upgrades will be unavoidable in some areas, demand reduction and energy efficiency measures should be maximised to reduce the peak as much as possible.

Key



Networks – Focus Zones – Generation Capacity

Renewable generation connection currently faces challenges due to long wait times for projects to be connected into the grid. This is also due to planning around capacity limits, and considerable work is being done by National Grid Electricity Transmission (NGET) and Distribution Network Operators (DNOs) to address the issues with the current system and find a feasible solution. Forward planning of renewables holistically will also help this.

Diversifying renewable generation can allow better utilisation of intermittent energy sources and reduce the need for large grid reinforcements. Carmarthenshire County Council has also set out its position on large overhead energy infrastructure in that it should be undergrounded rather than hosted on overground large-scale pylons. Distributed generation which is consumed locally can also provide opportunity for community-led, decentralised projects and can be supported by Power Purchase Agreements or Peer-to-Peer networks which also avoid the new for large grid upgrades.

For each primary substation area, the hourly intersection of renewable generation was analysed to determine the peak generation. This was compared against the existing network capacity and additional capacity requirements were reviewed. As with the demand capacity data, this is high level and therefore has been provided as a RAG assessment. For some zones, the generation capacity data was unavailable and therefore this assessment has not been completed.

Distribution Networks Operators are actively using Load Management Schemes to more actively manage network loading across the electricity system. This allows greater amounts of generation to be connected without triggering all of the reinforcement, which may further reduce total cost. It should also be noted that some of the total costs will be covered through private investment for the network, and therefore not all of the cost will be borne by bill payers. Additionally, a large amount of initial cost for generation sites will be 'sole use assets' – connecting the site to the closest point on the network. This cost is also funded by the connecting customer. Overall it was found that 17 of the primary substations could have generation capacity constraints depending on final build out of renewable potential. This is estimated to require an investment of around £500mn for network upgrades by 2050 to accommodate the additional power.

NGED is continuously planning and developing the network to accommodate for predicted constraints. Therefore, this LAEP will support in assessing demand beyond the amount NGED already anticipates.



Networks – Focus Zones

Regardless of the decision on hydrogen for heating or its use in agriculture, hydrogen could still play a key role in the area if used within the wider industry hub or for heavy vehicles. The potential use of hydrogen could be planned strategically to enhance the associated potential economic opportunities and reduce the distribution and infrastructure costs. This includes the possibility to tap into the existing gas grid at desired locations, as a hydrogen distribution network, should the grid be repurposed.

The opportunity around the development of HyLine Cymru could provide a valuable source of hydrogen and distribution to Carmarthenshire and the surrounding local authorities. Plans around HyLine Cymru and further developments of the potential for hydrogen's use across industry and transport should be drawn together to understand how shared infrastructure could be developed.

Focus Zones present areas where hydrogen could be needed across the different sectors and strategic, spatial planning would be effective. This includes key hydrogen vehicle refuelling points, areas which could host hydrogen bus depots and hotspots for industry or agriculture. These areas and any corresponding programmes and opportunities should be discussed through engagement with WWU and industry bodies such as SWIC.







Action Plan Overview

This section discusses the Action Plan. The Action Plan provides the detail of priority actions to achieve the milestone targets set out in the Net Zero Pathway, and support Carmarthenshire's journey to a net zero energy system. Each action has been allotted a time frame for successful implementation/completion as follows:



Short-Term: Implementation over two years. **Medium-Term:** Implementation over two to five years.

Long-Term: Implementation over five years or more

The Action Plan acts as a catalyst for future initiatives, informing upcoming projects, policies, and strategies. It provides clear, but intentionally flexible direction, channelling the broader focus on decarbonisation into a set of collective actions. Whilst many of the levers are local, a large number are regional and the LAEP has considered existing regional governance structures.

Its purpose is not to prescribe an exact process or steps to reach net zero, but rather to recommend directions that guide the correct trajectory and ensure the involvement of relevant stakeholders in future projects and decisions. Moreover, the time period will be subject to significant changes and uncertainties across technology, policy, and markets that cannot currently be predicted. Therefore, the Action Plan and its actions will require regular updates (every three to five years) to adapt to the evolving environment.



