Tyfu Canolbarth Cymru
Growing Mid Wales

Mid Wales Energy Strategy

Summer 2020

Funded and supported by:

Llywodraeth Cymru
Welsh Government

Supported by:

Cyngor Sir
CEREDIGION
County Council

Powys

Prepared by:

Gwasanaeth Ynni
Energy Service

Contents

Executive summary

Executive summary

This regional energy strategy for Mid Wales has been developed by the Growing Mid Wales Partnership, Powys County Council and Ceredigion County Council, with support from regional stakeholders and the Welsh Government Energy Service. The Energy Service coordinated the development and production of this strategy document, and completed the energy modelling and economic analysis.

Our vision for Mid Wales is:

> **To achieve a net zero-carbon energy system that delivers social and economic benefits, eliminates fuel poverty, better connects Mid Wales to the rest of the UK, and contributes to wider UK decarbonisation.**

Our priorities for achieving this vision are to:

1. Drive forward the decarbonisation of the region's housing and building stock
2. Work proactively to ensure that electricity and gas grids in the region are suitable for a 100% decarbonised future
3. Boost the use of renewable energy through new generation and storage
4. Accelerate the shift to zero carbon transport and improve connectivity
5. Develop and harness the potential of agriculture to contribute to zero carbon goals
6. Harness innovation to support decarbonisation and clean growth

The baseline energy assessment sets out the current energy use and generation in the region:

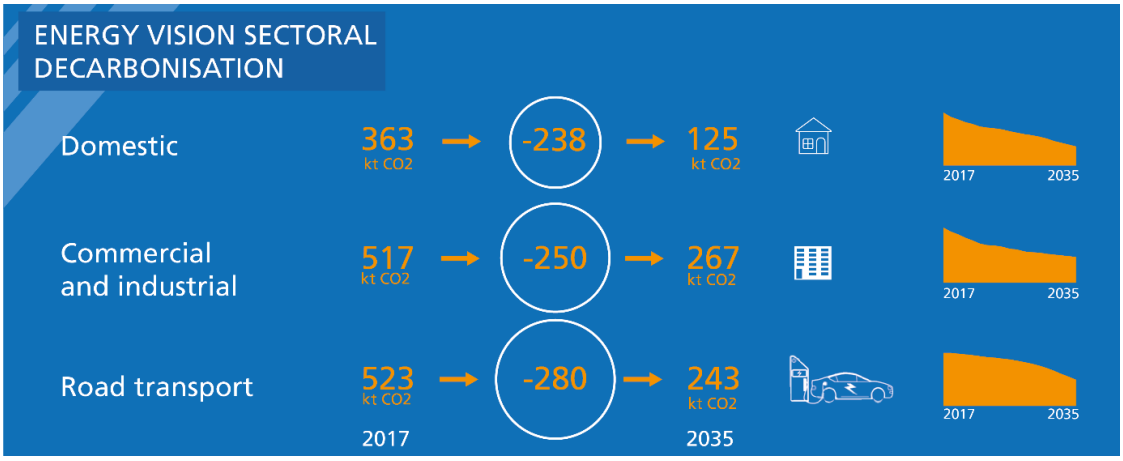
- Mid Wales hosts 7% of Wales' population and consumes ~6% of Wales' energy consumption;
- Energy demand is split roughly equally between the commercial and industrial sector (35%), the domestic sector (33%) and the transport sector (32%);
- Mid Wales generates the equivalent of 97% of its electricity consumption from renewable energy sources;
- Mid Wales hosts ~25% of Wales' onshore wind capacity and has the highest deployment of renewable heat installations of all the Welsh regions, with nearly 2% of homes using a biomass boiler or heat pump;
- Of the 412MW of renewable energy installed capacity in the region, 51MW (12%) is locally owned;
- Since 2005, total energy consumption has fallen by ~14% and the associated greenhouse gas emissions have fallen by ~20%; since 1990, greenhouse gas emissions from the region's energy system have fallen by 40%.

Note on scope: this baseline assessment and strategy focusses on the energy system only, covering power, heat and transport. It does not include greenhouse gas emissions or sequestration from non-energy related activity such as land use.

Achieving our energy vision for Mid Wales: to meet Welsh Government targets, and to be on track for net zero by 2050, Mid Wales needs to reduce emissions from its energy system by 55% by 2035. Our energy modelling achieves this reduction, split by sector as follows:

- 66% reduction in domestic emissions;
- 48% reduction in commercial and industrial emissions;
- 54% reduction in road transport emissions.

Figure 1. Energy System Vision sectoral decarbonisation



The energy vision scenario modelling demonstrates a pathway to achieve these emissions reductions and assumes a significant shift away from business as usual. The actions to achieve the emissions reduction and the future vision have been modelled and include:

Domestic:

- 30,000 homes insulated;
- 26,000 heat pumps installed;
- Electrification of heating systems in off-grid homes which currently use oil, LPG and solid fuels;
- No new gas connections for homes from 2025.

Commercial and industrial:

- A significant energy efficiency programme to reduce energy demand by 23%;
- A switch to alternative fuels and electrification of heating;
- Behind the meter renewable generation.

Road transport:

- 53% of vehicles driven in Mid Wales in 2035 are electric, equivalent to 2,000 more electric vehicles per year by the mid-2020s, peaking at 10,000 per year in the 2030s;
- 20% reduction in private vehicle mileage in 2035;
- A slowing in the total number of vehicles on the road, facilitated by increased public transport and active travel.

Electricity:

- Underpinning the changes in all of these sectors is the growing decarbonisation of electricity generation with emissions per consumed kWh falling to 30 gCO_2/kWh by 2035 in line with the assumptions used by National Grid's 2019 Future Energy Scenarios.

These assumptions summarise the level of action required between 2020 and 2035 to be on track to achieve net zero by 2050. The energy modelling focuses on proven decarbonisation technologies and actions that could be implemented by 2035 in order to demonstrate a potential decarbonisation route. The scenario is not intended to be prescriptive. There are a number of potential pathways to achieve energy system transformation, including new opportunities from technology innovation that will certainly emerge as the transformation takes place. The rapid evolution of technologies and pathways means that there are some major uncertainties and varying opinions about the precise route forward. What is clear is that different pathways all must achieve significant decarbonisation; should less action be achieved in any of the areas summarized above, other sectors will need to compensate with higher action to achieve the same results.

The level of transformation described by the energy modelling actions is significant. More importantly, the modelling demonstrates the potential to be on a net zero pathway by using proven technologies and underscores the critical role of short- and medium-term action. Innovation will be essential to compliment this action and to develop technologies, skills, and practices that continue to achieve decarbonisation beyond 2035.

The economic impacts of achieving the energy vision have been assessed in terms of job creation, gross value added (GVA) and the investment (or spending) required for the energy transition, in comparison to business as usual. The economic analysis demonstrates that almost £1 billion of additional investment/spending is needed to achieve the energy efficiency, electricity generation, and heat aspirations described in the energy vision between now and 2035. This represents approximately £66 million per year and will need to be financed from a range of sources including the private sector, households, and national and local government. This investment is 60% more than is expected to be spent in the corresponding sectors under a business as usual scenario.

The energy vision scenario is estimated to result in approximately an additional 5,200 net direct jobs, with an associated increase in GVA of ~£429m, associated with the delivery of accelerated deployment of renewable electricity generation technologies and enhanced levels of energy efficiency. In addition, it is estimated that there will be over 530 more gross jobs associated with the provision of low-carbon heating technologies in the ESV scenario than the BAU scenario, associated with £72m of GVA.

When considering the job figures presented its important to reflect on where these jobs will be located. The methodology focuses on direct jobs, a greater proportion of which are considered likely to be located in the region than indirect or induced jobs[1]. However, we are unable to comment on the specific location of the jobs estimated; a portion of the jobs are likely to be located in Mid Wales and a portion may be held by persons residing outside of the region. The experience of Wales to date has been that many electricity generation jobs are held by those living outside of the region. This contrasts with energy efficiency jobs which are often held by local residents who provide services to the surrounding area. In order help Mid Wales benefit from jobs associated with future

[1] Direct jobs are typically associated with the manufacture, construction, and installation of equipment. Indirect jobs arise in the supply chain of the energy technology. Induced jobs related to jobs generated as a result of spending incomes earned from direct employment.

local electricity generation it will be important to first understand the reasons for any lack in local jobs and then to develop a policy response. **Note:** please refer to the economic modelling chapter and technical annex for details on data sources, limitations and methodology.

Table 1. Estimated difference in jobs, GVA and investment between the energy vision scenario and business as usual, from 2020 to 2035

Energy vision scenario for:	Jobs**	GVA	Investment required
Electricity generation*	2,240 (net) **(+16%)**	£ 255m **(+15%)**	£ 205m **(+37%)**
Domestic heat	540 (gross) **(+243%)**	£72m **(+302%)**	£127m **(+213%)**
Domestic energy efficiency	3,000 (net) **(+63%)**	£174m **(+62%)**	£612m **(+64%)**
Total additional investment required to achieve the energy vision scenario			**£944m**

**Electricity generation jobs figures were calculated using direct job intensity indicators. A reasonable proportion of direct jobs is likely to be held by residents local to an energy site. However, to date this has not always been the experience of Mid Wales. If business as usual policies continue, we expect that a potentially significant number of these jobs will be held by persons resident outside of the region.*
***Impact on jobs is presented as either net or gross jobs depending on the available data.*
****All figures are rounded. If figures do not sum it is due to rounding.*

Green recovery from the Covid-19 pandemic: this strategy has been finalised in the midst of the COVID-19 pandemic. At the time of writing, the true economic and societal costs of the pandemic for Mid Wales are not fully clear.

As we move from the immediate emergency response to considering our options for economic recovery, this energy strategy has the potential to play a significant role in helping Mid Wales to recover and rebuild sustainably. It sets out a pathway for accelerating the shift to a decarbonised energy system in the region and demonstrates the potential for achieving far greater local economic benefits than could be achieved by returning to business as usual.

Next steps: There are three key next steps to help this strategy come to life and to create action: developing the governance structure, socialising the strategy throughout the region, and developing a delivery plan.

Acknowledgement: We would like to thank all of the stakeholders who made valuable contributions to this work through their participation in workshops, completing surveys, providing data, and additional communication on the phone and by e-mail.

Acronyms and abbreviations

ASHP	Air Source Heat Pump
BAU	Business as Usual
BEIS	The Department for Business, Energy, and Industrial Strategy
bioSNG	Bio-synthetic natural gas
CCC	Committee on Climate Change
CHP	Combined Heat and Power
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CITB	Construction Industry Training Board
DNO	District Network Operator
DEFRA	Department for Environment, Food & Rural Affairs
DNS	Development of National Significance
ECO3	The Energy Company Obligation phase 3
EPC	Energy Performance Certificate
ESV	Energy System Vision
EV	Electric Vehicle
FES	Future Energy Scenarios
GSHP	Ground Source Heat Pump
GVA	Gross Value Added
GW	Gigawatt
GWh	Gigawatt hour
HGV	Heavy Goods Vehicle
HHP	Hybrid Heat Pump
kt	kiloton
kWh	Kilowatt hour
LPG	Liquid petroleum gas
MCS	Micro-generation Certification Scheme
MW	Megawatt
NAEI	National Atmospheric Emissions Inventory
NRW	Natural Resource Wales
PV	Photovoltaic
RHI	Renewable Heat Incentive
SME	Small and medium-sized enterprises
TWh	Terawatt hour
ULEV	Ultra-Low Emissions Vehicle
WGES	Welsh Government Energy Service
WHQS	Welsh Housing Quality Standard
WPD	Western Power Distribution
ZILF	Zero Interest Loan Finance

Introduction

Introduction

The Growing Mid Wales Partnership alongside Powys and Ceredigion County Councils, with support from the Welsh Government Energy Service, have undertaken a year-long project to develop a regional energy strategy for Mid Wales.

The energy transition and decarbonisation are priorities for the region; both Ceredigion and Powys County Councils have declared a climate emergency alongside a number of town councils including Aberystwyth, Machynlleth, Llanidloes, Newtown and Llanllwchaiarn, and Welshpool. The Welsh Government has also declared a climate emergency and set a target to reduce greenhouse gas emissions by 95% by 2050. Achieving this target will require substantial transformation of our energy system and will mean an evolution of the daily technologies that provide our heating, transportation, and power. Transitioning to a modern, place-based decarbonised energy system that is fit for the twenty-first century poses significant challenges, but it also has the potential to bring great benefit, both for the environment and for economic and social wellbeing of our communities.

This work seeks to provide a strategic direction for the future of a decarbonised energy system including heat, power and transport within Mid Wales. It will define steps to begin to overcome the challenges we face. Furthermore, while the energy transition has the potential to bring benefits to our communities, maximising this benefit requires a clear focus and action in order to ensure benefits are secured and retained within the region.

The work has been developed in support of tremendous efforts that are underway to develop a growth deal for the region. To be sustainable, economic growth in Mid Wales must be low carbon. This strategy provides a considered approach and an evidence base for the region to move forward collaboratively towards a future decarbonised energy system. In doing so, it seeks to help Mid Wales address the climate emergency. This strategy is presented in five chapters.

Chapter 1: Vision - The energy system vision that is presented in this strategy was developed with stakeholder contributions through the project's first workshop, survey feedback, and targeted stakeholder conversations. The vision describes the region's aspiration for what a future energy system will achieve and how it will function. Five core values have been defined that should be at the heart of future energy projects and decisions.

Chapter 2: Priorities - A literature review was undertaken combining key policy and evidence documents with expert interviews and workshop consultation to build a more comprehensive picture of the challenges and opportunities in Mid Wales. This includes available levers, barriers to development and key technologies. This research, and in particular the thoughts and ideas shared by stakeholders, informed the development of strategic priority areas. These priorities are central to achieving the region's decarbonisation goals and are important to its stakeholders.

Chapter 3: Energy system, energy use & emissions - A baseline study provides a portrait of the Mid Wales energy economy and landscape today. This chapter also summarises energy modelling that evaluates potential options for a pathway to a net zero energy system in the region.

Chapter 4: The future of energy and the economy - The fourth chapter considers the energy system pathways modelled and the economic impact of those pathways in terms of jobs, gross valued added (GVA), and the investment required to make those pathways a reality.

Chapter 5: Next Steps – Outlining the three key next steps that we will take to translate the Mid Wales energy system vision into reality.

We would like to thank all of the stakeholders who made valuable contributions to this work through their participation in workshops, completing surveys, providing data, and additional communication on the phone and by e-mail.

Impact of the Covid-19 pandemic

This strategy has been finalised in the midst of the COVID-19 pandemic, which is having a profound effect on the lives of millions of people around the world, bringing unprecedented challenges for our economy, our society and our communities. At the time of writing, the true economic and societal costs of the pandemic for Wales and the Mid Wales region are not fully clear, but the severity of the impacts on the global economy are forecast by many commentators to exceed that of the 2008 financial crisis.

The pandemic is also taking place against the backdrop of the ongoing climate emergency. And whilst the economic damage caused will undoubtedly result in a short-term reduction in greenhouse gas emissions, it is possible that emissions could rebound if climate positive solutions are not included as central elements in our economic stimulus packages.

As we move from the immediate emergency response to save lives, support the health sector, retain jobs and support our society and economy, we must recognise that our approach to the economic recovery that will follow provides us with a unique opportunity to sustainably rebuild our economy and make greener investments and climate positive decisions that set us on a pathway that aligns with the Welsh, UK and international climate targets.

In this context, it is essential to acknowledge that our economic recovery and growth plans need to be decoupled from greenhouse gas emissions. We need to recognise the significant economic potential that a green recovery can have to rebuilding a sustainable economy in Mid Wales.

The Committee for Climate Change (CCC)[2] has identified 6 key principles for a resilient recovery from the pandemic, and we must ensure that our strategy is underpinned by these cross-cutting principles to help put Mid Wales in a position to capitalise on opportunities that may arise from the recovery:

1. Use climate investments to support economic recovery and jobs
2. Lead a shift towards positive, long-term behaviors
3. Tackle the wider 'resilience deficit' on climate change
4. Embed fairness as a core principle
5. Ensure the recovery does not lock-in greenhouse gas emissions or increased risk
6. Strengthen incentives to reduce emissions when considering tax changes.

We must also learn from the pandemic, taking the lessons from our response and apply them to the climate emergency. This may include for example:

- the need for openness and transparency;
- the importance of good data;
- the speed with which people can change behaviours and industry re-purpose;
- the need to support individuals and businesses through economic transition; and
- the importance of global collaboration.

[2] Climate Change Committee: Take urgent action on six key principles for a resilient recovery

Other lessons will undoubtedly emerge. But perhaps the biggest lesson from the COVID-19 pandemic is about the need for anticipation and preparedness in dealing with major societal issues, and the population's capacity and willingness to accept significant lifestyle changes if it is deemed necessary for the good of society. If it teaches us anything it is that we cannot afford to ignore science or expert judgement about the risks faced by our societies or wait for problems to arrive before taking action. Learning lessons from the response to a global health emergency, and applying this to that of the global climate emergency could pave the way for the accelerated and sustained change that is so critical in solving the problem of climate change.

As the COVID-19 crisis is still ongoing at the time of writing, it is still somewhat unclear when and how Wales will emerge fully from the current lockdown, and the process and timeframe through which the lockdown and social distancing will be eased; or, indeed, whether we will encounter a subsequent lockdown in the future, whether at national or local levels. We must therefore acknowledge the significant uncertainties that exist around how the Mid Wales economy will emerge from the crisis as well as the uncertainties associated with the shape of the future economic growth and decarbonisation trajectories modelled in this strategy. As such, the economic and climate modelling that underpins this strategy will need to be kept under review and updated when, and how, our emergence from the COVID-19 crisis becomes clearer. Certain elements of the strategy, such as our understanding of what it means to make 'futureproof decisions', may also need to be revisited.

In addition, Mid Wales may be able to capitalise on the opportunity to sustain behaviours observed throughout the pandemic that have had a positive effect on reducing emissions, such as the increase in active travel, reduction in travel by private car, increased working from home practices and willingness to invest in domestic property improvements. Directing resources towards infrastructure that will support the embedding of such behaviours into business as usual for communities and businesses has the potential to drive lasting emissions reduction as we recover from the COVID-19 crisis.

However, the fundamental principles of this strategy remain firmly relevant. With its focus on cleaner, fairer economic growth, this energy strategy has the potential to play a significant role in helping Mid Wales to recover and rebuild sustainably. It sets out a pathway for accelerating the shift to a decarbonised energy system in the region and demonstrates the potential for achieving far greater local economic benefits than could be achieved by returning to business as usual.

Our energy vision

Our energy vision:

To achieve a net zero carbon energy system that delivers social and economic benefits, eliminates fuel poverty, better connects Mid Wales to the rest of the UK, and contributes to wider UK decarbonisation.

Our vision is guided by five core principles:

1

Leadership in decarbonisation

Our vision should drive significant carbon reductions across sectors and the whole energy system to achieve a pathway towards net negative carbon emissions.

2

Deliver additional social and economic benefits to the community

Our vision should deliver a just transition as well as support investment in the region, job creation, affordable energy and encourage increased community and public sector ownership of energy assets.

3

Enabling Mid Wales to play an important role in broader Welsh and UK decarbonisation

Our vision should seek to overcome grid constraints while making sure that the energy transition is compatible with the restoration of natural habitats and takes place alongside adaptation.

4

Developing innovation

Developing innovation will be important to deliver economic benefits by scaling up and out, to propel the region to leadership in new technologies and business models, and to overcome challenges that are unique to the region due to its rurality.

5

Where possible, choosing future proofed solutions

Where possible choosing future proofed solutions: without impeding investment ensuring that solutions, infrastructure, and technologies implemented will have a long life, can integrate with future systems, and will continue to provide benefits for the duration of their lifespan.

Our priorities

Our priorities

To achieve our vision we have defined the following six priority areas:

Drive forward the decarbonisation of the region's housing and building stock

Work proactively to ensure that electricity and gas grids in the region are suitable for a 100% decarbonised future

Boost the use of renewable energy through new generation and storage

Accelerate the shift to zero carbon transport and improve connectivity

Develop and harness the potential of agriculture to contribute to zero carbon goals

Harness innovation to support decarbonisation and clean growth

Understanding our priorities

Drive forward the decarbonisation of the region's housing and building stock

- Prioritise increasing **energy efficiency of the current housing stock** to enable a significant reduction in domestic energy demand.
- **Combat fuel poverty** by driving forward energy efficiency, targeting low EPC rated homes, and reducing energy costs through appropriate heat technology choices.
- Decrease the number of properties using fossil fuels to heat their homes through the acceleration of **heat pump deployment**.
- **Support small businesses** to implement energy efficiency and to explore new tariffs that could drive savings.
- **Encourage commercial and industrial** businesses in the region to implement energy efficiency and onsite renewable energy generation to benefit from energy savings.
- Increase **acceptance of energy efficiency upgrades** in the older housing stock through encouraging solutions that are appropriate for the local architecture and by increasing the visibility of energy savings, health benefits, and house value.
- Work with local educational institutions to design training programmes that **upskill local trades people** in the building industry.
- Use building regulations to drive **energy efficiency and low carbon heat in new homes** and remove barriers to energy efficiency in existing homes.

Work proactively to ensure that electricity and gas grids in the region are suitable for a 100% decarbonised future

- Facilitate collaboration between the planning authorities, Natural Resources Wales, developers, community energy groups, and the Distribution Network Operators in order to improve the current processes and to **overcome current and future grid capacity constraints** that will limit the uptake of low carbon heat, EV charging, and renewables.
- **Explore the use of smart solutions** to solve grid capacity issues**.**
- Additionally, review planning processes to ensure that communication and timing does not hinder development.

Boost the use of renewable energy through new generation and storage

- Explore the use of **energy storage** to maximise the use of existing and new renewable energy generation.
- Explore significant scale **public and community ownership** of renewable projects.
- Facilitate the use of **small-scale generating technologies** in addition to large-scale renewables.
- Facilitate use of **roof mounted solar** on homes and businesses.
- **Optimise existing onshore wind** sites through repowering and on-site storage.
- Accelerate visually sympathetic **onshore wind deployment** and define how this can lead to local economic and social benefits and contribute to a vibrant low carbon economy.
- Drive **increased public understanding** of low carbon technologies and their potential community benefits and combat misconceptions surrounding these technologies.

Accelerate the shift to zero carbon transport whilst also improving the region's connectivity

- Make **public transportation infrastructure** more connected and focus on strategic transport routes, making use of market towns as transport hubs that facilitate mixed modes of transport.
- Prioritise supporting the transition of private cars to low carbon forms of transport given the region's dependence on the private car. As a first step, the region should implement an effective **electric vehicle charging network**. In the longer term, prepare infrastructure for hydrogen fuelling for HGV vehicles.
- Collaborate with the Distribution Network Operators to ensure that appropriate, **future proof solutions** for EV charging are put in place and that network infrastructure is capable of dealing with a high roll-out of EVs.
- Improve **digital connectivity** to reduce the need for travel by facilitating alternatives such as remote working.
- Deploy more infrastructure to encourage **active travel**, including cycle spaces on trains, cycle lanes and urban cycle routes that are linked with transport hubs.
- Generate **behavioural change** to reduce private car use through carpooling and use of shared vehicles.

Develop and harness the potential of agriculture to contribute to zero carbon energy

- Ensure that the **farming community is properly engaged** with respect to the low carbon transition.
- Explore **on-farm generation and battery storage** as a means of utilising more of the region's own renewable energy.
- Facilitate the sustainable use of **anaerobic digestion** and build the relevant supply chains to supply the region with power from generated low carbon gas.

Harness innovation to support decarbonisation and clean growth

- **Collaborate with other regions** in Wales to maximise efforts and create synergies through sharing lessons learned and best practices.
- Engage with key industry stakeholders to understand the skills gap and support **training and skills development** to attract young graduates and fuel innovation. Increase apprenticeships and ensure that job opportunities in the industry exist for young people in the region.
- Encourage public bodies in Mid Wales to support the development of **circular economy businesses** within the region.
- Develop of an **understanding of the role hydrogen has to play** in decarbonising industry and transport in the region.
- Explore methods for **reducing tourism-related emissions**.
- Support organisations in the region to embrace **innovative financial models** for the deployment of low carbon technologies and business models.
- Support the **commercialisation of low carbon innovation** in order to create jobs and support the local economy.
- Support the use of **demand side response** and the **development of local energy markets.**

Our energy system, energy use and emissions

Modelling an 'Energy Vision' scenario

Aims of undertaking scenario modelling

Scenario modelling has been undertaken to create two scenarios for future energy systems in Mid Wales. The first scenario is a business as usual (BAU) scenario. The second scenario is a 2035 Mid Wales energy vision scenario (ESV) that could deliver against the level of ambition set out in the Energy Vision statement. This chapter shares business as usual insights, but mainly focuses on presenting the actions in the energy system vision scenario. The modelling outcomes are unique to the region, taking advantage of local resources and opportunities.

The overall aim of the energy vision scenario is to set out a potential decarbonisation route that will put the region on a path consistent with achieving a net zero energy system by 2050. The scenario is not intended to be prescriptive. There are a number of potential pathways to achieve energy system transformation, including new opportunities from technology innovation and changes to energy demand that will certainly emerge as the transformation takes place.

The modelling presents a potential development scenario that is intended to:

- highlight the scale of the challenge
- identify existing opportunities and barriers
- point to new opportunities and key decisions
- provoke discussion and inspire action planning.

The scenario focuses on known decarbonisation solutions that could be implemented by 2035, which would put Mid Wales on a pathway consistent with achieving net zero emissions by 2050. The focus on known and proven technologies demonstrates that this pathway can be achieved and also removes uncertainty associated with more nascent technologies. Despite the focus on proven technologies innovation will undoubtedly play an important role in the energy transition and should be pursued. The modelling takes a multi-vector approach, considering the interactions between heat, transport and electricity demand. For example, the impact of decarbonising heat through electrification is reflected in increased annual electricity demand.

Why does the scenario look to achieve zero emissions from energy in 2050 and not 95% decarbonisation?

Box 1. Why does the scenario look to achieve zero emissions from energy in 2050 and not 95% decarbonisation?

The Committee on Climate Change (CCC) has recommended that Wales adopts an overall decarbonisation target reduction of 95% against a 1990 baseline by 2050. This target, which is lower than the equivalent UK 2050 net zero decarbonisation target, recognises that Wales faces several additional challenges including higher greenhouse gas emission from its agriculture and parts of its heavy industry.

However, the Welsh Government has expressed an ambition to exceed this target and aim for 100% decarbonisation. Non-energy industrial, agriculture, waste, and land use change emissions are out of scope of this energy system study. Both a Welsh 95% and a 100% emissions reduction target require the energy system to maximise its decarbonisation, reserving any residual emissions for more difficult to decarbonise sectors such as agriculture and heavy industry. It is worth noting that during the course of our engagement, stakeholders in the region have expressed very strong support for ambitious decarbonisation.

Methodology in brief

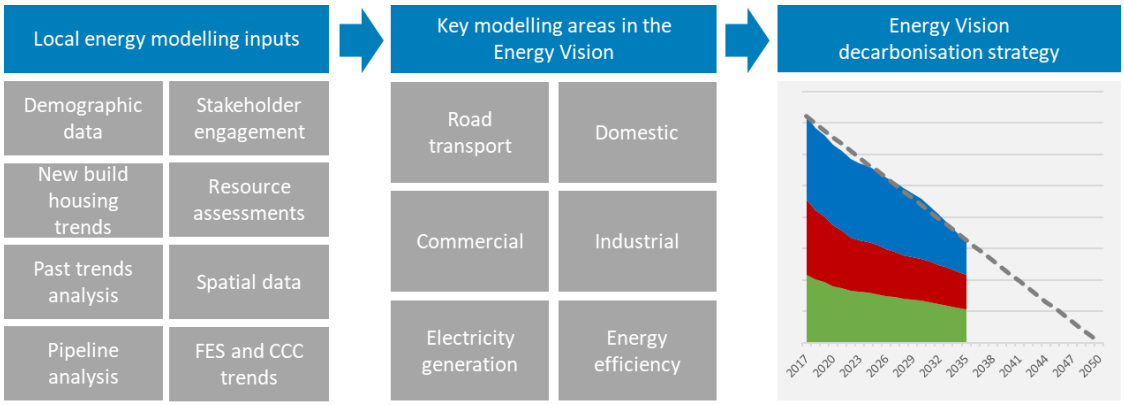
The modelling sets an indicative decarbonisation trajectory to 2035 that is consistent with achieving net zero emissions by 2050. The trajectory has been created using a methodology that reflects the high-level methodology used by the Committee on Climate Change in its 2019 Progress Report[3]. This absolute contraction methodology assumes a constant rate of decarbonisation is achieved between now and achieving net zero by 2050. This is used as a preliminary benchmark pending next year's more detailed assessment by the CCC which will set out more detailed carbon budgets consistent with the new net zero target.

The baseline has been established by gathering and analysing national and local datasets of energy consumption, energy efficiency and generation. The model has been created through a bottom-up analysis of the potential level of uptake of measures/technologies that is possible by 2035. Assumptions have been drawn from a range of sources including:

- The Committee on Climate Change reports[4],[5];
- National Grid's Future Energy Scenarios[6];
- The project team's past work on future energy scenarios for Wales & West Utilities and for Western Power Distribution (WPD)[7]; and
- Discussion with local, regional and national stakeholders;

The methodology results in a bottom-up, stakeholder-informed Energy Vision for each unique Welsh region

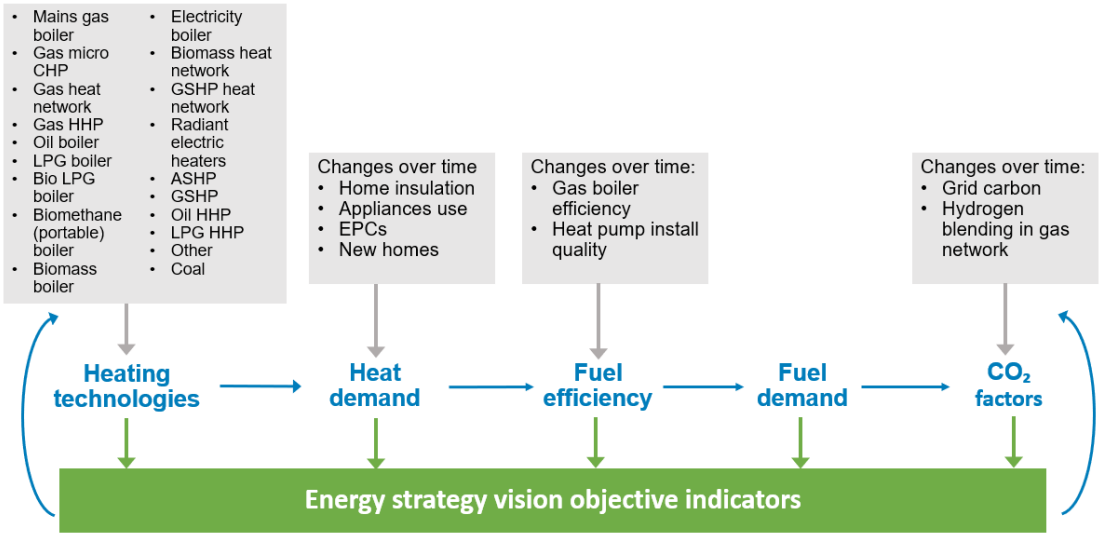
Figure 2. Modelling methodology



Worked example: The modelling approach for domestic heat

[3] Committee on Climate Change (2019) 2019 Progress Report to Parliament
[4] Committee on Climate Change (2019) 2019 Progress Report to Parliament
[5] Committee on Climate Change (2018) Hydrogen in a low-carbon economy
[6] National Grid (2019) Future Energy Scenarios
[7] Regen: Local future energy scenarios
Regen: Wales and West Utilities - Regional growth scenarios for gas

Figure 3. Modelling approach worked example



A note on scope

Box 2. A note on the scope of emissions assessed

The strategy is focused on emissions associated with the energy system in Mid Wales. As a result, the scope of the modelling is limited to the energy system, which includes transport, power, and heat use. Emissions or sequestration from non-energy activity such as agriculture and land use are not considered in the model. Data limitations and issues around whether emissions are considered locally or nationally mean that some other emissions that are within the energy system are also not considered by the model. These include aviation, shipping, and some very large industrial energy users.

A note on energy modelling and Covid-19

Box 3. A note on energy modelling and Covid-19

The energy modelling was undertaken pre-Covid-19. In terms of energy modelling, this means that the results presented here do not take into account energy consumption changes associated with Covid-19 impacts such as a switch to working from home. We are only beginning to understand the behavioural and economic impacts from Covid-19 and their knock-off effects on energy usage, as well as the extent to which any changes will persist into the future. As such, the energy modelling that underpins this strategy will need to be kept under review and updated when, and how, our emergence from the COVID-19 crisis becomes clearer.