The remainder of this section includes:

Action Roadmap: Provides an overview of the sequential implementation of the 13 priority actions. However, this selection of actions does not preclude support for initiatives beyond this list or those featured in other plans.

Priority Actions by Sector: Includes an overview of each action by sector, including example key steps, Key Performance Indicators (KPIs), location, and additional benefits. Further details (such as key stakeholders, costs, and risks) have been provided to the Council.

Next Steps: Immediate next steps to mobilise the recommendations from the LAEP.



Action Plan Overview

	Crosscutting Enabling Actions	Actions that foster a supportive environment and promote a holistic approach to addressing complex challenges. The actions enable Carmarthenshire to navigate energy transition challenges and embrace a low carbon future.		Action 1: Establish a Regional LAEP Steering Image: Comparison of the stabilish a Regional LAEP Steering Group Action 2: Support Long-Term Green Skills Programme Image: Comparison of the stabilish a Regional LAEP Learnings into Wider Action 3: Embed LAEP Learnings into Wider Image: Compute Stabilish a Regional LAEP Learnings into Wider Processes & Communications Image: Compute Stabilish a Regional LAEP Learnings	100 - 100 -
	Building Efficiency,	Actions that enable the delivery of building efficiency, retrofit and heating interventions. The actions address the decarbonisation of the building stock and position Carmarthenshire to facilitate decarbonisation benefits for residents.		Action 4: Create a Retrofit & Low Carbon	Ð,
	Actions			Purchasing Scheme for Social Housing	
		Actions that support transport decarbonisation and the Sustainable Transport Hierarchy. The actions encourage the reduction dependence on personal motorised vehicles, fostering a greener and more accessible transportation landscape.		Action 6: Development of a Retrofit and Low Carbon Heating Local Supply Chain	
	Transport Actions		_	Action 7: Improve the Accessibility of EV	Ø)
				Action 8: Facilitate Low & Zero Carbon Vehicle Public Fleet Uptake	
	Generation & Networks Actions	Actions that underscore a commitment to a future-proofed energy system. The county aims to leverage expertise and resources to fortify infrastructure, reduce peak demand and plan for a hydrogen future.		Action 9: Enhance Active Travel & Public	Ð,
				Action 10: Continue Collaboration with Electricity & Gas Network Operators	Ð)
				Action 11: Address Future Needs of Hydrogen- Fuelled Vehicles	
	Industry Actions	Actions that support the decarbonisation of industry. Carmarthenshire aims to advance energy-related opportunities, drive innovation, nurture growth, and accelerate the transition to a decarbonised industrial landscape.		Action 12: Establish an Industry Engagement	۳
				Action 13: Support the Green Industries Investment Zone	

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Action Roadmap – Priority Actions



Priority Actions – Crosscutting Enabling Actions



Action 1: Establish a Regional LAEP Steering Group to Enable the Delivery of LAEP Outcomes

Establish a Regional LAEP Steering Group for effective LAEP action implementation. The group will align actions from the four LAEPs, mobilise and oversee the actions at a programme level, delegate ownership, provide funding support (which is to be aligned with the Regional Directors' Group) and monitoring. Operational support will come from the new regional project management team and the dedicated Regional Energy Team, reporting directly to the influential South West Wales Energy Core Group.



Action 2: Support Long-Term Green Skills Programme to Enable the Delivery of Decarbonisation Measures

Establish a resilient, enduring skills and professional development programme, ensuring the availability of local and in-house expertise for adept delivery and maintenance of low carbon installations and technical systems (e.g. heat pumps, solar PV, EVs). The programme builds a sustainable, adaptable workforce, addressing skill gaps from early career to established professionals. Collaborations and tailored training enable a skilled workforce for regional decarbonisation goals.