Baseline and modelling results

Our energy consumption

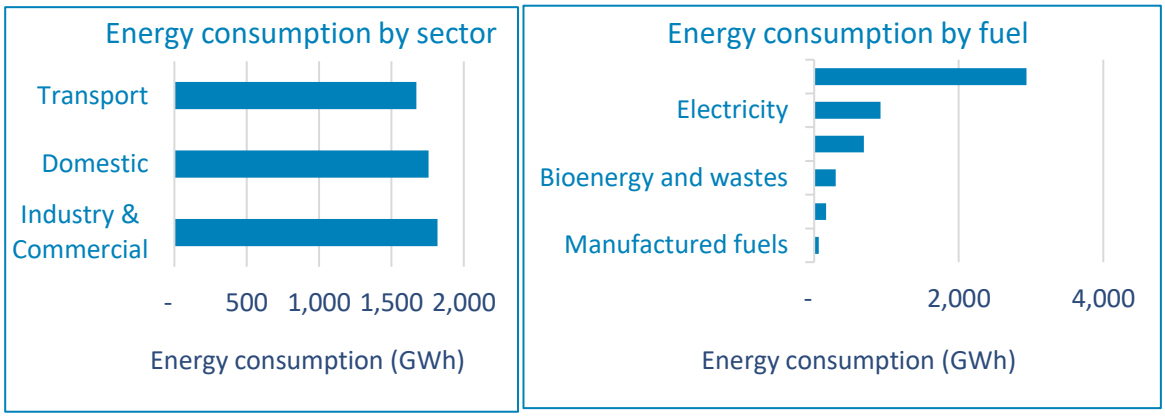
Baseline: energy consumption by sector

Mid Wales currently consumes around 6% of all energy consumed in Wales[8], which is slightly lower than its 7% share of the Welsh population[9].

The region's total energy demand is split broadly into three main areas, weighted towards commercial and industrial use, with:

- Transportation consuming 32%
- The domestic sector – household heat and power use - consuming 33%
- The commercial and industrial sector consuming 35%

Figure 4: Energy consumption trends in Mid Wales. Source: BEIS Sub national total final energy consumption, 2017.



Box 4. Definition and scope of transport, domestic, and commercial and industrial sectors

Transport –energy consumption and resulting emissions associated with road transport, including HGVs, vans, cars and buses.

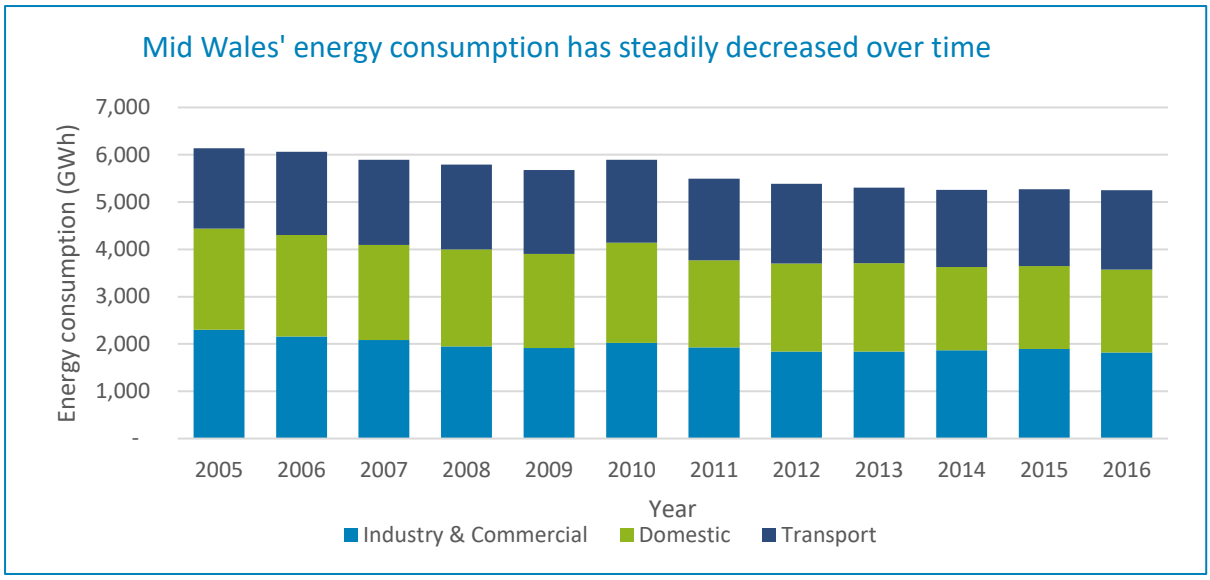
Domestic –energy consumption and resulting emissions associated with all heating, lighting, cooking and appliance use in the home

Commercial and Industrial – energy consumption and resulting emissions associated with all non-domestic activity, including business, the public and third sectors and industrial processes (some very large industrial users are excluded from the data due to issues around commercial sensitivity).

[8] BEIS: Regional and local authority electricity consumption statistics, 2019

[9] StatsWales: Population estimates by local authority and year

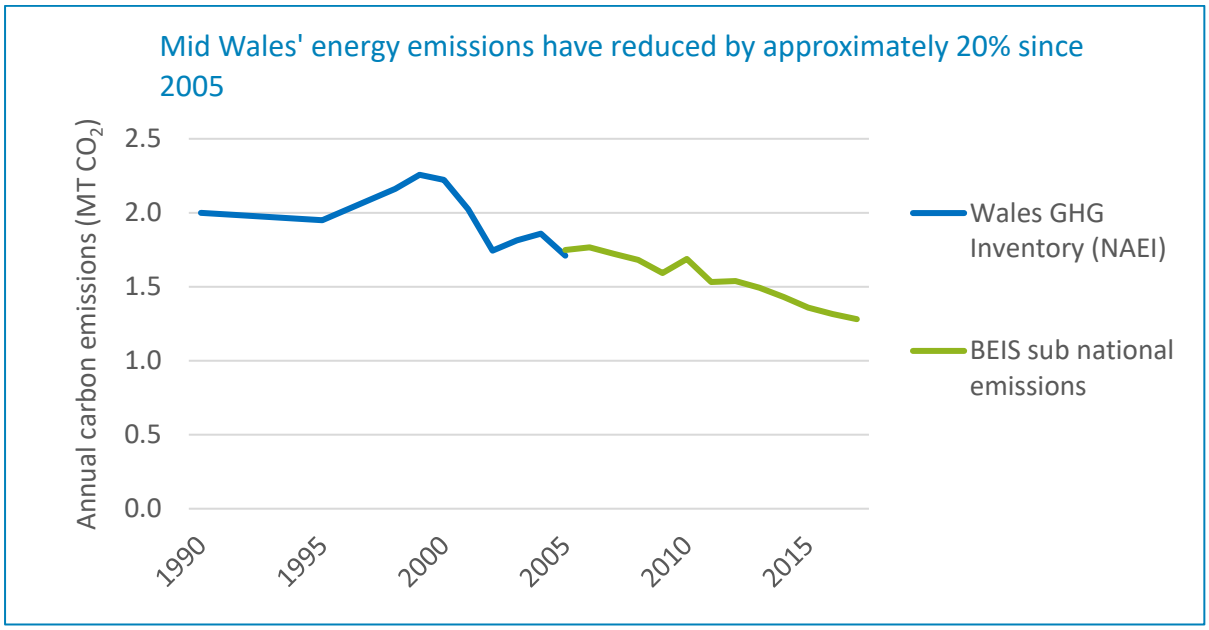
Figure 5. Energy consumption by sector in the Mid Wales Region. Source: BEIS total final energy consumption (2019)



Analysis of BEIS sub-regional data[10] shows that total energy consumption has fallen by 14% since 2005, an average rate of about 1% per year. This is less than the 20% reduction in energy demand experienced across Great Britain over the same period.

The emissions resulting from energy consumption have reduced by around 20% since 2005, and nearly 40% since 1990, with a larger proportional decrease in emissions than consumption, largely attributable to decarbonisation of the electricity grid.

Figure 6: Estimated historic emissions in Mid Wales. Source: BEIS sub-national emissions, Wales NAEI Greenhouse gas inventory



[10] BEIS: Regional and local authority energy consumption statistics, 2019

Energy system vision: energy consumption by sector

To be on track for net zero by 2050, Mid Wales needs to achieve a 55% decarbonisation of its energy system by 2035. By reviewing the measures that could be implemented in Mid Wales by 2035, this 55% target decarbonisation can be split by sector into:

- 66% domestic emissions reduction;
- 48% commercial and industrial emissions reduction;
- 54% transport emissions reduction.

Figure 7. Mid Wales' Energy Vision decarbonisation trajectory by sector to meet net zero 2050 under an absolute contraction methodology Source: WGES analysis

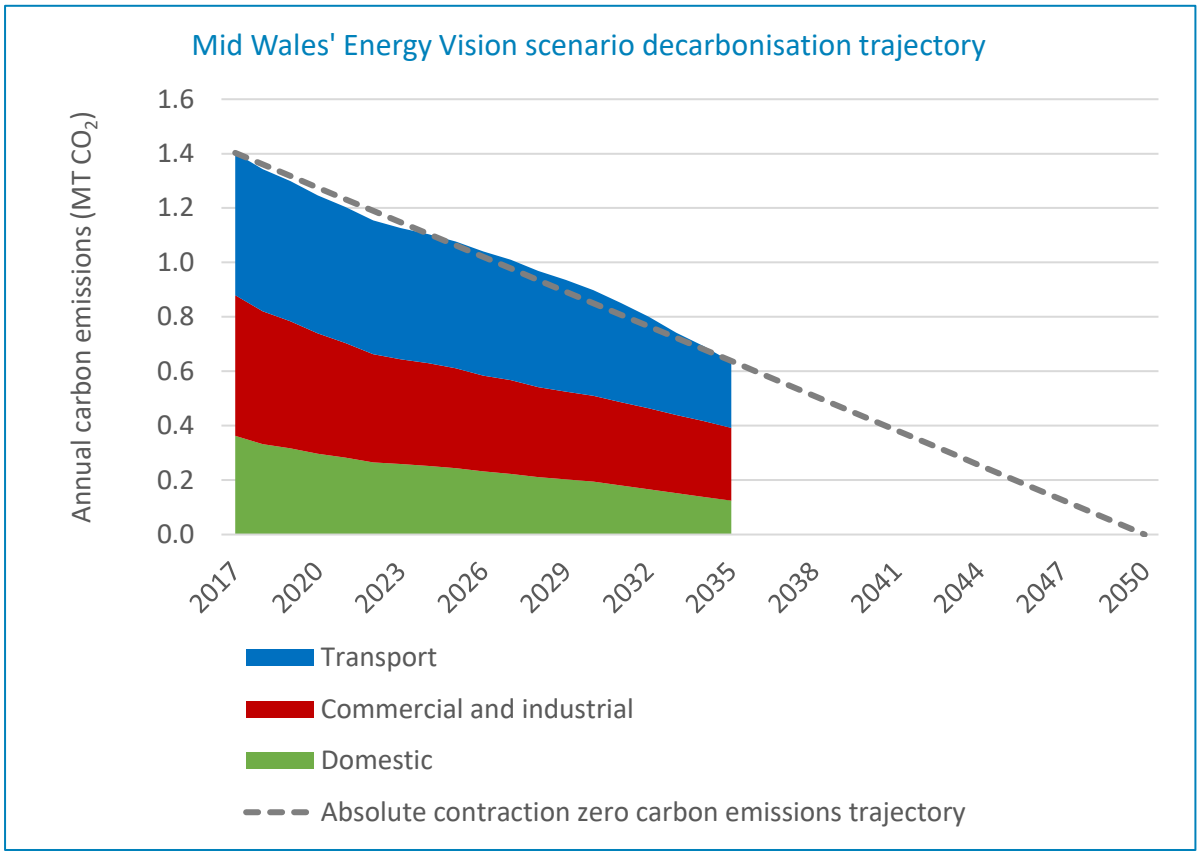
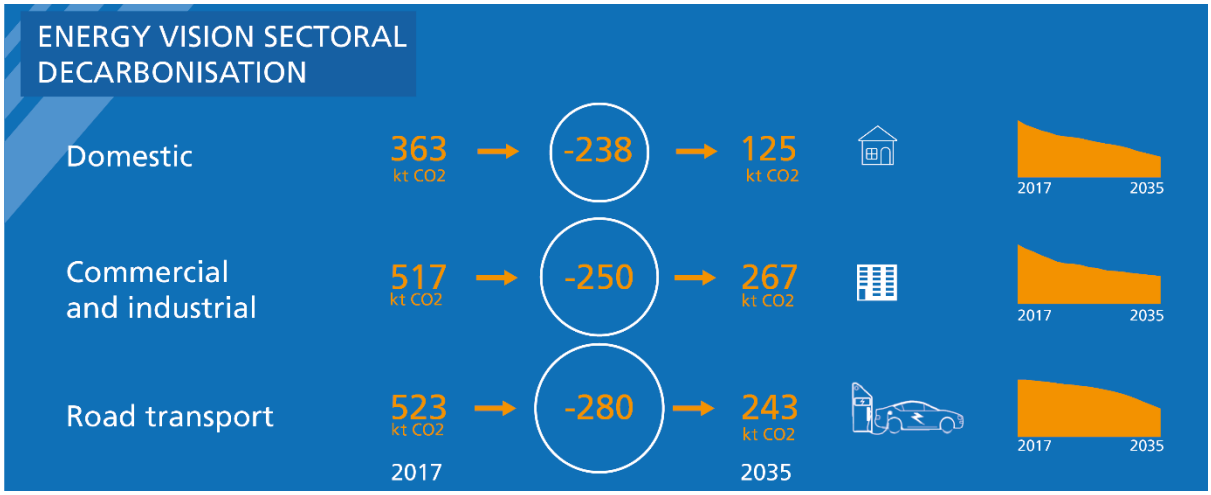


Figure 8. Sectoral summary of the Energy Vision's emission reductions Source: WGES analysis

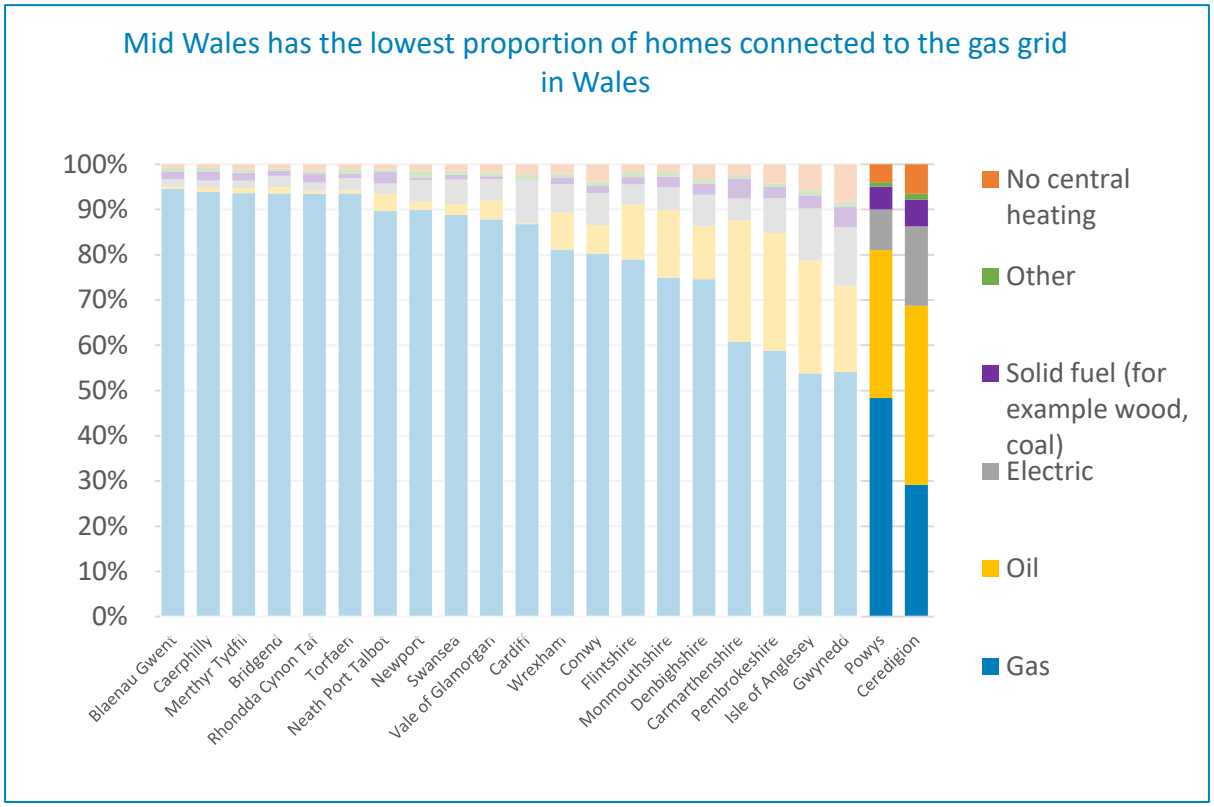


Our domestic energy consumption

Baseline: Domestic

As a largely rural region, energy demand is dispersed and the gas network does not reach many areas of Mid Wales. The region has the highest proportion of off gas grid properties in Wales with 52% of properties in Powys off gas grid and 72% in Ceredigion.

Figure 9: Percentage of homes heated by different heating fuels in each Welsh local authority. Source: Census, 2011. MHCLG, Energy Performance Certificates.



Mid Wales has the highest deployment of renewable heat installations in Wales, with nearly 2% of homes having a heat pump or biomass boiler.

Figure 10: Renewable heat projects by region in Wales. Source: Energy Generation in Wales, 2017

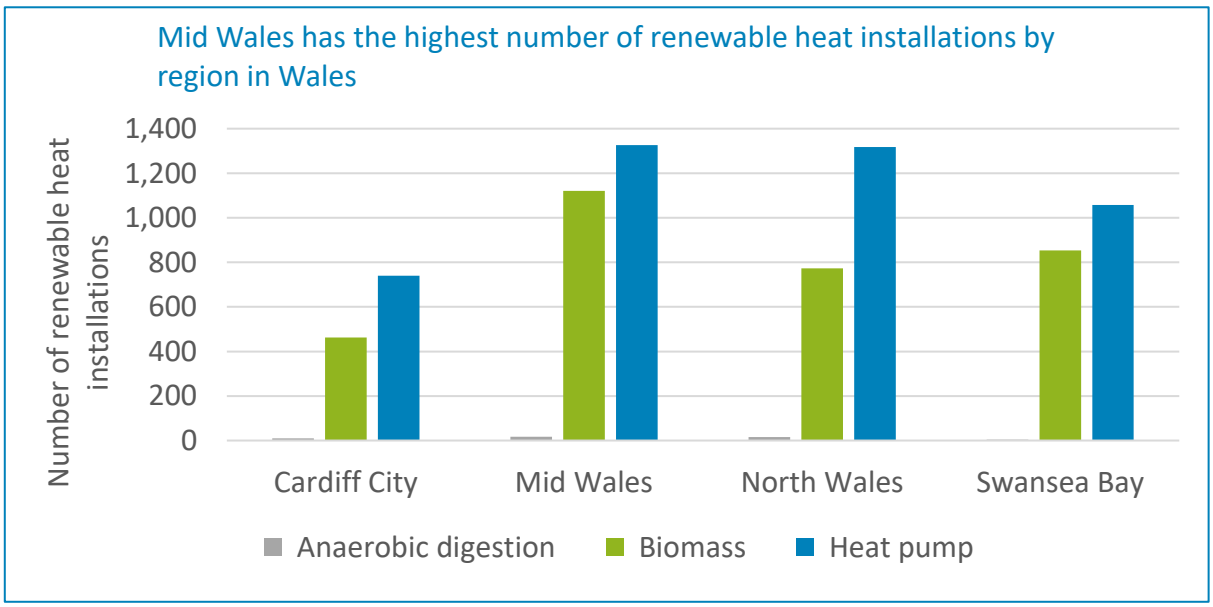
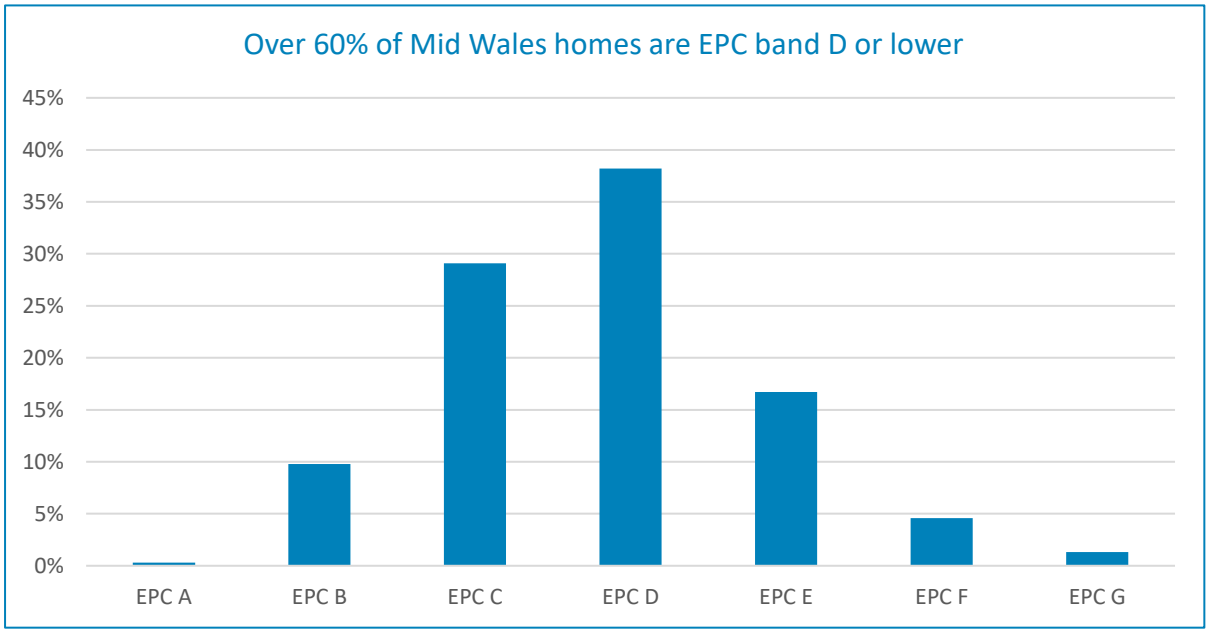


Figure 11: Proportion of homes in Mid Wales in each EPC band. Source: MHCLG, Energy Performance Certificates



Fuel poverty is relatively high in the region: approximately 17% of homes in Ceredigion and 14% of homes in Powys experience fuel poverty.

Domestic energy efficiency is relatively poor in Mid Wales, with an estimated 41 percent of homes rated as EPC band E, F or G, compared to 23% in Great Britain[11]. Rural homes tend to be older and harder to heat and are often more challenging to retrofit.

Despite this, domestic energy demand has fallen by 30% since 2005. Much of this decrease is due to boiler and appliance efficiency and use of condensing gas boilers.

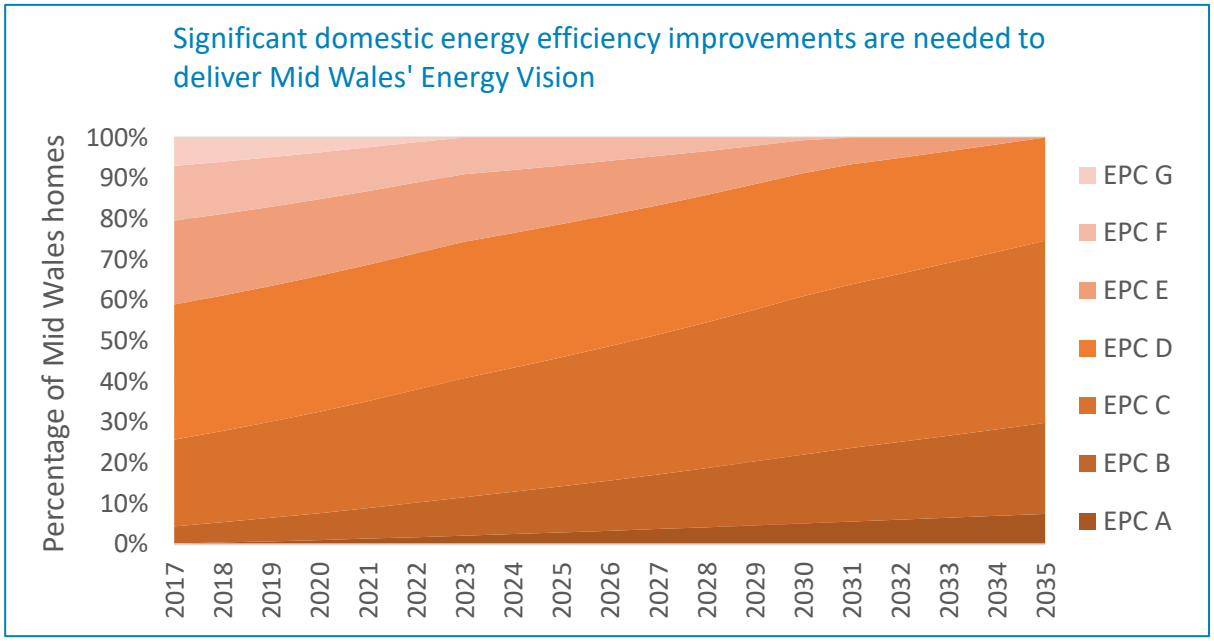
[11] Not all homes have a current EPC as these are only required when houses are advertised for sale or rent. As a result, the EPC figures are estimates based on extrapolating the known data.

Energy Vision scenario: Domestic

Achieving a 66% reduction in domestic carbon emissions by 2035 requires a significant shift in the way homes are heated and their level of energy efficiency.

The energy modelling scenario achieves improved energy efficiency by installing a variety of energy efficiency measures. In terms of EPC ratings and focusing on improving the worst performing homes, these energy efficiency measures could eliminate all E, F and G rated homes by 2035, as well as some improvements to homes with higher ratings. Under the Energy Vision scenario, 41% of all homes move from G, F and E to D, C and B ratings.

Figure 12: Estimated domestic EPC band changes to deliver the Energy Vision scenario. Source: WGES analysis



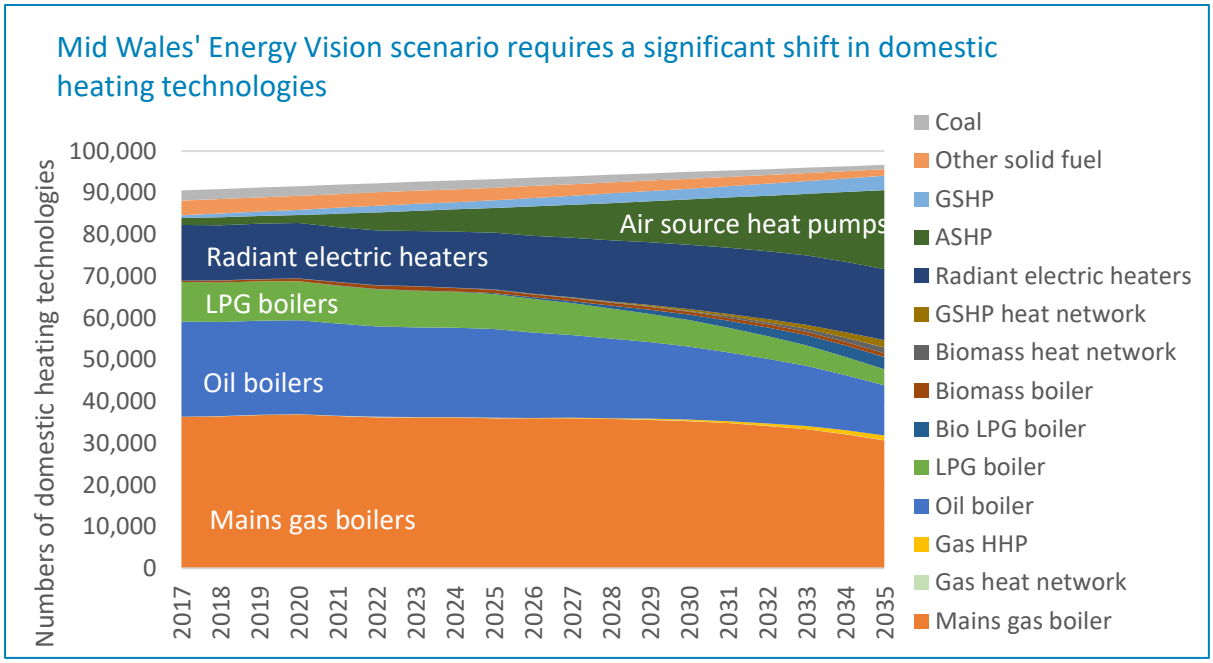
In terms of heating, the energy system vision scenario requires around 28,000 homes to move from oil or other fossil fuels to renewable heating. The scenario assumes this transition will be dominated by a shift to air source heat pumps, with a smaller role for ground source heat pumps, biomass and bio-LPG fuelled heating options as can be seen in Figure 13 below. By 2035, the scenario assumes over 26,000 heat pumps have been installed in Mid Wales. Heat networks have a limited role in Mid Wales due to the rurality of the area, with around 775 homes estimated to connect to a heat network by 2035.

The recent consultation from Welsh Government on Building Regulations Part L is looking to lay down the standards for housing construction for 2020 to 2025 and give industry notice by exploring the expected standards that will be in place from 2025. The current proposals for 2020 are to improve the target emissions rate for new build homes by raising the fabric standards and introducing renewable energy technology into the notional buildings that sets the target emission rate. To meet the new target, developers may, for example, choose to install low carbon heating, but if not, will be required to future proof so that low carbon heating can be easily retrofitted in the future. The target outcome is that homes built in 2025 will emit 75% to 80% less carbon than those built to the 2014 Part L requirements[12]. The challenge will be to close the remaining gap to true zero carbon development.

[12] Welsh Government (2019) Welsh Government Consultation Document: Building Regulations Part L and F Review

The energy vision scenario relies on new homes being built with low carbon heating and high standards of energy efficiency from 2025, rather than building properties that will need retrofitting at a later date. If Welsh Government or the local authorities in Mid Wales choose to bring this date forwards, there will be a benefit in that the number of homes needing retrofitted by 2050 would be reduced.

Figure 13: Energy Vision scenario domestic heating technology numbers, including existing and new build houses. Source: WGES analysis



Scenario summary: domestic

Table 2. Domestic heat and energy efficiency energy vision scenario example outcomes

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Domestic heat and energy efficiency	5,500 houses fitted with internal or external wall insulation 24,500 homes fitted with other insulation measures Over 26,000 heat pumps Prioritisation of electrifying heat use in oil, LPG and solid fuel heated homes No gas in new homes from 2025 to avoid retrofitting at a later date	20% reduction in thermal energy demand 39% net decrease in domestic heating energy consumption	236 kt CO_2 (68% reduction)

Additional detail regarding the assumptions behind the domestic heating energy modelling can be found in Box 5 and Table 3 below. It's worth noting that the Wales & West Utilities outlook regarding the potential for biomethane and hydrogen has evolved since the modelling was undertaken following the UK government evolution to a net zero target last year. Wales and West Utilities' net zero scenario shows higher potential for biomethane and hydrogen. For example, when incentivised, biomethane levels can exceed previous upper

limits and in some parts of the WWU network will reach over 20% by 2021. These ambitions are still complimented by high levels of insulation to reduce energy demand and will still require substantial changes to come to fruition.

Box 5. Assumptions regarding the decarbonisation of domestic heating in Mid Wales

The Mid Wales energy strategy modelling assumptions for domestic heating are based on input from regional stakeholders and the 2019 Wales & West Utilities Distribution Future Energy Scenario (DFES) project which explored potential future scenarios for the gas network in Mid Wales in 2035. Some of the key scenario highlights from the 2019 DFES included:

- Around 20% of homes could be heated by a heat pump by 2035, subject to being suitable for the property, predominantly air source or ground source heat pumps replacing more expensive oil, LPG or solid fuel heating.
- It is assumed in the Energy Vision and 2019 DFES that there is no injection of biomethane into the gas grid in Mid Wales by 2035. This is predominantly due to a geographical mismatch between biomethane resources and the gas grid, and the nature and scale of farming in Mid Wales.
- Consumption of natural gas energy in Wales could fall by over 20% between now and 2035.
- Projections on the uptake of heat pumps, including the proportion of hybrid heat pumps, were based on FES 2019 scenarios. Since then, the FES 2020 study has been published and includes a higher proportion of hybrid gas heat pumps, particularly under the Leading the Way scenario.