Priority Actions – Crosscutting Enabling Actions



Action 3: Embed LAEP Learnings into Wider Processes and Communications to Enable the Delivery of LAEP

Short Delivery Timeframe

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Outcomes

Action 5: Implement a Retrofit & Heat Bulk Purchasing

Facilitate the decarbonisation of all social housing by implementing an

innovative bulk purchasing initiative. The strategic scheme should aim not

only to make retrofit measures and low carbon heating technologies more

affordable, but consider the inclusion of the bulk procurement of energy.

The approach should be designed to alleviate energy costs for residents,

effectively addressing fuel poverty and aligning with affordability

requirement in the Welsh Housing Quality Standard 2023.

Scheme to Decarbonise Social Housing

Priority Actions – Building Efficiency, Retrofit & Heat



Action 4: Create a Behaviour Change Campaign to Increase Uptake of Retrofit and Low Carbon Heating

Develop behaviour change initiatives for residential and commercial properties. The dynamic campaign should be designed to inform, educate and cultivate transformative shifts in behaviour concerning energy efficiency, retrofit practices, and the adoption of low carbon technologies. The initiative should aim to instigate a positive and lasting transformation in behaviour, contributing to a more energy-efficient and environmentally conscious community.


Priority Actions – Building Efficiency, Retrofit & Heat

Action 6: Support the Development of a Retrofit and Low Carbon Heating Local Supply Chain to Enable the Delivery of Decarbonisation Measures

Support the development and growth of the local supply chain to meet county-wide demands for low carbon heating and retrofit solutions. The aim is to create an enabling environment that nurtures a robust and responsive local supply chain, contributing to the broader goals of sustainable energy adoption in the county. The action focuses on funding, support and increasing demand for retrofit and low carbon heating. Skills development is an also important factor and is covered by Action 2.



Medium Delivery Timeframe

Priority Actions – Transport



Action 7: Improve the Accessibility of EV Charging Infrastructure to Support EV Uptake

Support the UK government's Zero Emission Vehicle 2035 commitment by creating a comprehensive, accessible, reliable and convenient EV charging network to enable the EV transition. This should be achieved by building on the EV Charging Infrastructure Strategy, to increase EV charging availability in public and private priority locations through strategic Public-Private Partnerships (PPPs), and the facilitation of workplace and residential installations.



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Action 8: Facilitate Low and Zero Carbon Vehicle Uptake to Decarbonise Public Fleets

Continue to facilitate the transition to low and zero carbon buses and HGVs in the fleets of Carmarthenshire Council and other public bodies through a structured programme for fleet transition. The programme should establish a clear roadmap for transitioning public transport fleets, and incorporating strategic milestones, funding exploration, technology testing, collaborative efforts, and community education to ensure an impactful shift towards low and zero carbon options

Priority Actions – Transport

Action 9: Enhance Active Travel and Public Transport to Reduce Reliance on Personal Motorised Vehicles

Enable active travel initiatives and funding, and enhance public transport to foster a greener and more efficient transportation landscape with reduced reliance on motorised vehicles. The action aims to encompass strategising, advocating, and implementing measures to create a more sustainable and efficient transportation ecosystem.



Long Delivery Timeframe

Priority Actions – Generation & Networks



Action 10: Continue Collaboration with Electricity and Gas Network Operators to Foster a Robust Future Energy System

Deepen collaboration with National Grid Electricity Transmission (NGET), NGED and WWU to catalyse the development of new and reinforced electricity grid infrastructure, and enable planning for gas network reinforcement or removal as early as possible. This entails building on the existing relationship with enhanced ongoing dialogue, improved connections, and streamlined planning processes.



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Action 11: Support the Zero Emission Vehicle Infrastructure Strategy to Address Future Needs of Hydrogen-Fuelled Vehicles in the Region

Support the Swansea Bay City Deal project's Zero Emission Vehicle Infrastructure Strategy, emphasising preparing for the potential adoption of hydrogen-fuelled vehicles. While Carmarthenshire Council currently prioritises fleet electrification due to hydrogen uncertainties, this action ensures it remains adaptable to regional and national hydrogen infrastructure demands, to ensure resilience amid the evolving landscape.