Table 3 Source: Regen (2019) Regional Growth Scenarios for Gas and Heat for Wales & West Utilities

Key assumptions for domestic heating fuels		2019 WWU DFES Study			WGES Energy Strategy Study
		Two Degrees Scenario	Community Renewables Scenario	Hybrid Accelerator scenario	
Heat pump deployment (% of houses with a HP by 2035)		15%	25%	19% (including significantly higher proportion of hybrid heat pumps)	26%
Biomethane and bioSNG energy	Biomethane and bioSNG heat energy for domestic and C&I heating in 2035	0 GWh	0 GWh	0 GWh	0 GWh
	Biomethane and bioSNG percentage of heat delivered by the gas network	0% of gas network energy	0% of gas network energy	0% of gas network energy	0% of gas network energy
Hydrogen use for domestic and commercial heating (Hydrogen for industrial processes and transport is modelled separately)		None modelled before 2035	None modelled before 2035	None modelled before 2035	None modelled before 2035 although there is potential for some domestic heating associated with industrial clusters

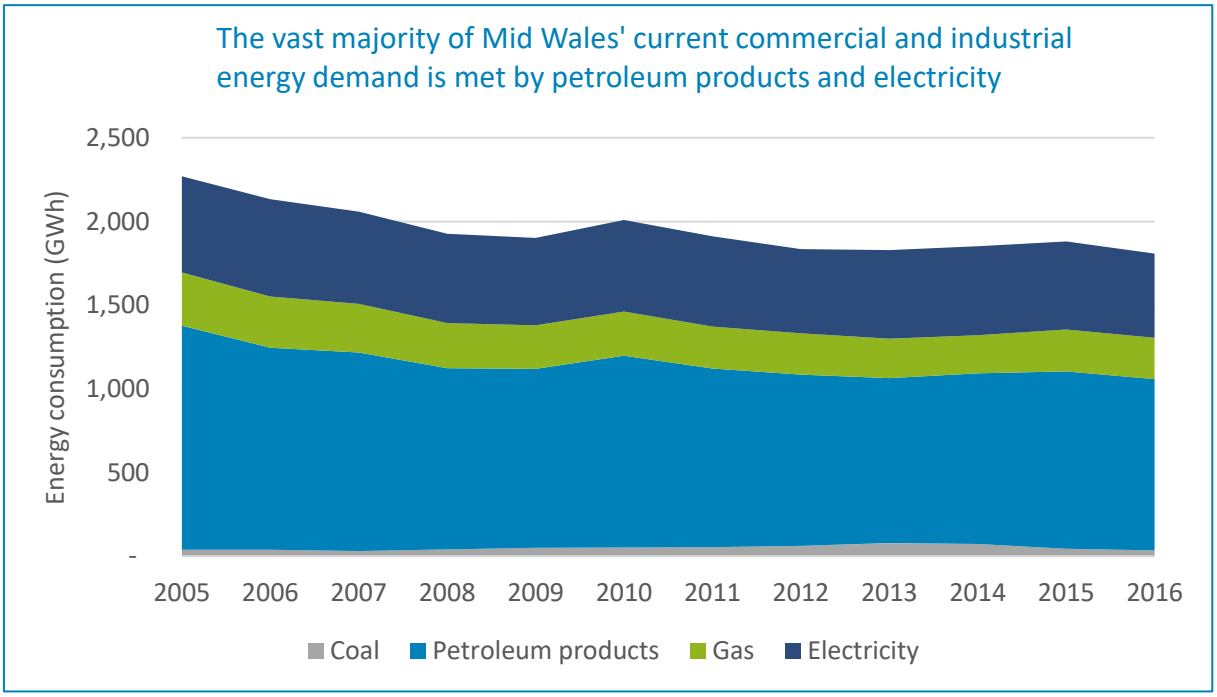
Our commercial and industrial energy consumption

Baseline: commercial and industrial

Only 12% of commercial and industrial demand is met by gas, reflecting the off-gas nature of the region.

Industrial demand has decreased by 10% since 2005 and emissions have decreased by 37%, in large part due to decarbonisation of the UK's electricity grid.

Figure 14: Mid Wales' baseline commercial and industrial energy consumption by fuel. Source: BEIS total final energy consumption (2019)



Energy Vision scenario: commercial and industrial

Achieving 48% reduction in commercial and industrial emissions requires a 23% decrease in energy demand, plus significant further decarbonisation of our electricity network through renewable generation. Achieving a grid carbon factor of 30g/CO_2 per kWh[13] achieves on its own a 24% reduction in emissions in Mid Wales. This grid carbon factor would require significant investment in renewable generation in the region and across the UK. (See Box 6 for information about grid carbon factors).

[13] Assumption based on Community Renewables and Two Degrees scenarios in National Grid (2019) Future Energy Scenarios

Figure 15: Energy Vision scenario commercial and industrial energy consumption, by fuel. Source: WGES analysis

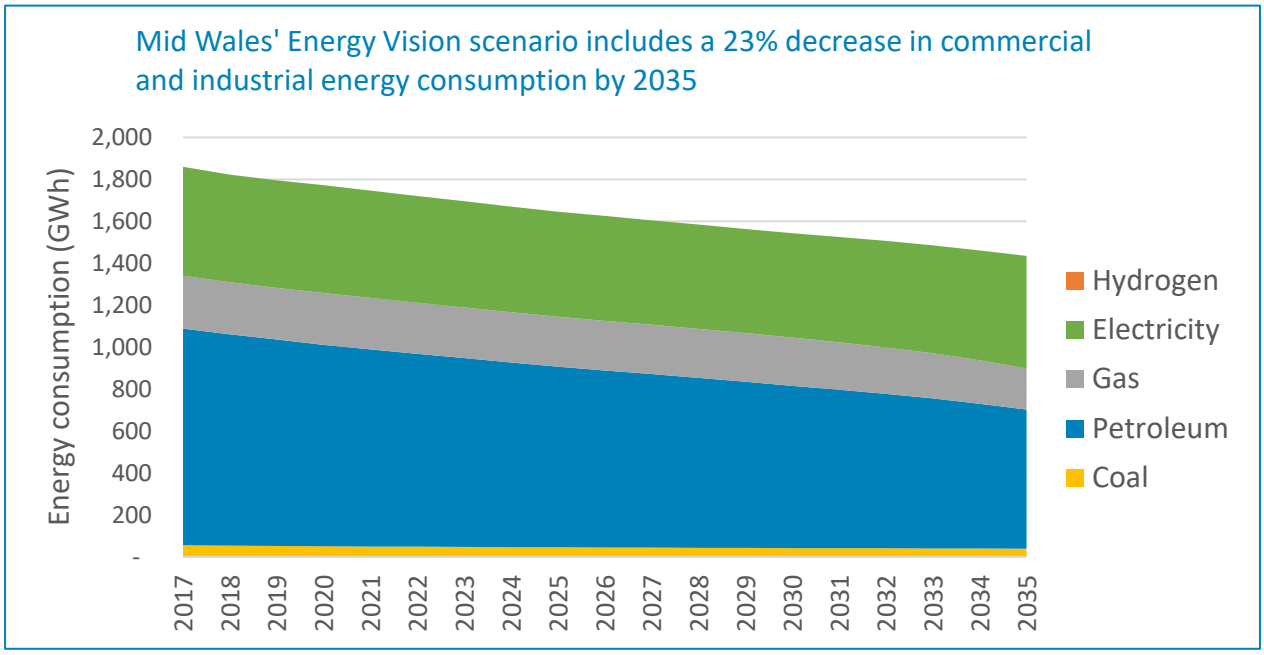
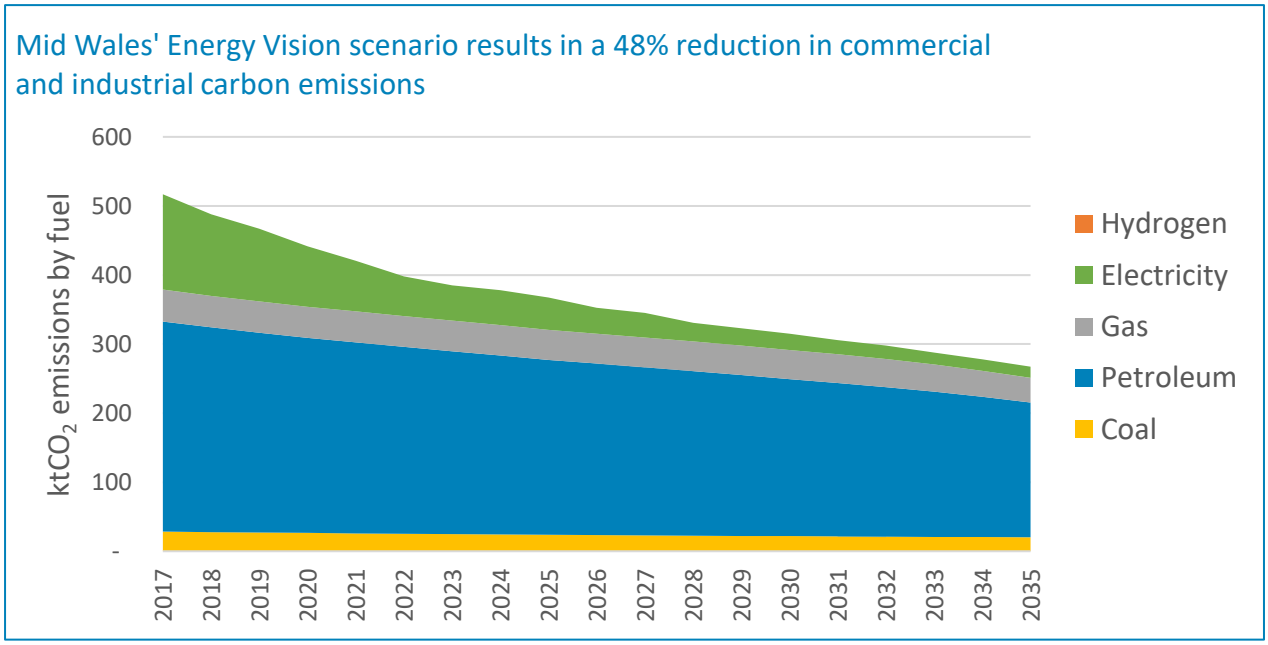


Figure 16: Energy Vision scenario commercial and industrial emissions estimates, by fuel. Source: WGES analysis



Scenario summary: commercial and industrial

Table 4. Commercial and industrial energy demand energy vision scenario example outcomes

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Commercial and industrial energy demand	Significant energy efficiency programme to exceed UK Clean Growth Strategy 20% target A switch to alternative fuels and electrification of heating Decarbonisation of electricity network through renewables and behind the meter renewable generation	35% reduction in coal and petroleum energy consumption 11% reduction in gas consumption 3% increase in electricity demand	250 kt CO_2 (48% reduction)

Our transport

Baseline: transport

Mid Wales has a high dependence on private cars for transport. Less than 1% of road miles are driven by buses in Mid Wales, and there are nearly half the number of buses per capita than the more densely populated regions in South Wales. Mid Wales with its hilly terrain and dispersed settlements is assumed to follow Welsh trends for active travel in having the joint lowest percentage of all journeys taken by walking and cycling when compared to other regions in Great Britain.[14]

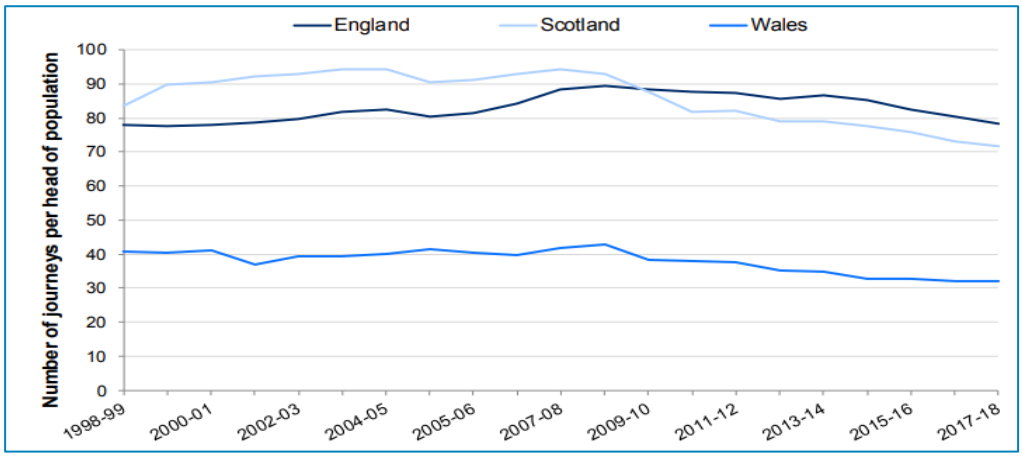
To date, Mid Wales has seen a slow uptake of electric vehicles. Approximately 0.2% of cars registered in the area are electric, meaning Mid Wales has below average uptake of EVs compared to Great Britain, where on average 0.5% of vehicles are now electric. Furthermore, the number of EV chargers in Mid Wales remains low, with just 88 public chargepoints including 3 rapid chargers installed by October 2019[15]. This reflects the relatively low deployment of public chargepoints across Wales to date, in which there are approximately half as many public chargepoints per head as in Scotland[16].

Low uptake of EVs in Mid Wales is likely to be due to a range of factors, including the high cost of purchasing an EV, the distances between settlements in the area giving rise to range anxiety, and the lack of existing chargepoint infrastructure.

Average annual vehicle miles in Mid Wales are similar to those in other Welsh regions at 9,407 miles per car, which is only 1% higher than cars registered in North Wales and 2% higher than those registered in the Cardiff Capital Region[17].

Figure 17: Passenger journeys per head on local bus services by country, 1998-2018. Source: Public service vehicles statistical bulletin (2019)

Wales has far lower historic bus utilisation rates than England or Scotland



[14] Personal travel in Wales – 2012 statistical bulletin (2013)
[15] DFT (2019) Electric Vehicle Charging Device Statistics
[16] Ibid
[17] Regen analysis of DfT licencing statistics (2018) DfT Vehicles statistics and Car vehicle traffic by local authority (2018)

Energy Vision scenario: transport

Achieving a 54% reduction in transport emissions by 2035 is a significant challenge for Mid Wales with its high dependency on private vehicles. The scenario assumes:

- 53% of vehicles driven in Mid Wales in 2035 are electric, with the ban on fossil fuel vehicle sales brought forward to 2030[18].
- 20% reduction in private vehicle mileage in 2035, which rises from a 10% reduction in 2030
- A slowing in the total number of vehicles on the road, facilitated by increased public transport and active travel. In terms of overall vehicle numbers, this means a substantially reduced rate of increase so that between by 2035 the number of

Figure 18. Energy System Vision road vehicle emissions, by fuel. Source: WGES analysis

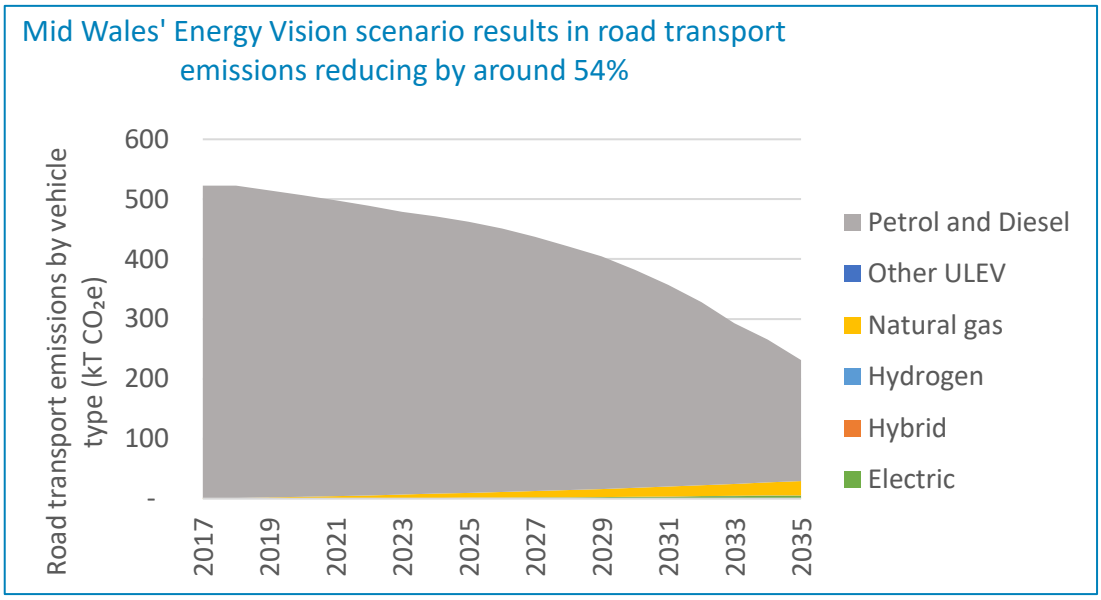
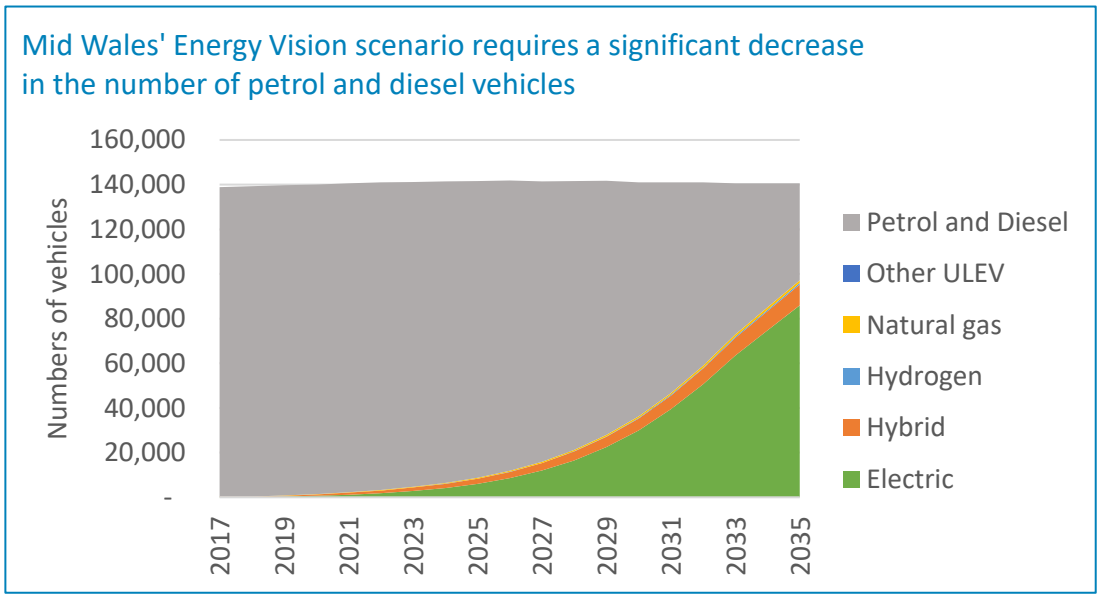


Figure 19. Energy vision scenario Road transportation vehicles by fuel. Source: WGES analysis



[18] The UK Government has committed to bringing the ban forward to 2035 subject to consultation. The consultation will also consider earlier dates. The scenario makes the assumption that 2030 has been agreed on.

vehicles has grown by less than 2,000 vehicles. This is reflected graphically in **Error! Reference source not found.**.

Summary: Transport

Table 5. Road transport energy vision scenario example outcomes

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Road transport	86,000 EVs 1,100 gas vehicles 700 hydrogen vehicles 1,500 public EV chargers 20% reduction in private vehicle mileage	1.1 TWh less petrol and diesel energy consumption 0.2 TWh increase in electricity consumption	263 kt CO_2

Achieving these outcomes requires 2,000 EV sales per year by the mid-2020s, peaking briefly at 10,000 per year in the 2030s before reducing to 7,000 per year. Peak sales of fossil-fuelled cars in Mid Wales have historically reached 7,000 per annum[1]. Additional support, such as a scrappage scheme alongside a 2030 ban on new fossil-fuelled car sales, would be needed to retire some fossil-fuelled vehicles earlier than their average lifespan, in order to achieve a peak of 10,000 EV sales per year in the 2030s.

This level of EV sales will also require a supportive area-wide EV charging network, in turn supported by electricity network infrastructure capable of dealing with high roll-out of EVs. Similarly, the switch to gas powered HGVs is reliant on the fuelling infrastructure being in place. Reducing personal vehicle miles by 20% will require significant investment in public transport infrastructure.

Our annual electricity demand

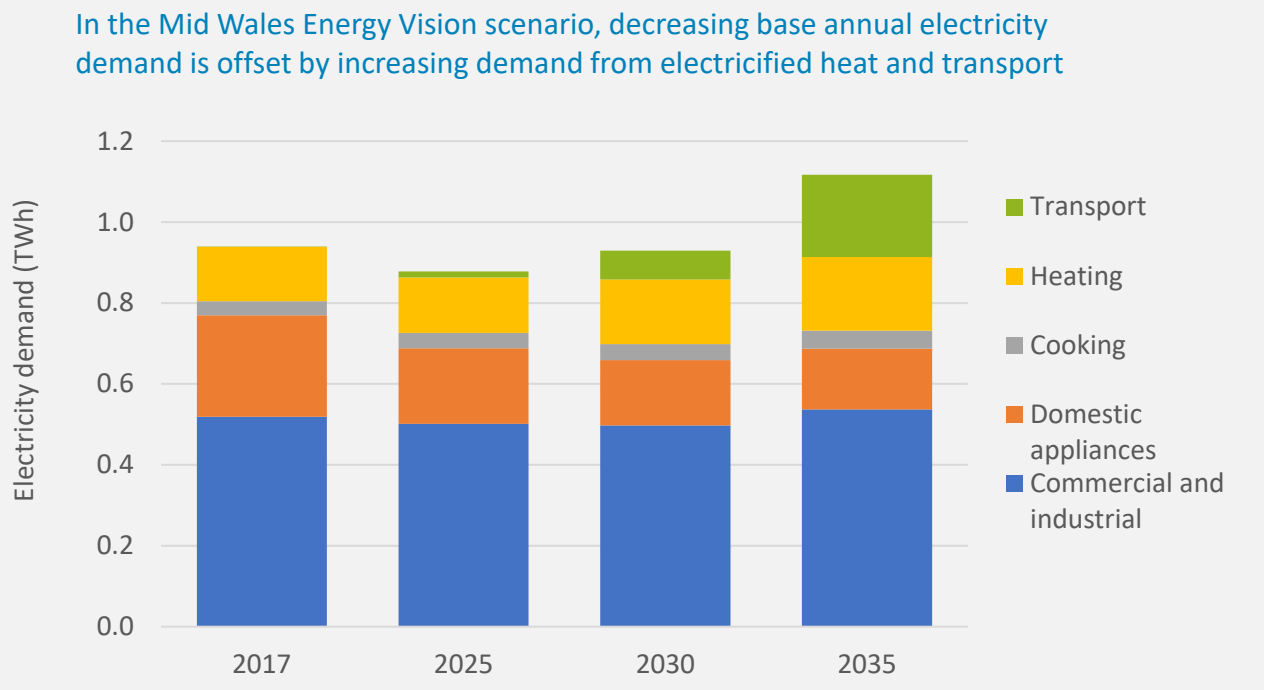
Baseline: annual electricity demand

Annual electricity demand in Mid Wales is currently approximately 0.94 TWh. It has fallen steadily since at least 2005 when electricity demand was over 1 TWh. Over 50% of electricity in the region is consumed by the commercial and industrial sector.

Energy Vision scenario: annual electricity demand

The scenario projects a 19% increase in annual electricity demand for Mid Wales by 2035 against 2017 figures. Increased energy efficiency measures and appliance efficiency lead to a decrease in the base electricity demand, with the increase resulting from the electrification of heating and transport.

Figure 18: Mid Wales Energy Vision scenario demand by sector. Source: WGES analysis

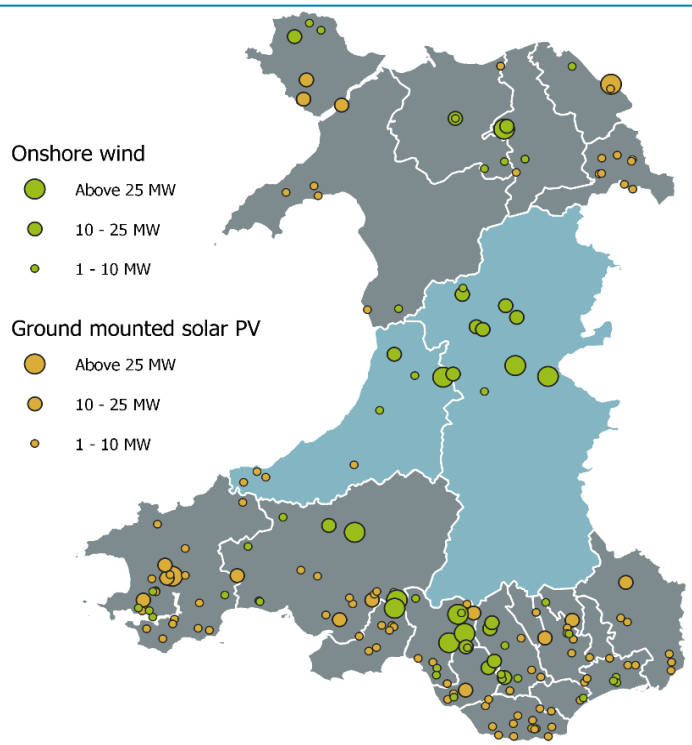


Our electricity generation

Baseline: electricity generation

Figure 19: Solar PV and onshore wind projects (>1MW) currently generating in Wales Source: BEIS Renewable Energy Planning Database (2019)

270 MW of onshore wind projects and 51 MW of solar PV in Mid Wales



Renewable energy generation in Mid Wales is predominantly from onshore wind, which makes up 72% of generation and 66% of capacity. Solar PV has a relatively high installed capacity, but, due to a lower capacity factor, supplies around 6% of renewable energy generation in the region. 51MW of 412MW of renewable capacity in the region is locally owned.

Renewable electricity generation in Mid Wales has increased relatively slowly since 2004

Figure 20: Mid Wales renewable electricity generation trends 2000-2017. Source: WGES analysis, Welsh Government (2019) Energy Generation in Wales 2018

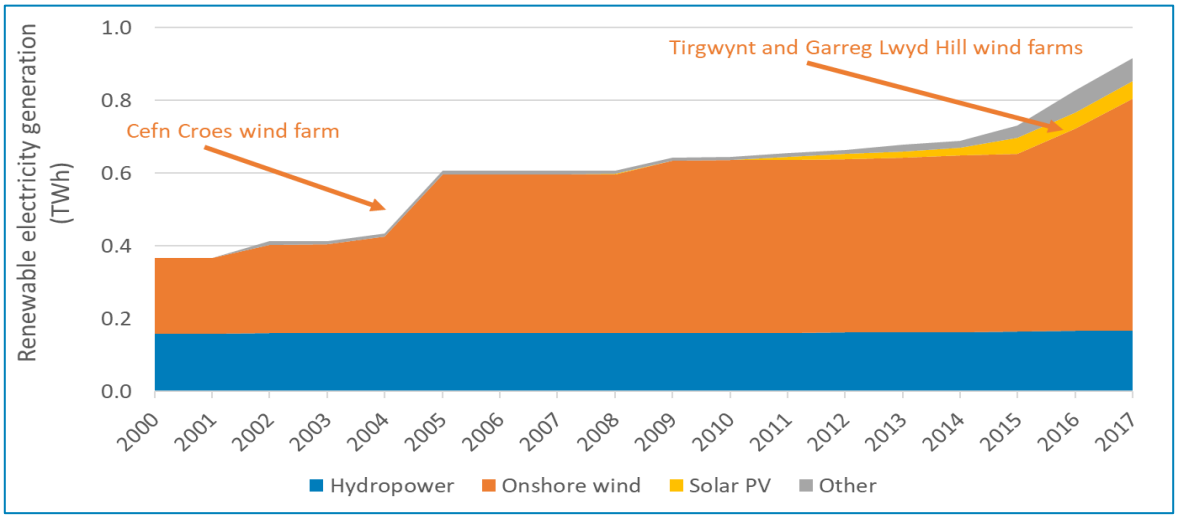
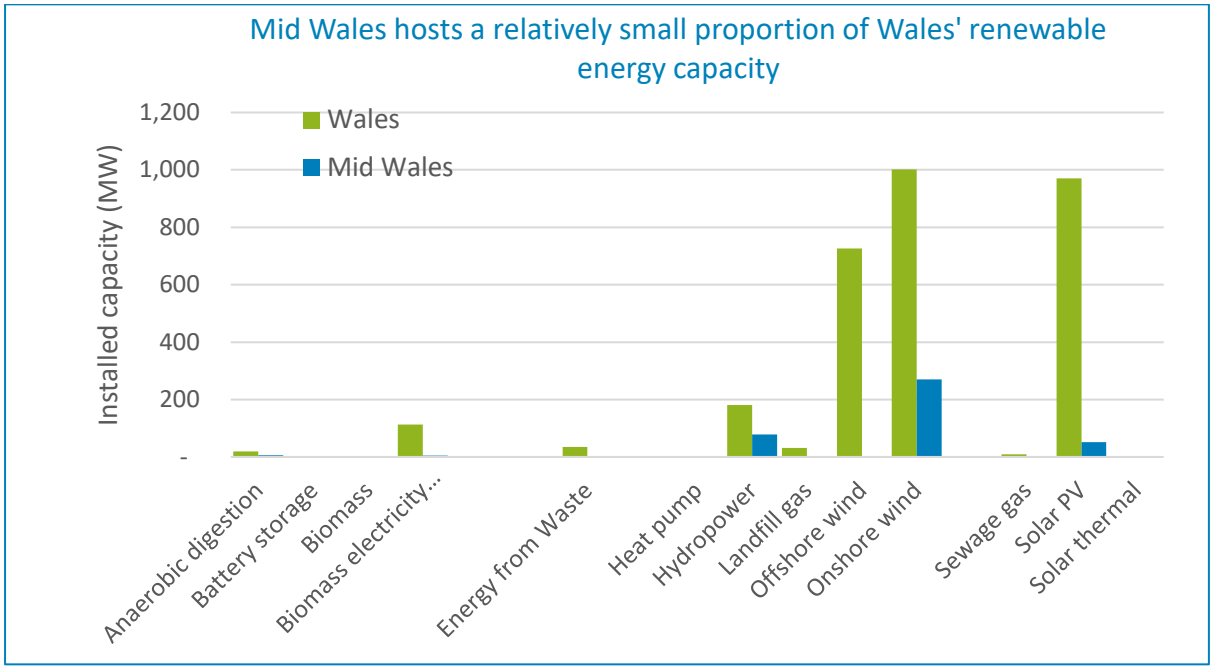


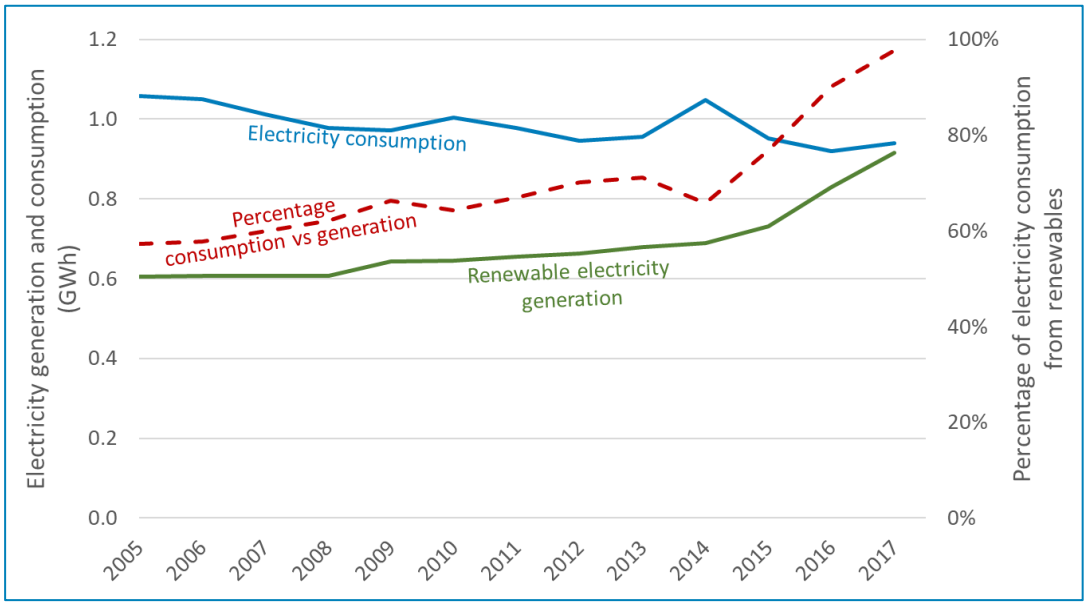
Figure 21: Renewable electricity capacity in Mid Wales region (2017).Source: WGES analysis, Welsh Government (2019) Energy Generation in Wales 2018



Mid Wales currently hosts 25% of Wales' onshore wind capacity. Across all technologies, Mid Wales is home to a relatively small proportion of Wales' renewable energy capacity However, due to relatively low and reducing electricity demand in the region and some significant onshore wind projects, Mid Wales currently generates the equivalent of 97% of the electricity that it consumes, from local renewable sources.