Countywide with a

focus on Energy

Collaborate with

organisations

community energy

Investment Zones

Priority Actions – Industry



Action 12: Establish an Industry Engagement Forum to **Identify and Progress Energy-Related Opportunities**

Set up an industry engagement forum group that focuses on electrical and gas network/hydrogen opportunities and challenges from an industrial perspective. The group will aim to integrate with and support existing groups, projects, and decarbonisation plans. Additionally, it will actively identify opportunities for collaboration, innovation, and sustainable growth within the industrial sector, fostering a dynamic and cooperative ecosystem.



Action 13 Support the Green Industries Investment Zone Project to Encourage the Decarbonisation of Industry

Identify and cultivate opportunities for a Green Industries Investment Zone in Carmarthenshire, aligning with the Welsh Government's Investment Zones framework. This initiative should drive low carbon energy projects, spur innovation, and cultivate the growth of emerging industries with an aim to create a higher-value, decarbonised economic future and enhanced well-being for residents.

Next Steps

This LAEP has set out the transformative steps required to transition Carmarthenshire's energy system towards achieving net zero carbon emissions by 2050. This was achieved through exploration of various technologies and scenarios employing whole energy systems modelling and analysis. Chapter 4 strategically pinpointed the most cost-effective, preferred pathway to net zero, optimised for maximum local benefits. Chapter 5 articulated the required interventions and necessary pace of change to align with the Net Zero Pathway. Finally, Chapter 6 detailed 13 priority actions that are recommended for near-term mobilisation.

To mobilise the actions, the following key next steps have been identified.

1. Regional Review

Carmarthenshire, Neath Port Talbot, Swansea, and Pembrokeshire Councils intend to collaboratively conduct a comprehensive regional review of the four LAEPs. This involves examining individual actions, identifying opportunities for integration, and determining actionable items that can be effectively mobilised at a regional level.

The actions intended for regional level implementation are shown on the right.

Action 1: Establish a Regional LAEP Steering Group Action 2: Support a Long-Term Green Skills Programme Action 3: Embed LAEP Learnings into Wider Processes & Communications

- Action 8: Low & Zero Carbon Vehicle Public Fleet Uptake Action 9: Enhance Active Travel & Public Transport
- Action 10: Strengthen Collaboration with National Grid Action 11: Address Future Needs of Hydrogen-Fuelled Vehicles

Action 12: Establish an Industry Engagement Forum

2. Prioritisation

The next step to mobilise is the establishment of a Regional LAEP Steering Group, a pivotal step that will enable the implementation of all other actions and associated projects.

Using the Actions Roadmap as a base, the group will assess and develop a phased delivery plan to optimise impact and foster a holistic approach. Actions that are recommended for priority mobilisation are shown on the right.



Action 2: Support a Long-Term Green Skills Programme

Action 3: Embed LAEP Learnings into Wider Processes & Communications

- Action 4: Create a Retrofit & Low Carbon Heating Behaviour Change Campaign
- Action 7: Improve the Accessibility of EV Charging Infrastructure

Action 9: Enhance Active Travel & Public Transport

Action 10: Strengthen Collaboration with National Grid

Action 12: Establish an Industry Engagement Forum

3. Collaboration

The Regional LAEP Steering Group will operate at a portfolio level, strategically overseeing actions. While the group may take ownership of certain actions, not all actions will fall under its purview. Instead, it will delegate ownership to appropriate parties. To initiate this, engagements with key stakeholders for each action (see Technical Annex) are essential. The collaborative determination of action owners is integral to this process.

4. Funding & Resource

Although the Council is best placed to facilitate the implementation of the LAEP, support is needed from Welsh Government, public and private sector organisations,, academia and the public to successfully deliver on the identified actions. Once ownership is identified the next step is to develop funding and resource plans for each action and to align political aims to reach net zero by 2050 across all sectors.



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