Mid Wales currently generates the equivalent of 97% of its electricity consumption from local renewable sources

Figure 22: Percentage of electricity consumption from renewables in Mid Wales. Source: WGES analysis, Welsh Government (2019) Energy Generation in Wales 2018



Energy Vision scenario: electricity generation

Box 6. Electricity decarbonisation assumptions

Achieving net zero carbon emissions across the UK requires the decarbonisation of the electricity grid. In line with industry best practice, the modelling for the Energy Vision scenario applies the UK grid carbon factor to electricity consumed in the region, rather than creating a regional factor based on electricity generated locally.

To be on track for net zero by 2050, the Energy Vision scenario assumes that an average UK grid carbon factor of 30 gCO_2/kWh has been achieved by 2035, in line with the Two Degrees scenario assumption used in National Grid's 2019 Future Energy Scenarios[1]. In order to achieve this level of grid decarbonisation, National Grid's Two Degrees scenario requires a net increase of 74 GW of low carbon electricity capacity across the UK by 2035. Mid Wales has the natural resources and the ambition to play a significant role in delivering renewable energy deployment.

The Energy Vision scenario developed is based on the region generating twice the renewable electricity it consumes. This figure has been arrived at by balancing the region's ambition against the available resources, investment requirement and potential grid capacity.

New electricity generation will also support the Welsh Government target that 70% of the electricity consumption in Wales come from Welsh renewables by 2030. We expect that new generation will also have elements of local ownership in support of Welsh Government targets that all new projects have an element of local ownership and that 1 GW of renewable energy is locally owned by 2030.Potential benefits to the region in addition to supporting decarbonisation would include investment opportunities, job creation, supply chain stimulation and community benefit funds. If projects are developed by or invested in by the public and community sector there are additional potential economic and social benefits that could result, enabling the region to retain a higher proportion of the value created. Figure 24 shows one pathway to achieving this level of electricity generation in the region.

Figure 23: Mid Wales Energy Vision scenario electricity consumption vs generation. Source: WGES analysis

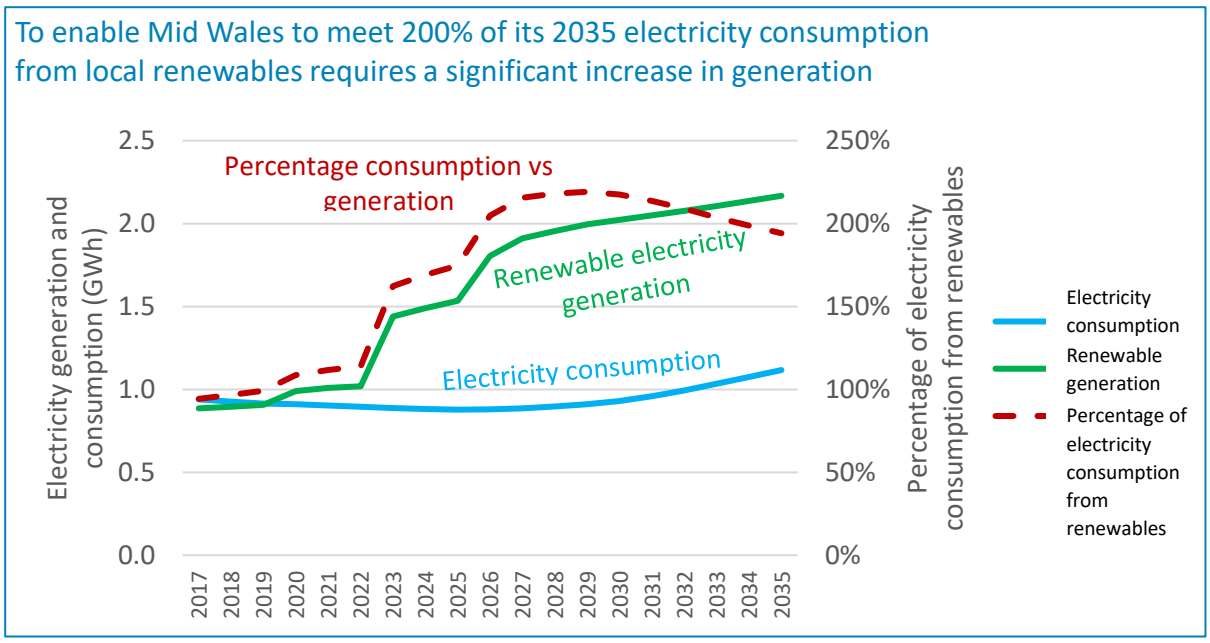
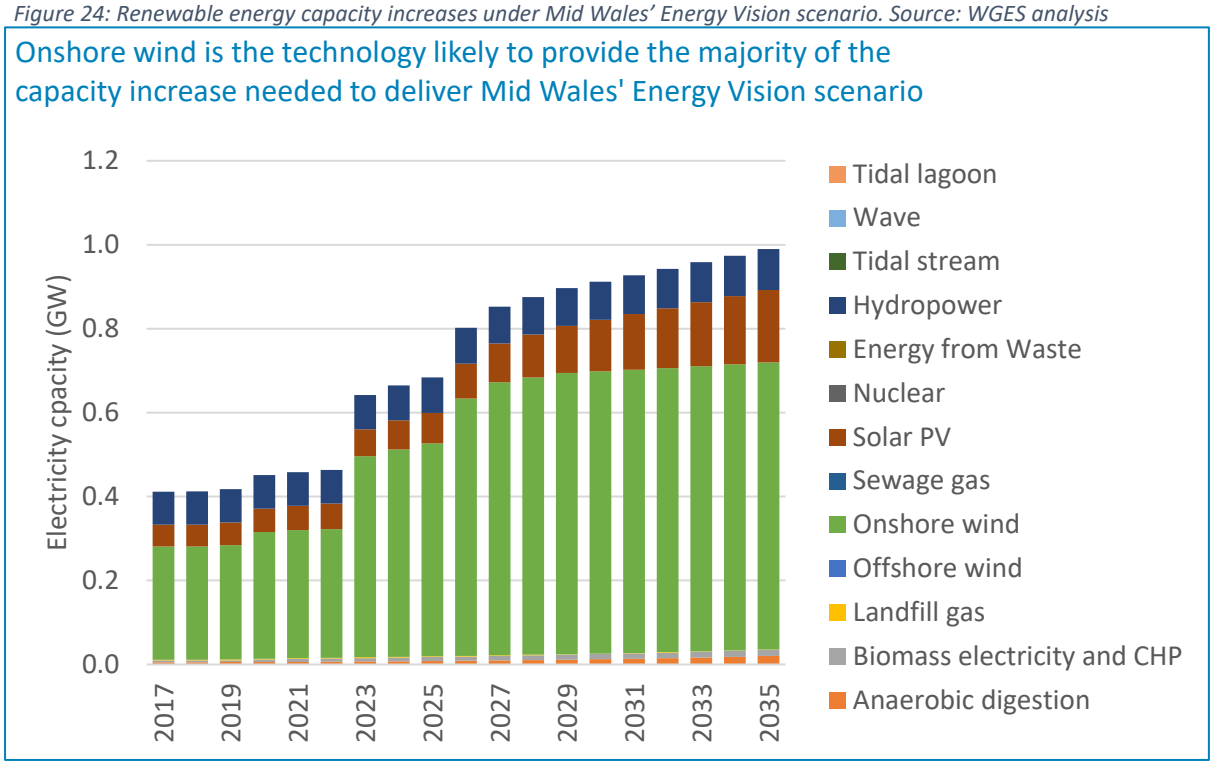


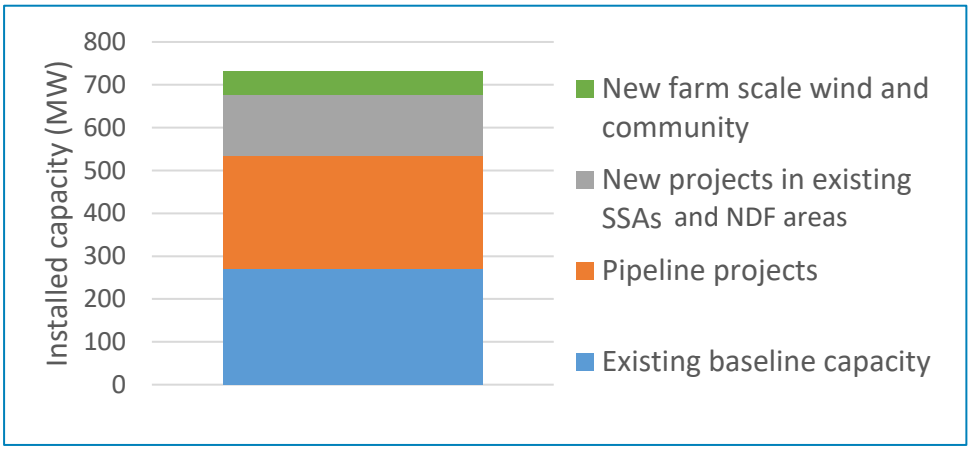
Figure 24: Renewable energy capacity increases under Mid Wales' Energy Vision scenario. Source: WGES analysis



Onshore wind

There is currently 270MW of onshore wind in Mid Wales. The Energy Vision scenario includes a significant increase in onshore wind capacity in the near term as a result of projects currently under development being built out by 2025. This increase also takes into account new projects in the existing Strategic Search Area (SSA), a potential extension to the SSA and an area designated by the proposed National Development Framework. Falling technology costs mean that onshore wind projects in good locations can now be viable without any subsidy, although in Mid Wales connection costs are prohibitive in many areas due to both constraints on the network and longer connection distances.

Figure 25: Mid Wales' Energy Vision scenario for onshore wind. Source: WGES analysis



Solar PV

The Mid Wales topography, access to grid capacity and irradiance levels are less suited to the very large-scale ground mounted solar farms which are becoming more common in other areas of the UK. Current deployment of solar PV is relatively low, with just 52MW installed. Around 30MW of this capacity is roof-mounted and 22MW is ground mounted.

The Energy System Vision includes a threefold increase in the installed capacity of solar PV by 2035. While solar PV projects are generally easier to deploy, solar PV has a lower capacity factor than onshore wind and as a result the required growth in capacity results in a lower impact on local renewable energy generation.

Other renewables, storage and flexibility

The Energy Vision scenario includes some growth in the deployment of anaerobic digestion including biomethane producing sites, biomass electricity/CHP and hydropower. Each of these technologies could have a small but significant impact on local renewable energy generation with associated economic benefits. While onshore wind and solar PV make up the majority of the installed capacity in the Energy System Vision, anaerobic digestion and biomass electricity/CHP each see a fourfold increase in installed capacity between 2020 and 2035. Despite the high growth rate of these technologies, current deployment is low resulting in an increase of 14 MW and 9 MW respectively during this time period. The installed capacity of hydropower increases by 18MW representing a 1.2 fold increase compared with 2020 levels.

Storage and flexibility, such as demand side response provision or the creation of local energy markets, could support the decarbonisation of energy generation in Mid Wales by enabling more renewables to connect to the network in constrained areas and supporting the business case for investing in renewables.

Summary: electricity generation

Table 6. Renewable energy generation energy vision scenario example outcomes

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Renewable generation	Nearly 1 GW of onshore wind and solar PV (1,939 GWhs of electricity generated from onshore wind and solar PV) by 2035	Generating the equivalent of nearly 200% of electricity consumption in 2035	Contribution towards significant reduction in UK grid carbon factor

A note on nuclear

The energy modelling considers that, if small modular reactor technology becomes viable, this technology is most likely to be developed on the site of historic large-scale nuclear reactors in the near term. There are no existing nuclear sites, or any allocated for development, in Mid Wales. As a result, the development of nuclear power was not considered within the scenario to 2035. On a related note, if large scale nuclear sites across the UK currently under consideration/development fail to proceed, there will be increased need for renewable generation. With the right electricity grid infrastructure and economic

incentives, Mid Wales could contribute to an even greater extent to Welsh and UK renewable generation.

A note on offshore wind

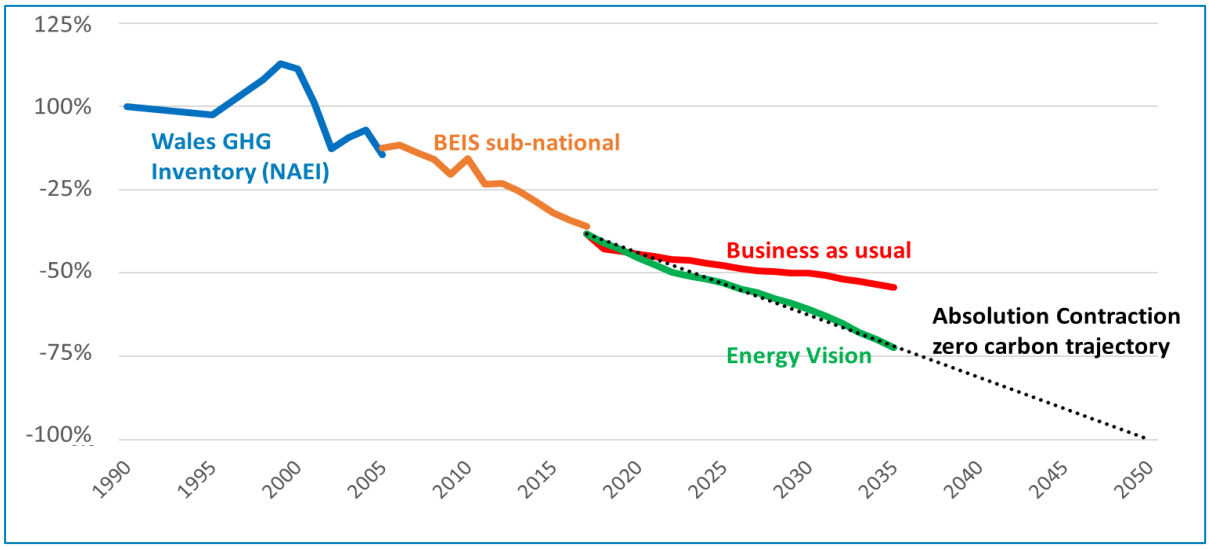
From a wind resource perspective, Cardigan Bay could potentially host offshore wind projects. However, to date no areas in Cardigan Bay have been identified by The Crown Estate for leasing in Round 4 or earlier rounds. Future floating wind and deeper water foundations could open up opportunities for further offshore wind projects in Wales, however, the focus at the moment is the Celtic Sea area off Pembrokeshire.

The Carbon Trust's 2018 report for the Welsh Government on the Future Potential for Offshore Wind in Wales identified more significant barriers to development of offshore wind in Mid Wales compared with other areas of Wales[19]. Constraints identified included environmental impacts, existing leases and military presence, seascape and visual impact, port and transport infrastructure and more significantly lack of access to the transmission network. In the timescales of the strategy, offshore wind is unlikely to be developed in the region. Considerable investment in the region's grid infrastructure would be needed to enable offshore wind to connect[20].

Future progress

Potential Business as Usual and Energy Vision decarbonisation trajectories in Mid Wales

Figure 26: Decarbonisation trajectories in Mid Wales. Source: WGES analysis



Under a Business as Usual scenario, Mid Wales is expected to achieve only 23% decarbonisation by 2035 against a baseline year of 2017, approximately half of the 55% needed to be on track for net zero by 2050. Delivering the Energy System Vision scenario represents a very significant step up from a Business as Usual scenario and will only happen with significant local, regional and national commitment.

[19] Carbon Trust for Welsh Government (2018) The Future Potential for Offshore Wind in Wales
[20] Carbon Trust for Welsh Government (2018) The Future Potential for Offshore Wind in Wales

The scale of the challenge identified through the Energy Vision scenario

The Energy Vision scenario is to 2035 and focuses on known deployable technology and behavioural change. Based on National Grid's 2019 Future Energy Scenarios[21] and the Committee on Climate Change[22], the scenario prioritises "clear, urgent, no regrets" actions. The modelling sets out the following key challenges to be achieved by 2035:

- **Domestic:** how can Mid Wales achieve energy efficiency retrofits of more than 41% of its housing stock and install renewable heat technologies in 28,000 homes?
- **Non-domestic:** how can Mid Wales reduce energy demand from its commercial and industrial organisations by 23%?
- **Transport:** how can Mid Wales ramp up the rate of electric vehicle sales, install around 1,500 public EV chargers and invest in electrified public transport and low carbon HGV fuelling networks?
- **Renewable electricity generation:** how can Mid Wales unlock the grid, planning and business model challenges to enable the installation of nearly 1 GW of new renewable electricity capacity in the region? *A number of steps can be taken: Publicity campaign to shift public opinion to realise the need and benefit of renewable energy in Wales and the Region; lobby BEIS / Ofgem to relax constraints on DNOs and make speculative grid investment possible; seek to fund public ownership of capacity to drive efficient investment in grid; development of an energy innovation zone (EIZ) alongside use of smart grid solutions.*
- **Innovation:** post-2035 and to achieve net zero, further decarbonisation of all aspects of the energy system will be required. In some cases, this further decarbonisation is dependent on innovation and/or overcoming significant challenges. For example, issues such as the role of hydrogen and the role of the gas network will need to be explored.

Post 2035 challenges and innovation

Post-2035 and to achieve net zero, further decarbonisation of all aspects of the energy system will be required. In some cases, this further decarbonisation is dependent on innovation, national policy and/or overcoming significant challenges. The following challenges were raised through the stakeholder survey and workshops

Domestic decarbonisation

- What is the future role of the gas network and transition technologies such as hybrid heat pumps post-2035?

Non-domestic decarbonisation

- Is there a role for hydrogen in industrial clusters and how could it be sustainably manufactured?
- What is the role for Carbon Capture and Storage technologies in supporting the decarbonisation of heavy industry?

[21] National Grid (2019) Future Energy Scenarios
[22] Committee on Climate Change (2019) 2019 Progress Report to Parliament

Transport

- What is the right low carbon transport fuel for use on farms?
- To what extent is hydrogen a potential substitute for electric vehicles in the rural context?

Low carbon generation

- How can the region support the longer-term potential for offshore wind development in Cardigan Bay?
- Is there a role for small modular reactors in Mid Wales in the medium term?

The future of energy and our economy

Economic assessment

Introduction

The changes required to develop a decarbonised future energy system have impacts that reach beyond reducing carbon emissions. Changing the technologies that we use to heat our homes, generate our electricity, and produce our energy will also affect the economic landscape. Examples of these effects include changes in:

- the geographic distribution of jobs as energy becomes less centralised,
- the job intensity required to produce electricity because this is unique to each generation technology,
- how expensive new technologies are to install, construct, and operate, and
- how income and spending circulates around local economies as a result of these changes.

We have built on the scenario modelling described in the previous chapter to try to better understand the impact on net job creation and gross value added. Additionally, we have estimated the level of investment required to achieve the scenarios. The impacts that we consider; job creation, gross value added, and investment required, are just some of the economic impacts related to the energy transition. Other impacts, such as the impact on the cost of supplying energy, and associated prices, are not included in analysis.

Approach

We have used an indicator-based approach to estimate job creation, gross value added, and investment. This involves using literature reviews to identify the most appropriate estimates such as jobs/MW, or GVA/employee. Subsequently, these indicators are applied to the results of the energy modelling and allow us to estimate the economic impact of changes in electricity generation, energy efficiency, and domestic heating. A technical annex that accompanies this report provides additional detail on the calculations and sources used in our analysis.

In practice, this approach has an important limitation in relation to low carbon heating. There is significantly less data available to assess the number of jobs associated with the transition to low carbon heating than electricity generation or energy efficiency. This means that the low carbon heating jobs are not comparable with the electricity generation or energy efficiency jobs. We discuss this in more detail in the low carbon heating section below.

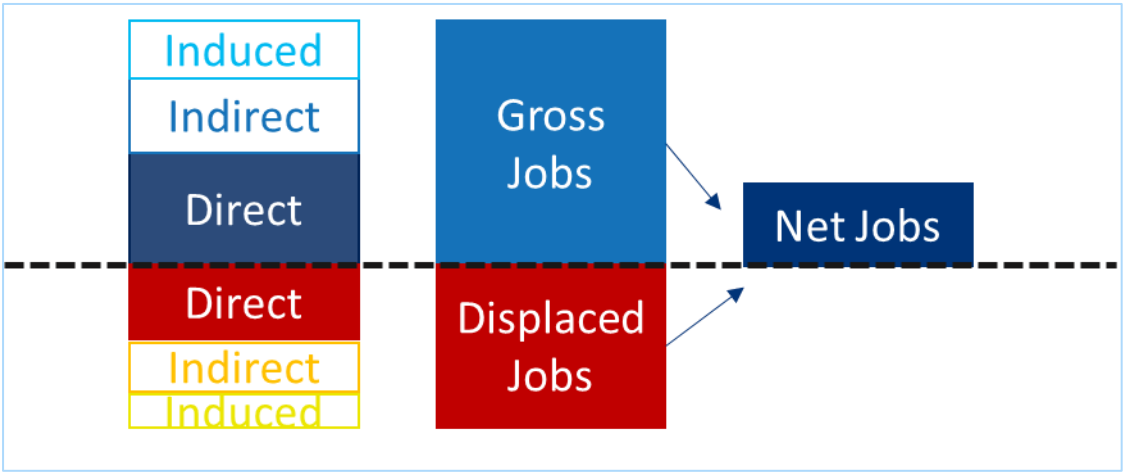
In terms of scope, the economic impact in terms of jobs, GVA and investment has not been calculated in relation to two sectors in the energy modelling: 1) transport and 2) commercial and industrial energy efficiency. The transport sector was excluded because the production and employment benefits associated with EV manufacture will not be strongly influenced by the speed of customer switching to EVs in the same region. It is also frequently assumed that there will be no net change in jobs from the transition to EV manufacturing and assembly. Commercial and industrial energy efficiency has not been assessed because the energy modelling inputs do not allow us to identify energy efficiency impacts from other factors influencing energy demand change, such as the macroeconomic assumptions underpinning the future energy scenarios.

Finally, it is important to provide clarity on the definition of the term “jobs” within the context of this analysis and how this applies to each technology area. Political and media commentary on “jobs” often refers to gross jobs, which are the direct jobs related to a specific project or intervention. In examining the economic impact of the energy transition the accepted standard is to calculate net

jobs – this considers the net impact of the job gains alongside the job losses associated with transitioning from one technology to another. Where data sources have made this possible, we have sought to present jobs estimates in net terms, in line with this best practice. We also define jobs in terms of Full Time Equivalents (FTE) wherever data allows.

Additionally, there is a difference between direct, indirect and induced jobs. In an energy context, direct jobs are typically associated with the manufacture, construction and installation of equipment. Indirect jobs arise in the supply chain of the energy technology. Induced jobs related to jobs generated as a result of spending incomes earned from direct employment. Figure 27 below visualises these concepts.

Figure 27. Shows the relationship between gross, displaced, and net jobs. Indirect direct and induced jobs are also shown. Indirect and induced jobs have not been filled with colour because these jobs are not taken into account in this analysis. [23]



Throughout this analysis we only calculate direct jobs as, depending on the area of decarbonisation, these are more likely to be local jobs than indirect or induced jobs. However, the analysis does not allow us to comment on the exact location of the job estimates. Some jobs are likely to be held by residents of Mid Wales; other jobs may be held by those who travel into the region to perform their roles.

Electricity generation

The results from assessing the economic impact related to the change in electricity generation technologies show that achieving the energy system vision scenario will require approximately £200 million of additional spending/investment over the period 2020 to 2035, equivalent to approximately £13 million per year, compared against the business as usual scenario. This spending/investment will be made by a wide range of parties included businesses (and their investors), households as well as local and national government. The energy system vision scenario will also create an estimated 2,200 additional jobs and contribute £250 million more in GVA than the business as usual scenario. These jobs may be held by persons inside or outside of Mid Wales, with the experience of Wales to date being that many electricity generation jobs are held by persons resident outside of the region. In order help Mid Wales benefit from jobs associated with future local electricity generation it will be important to fist understand the reasons for the lack of local jobs and then to develop a policy response.

[23] Adapted from UKERC. 2014. Low carbon jobs: The evidence from net job creation from policy support for energy efficiency and renewable energy.

Table 7 summarises the estimated economic impact of the business as usual and the energy system vision scenarios. The figures shown in the table represent the total value from all years from 2020 through to 2035. Similarly, Table 8 summarises the additional investment, jobs, and GVA associated with the Energy System Vision (ESV) scenario.

Table 7. BAU and ESV economic impact2020- 2035[24]

Scenario	Gross Direct Jobs	Discounted GVA	Discounted Investment
Business as usual (BAU)	13,600	£1.7b	£555m
Energy system vision (ESV)	15,900	£1.9b	£760m
**Gross direct job figures have been calculated based on UK or international direct job intensity indicators per technology. These full-time equivalent indicators include both short term (construction) and long term (operations and maintenance) jobs. However, short term jobs are weighted against the lifetime of the plant. A significant proportion of direct electricity generation could be taken by local residents. However, to date this has not been the experience of Wales. If business as usual policies continue, it may be that a potentially significant number of these jobs will be held by persons resident outside of the region.* **All figures are rounded.			

Table 8. Difference between the ESV and BAU scenarios 2020-2035[25]

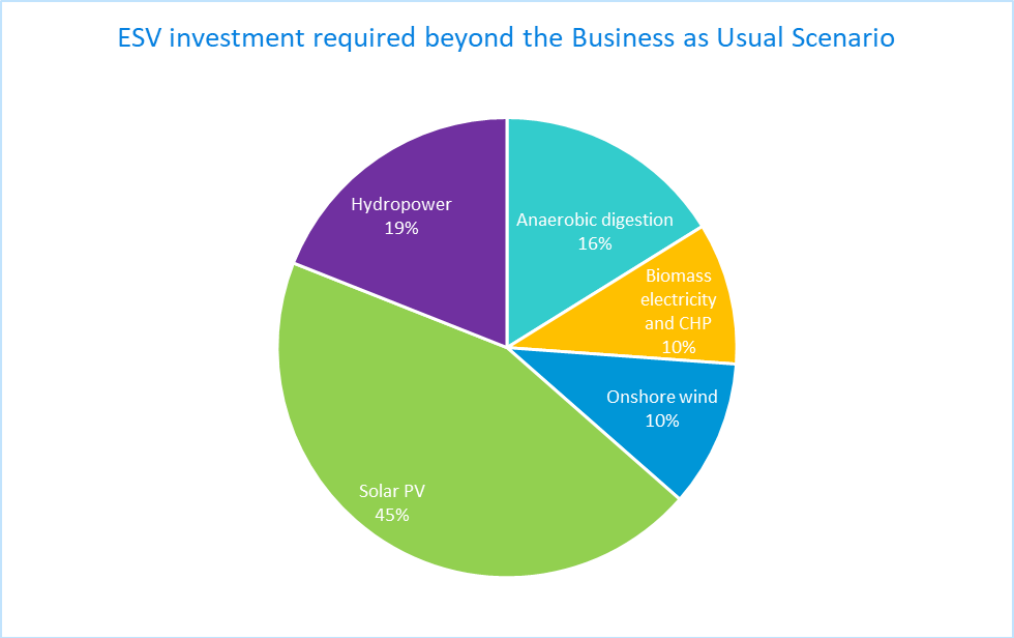
Scenario	Net Jobs	Discounted GVA	Discounted Investment
Difference between ESV and BAU	2,240	£ 255m	£205m
Difference between ESV and BAU (percentage)	+16%	+15%	+37%

Investment

The energy system vision scenario requires £205m of additional investment in new electricity generation. Figure 28 below shows the breakdown of this investment by technology. Solar PV requires the most additional investment at 45% of the £205m. This is followed by hydropower and anerobic digestion. Onshore wind and biomass electricity and CHP are estimated to require 10% of the total investment each.

[24] A discount rate of 3.5% is applied to calculate investment and GVA over the 2020 – 2035 time period.
[25] A discount rate of 3.5% is applied to calculate investment and GVA over the 2020 – 2035 time period.

Figure 28. ESV investment required beyond the business as usual scenario.



Jobs

The jobs figures presented include both the jobs associated with increases in capacity and output from some generation technologies (for example offshore wind) as well as jobs lost as the capacity and output from fossil-fuel based generation technologies falls. The jobs calculated are direct jobs which means that they relate to the manufacturing, construction, operation, and maintenance of the plant and equipment. A significant proportion of these jobs could be taken by residents that are local to energy generation sites, whereas indirect or induced jobs are expected to be more geographically diffuse. However, the experience of Mid Wales to date is that many renewable jobs are held by those living outside the region who commute to the region to undertake these jobs. The breakdown of jobs required in the energy system vision scenario is visualised on an annual basis in Figure 29 below.

It is estimated that in the energy system vision scenario electricity generation is responsible for just under 16,000 direct gross FTE jobs from 2020 to 2035.

Figure 29. ESV net jobs

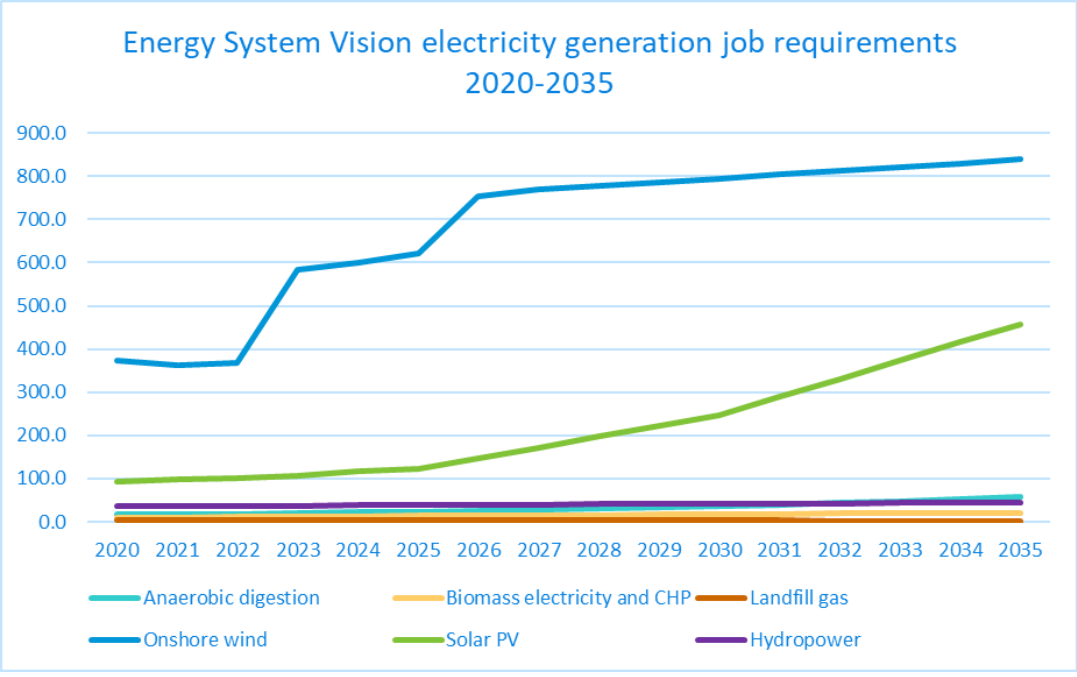


Figure 30. Additional Job distribution in the ESV scenario compared with the BAU scenario

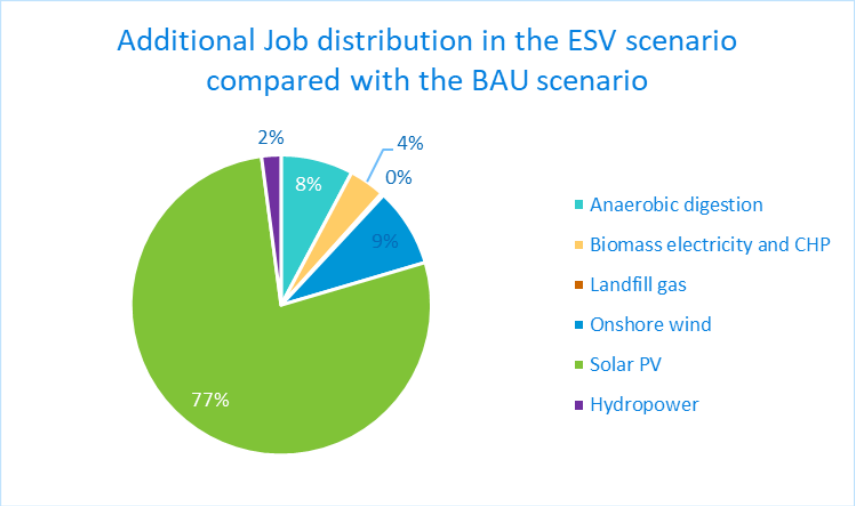


Figure 30 looks at which technologies in the energy vision scenario support additional jobs in comparison with the business as usual scenario. The difference between the two scenarios represents the net additional jobs supported by the energy system vision in comparison with the business as usual. Solar PV accounts for the largest difference in jobs between the two scenarios, followed by onshore wind and anaerobic digestion.

Domestic energy efficiency

As with electricity generation, the increases in domestic energy efficiency associated with the Energy System Vision scenario relative to the BAU scenario require more investment, support more jobs, and lead to an enhanced contribution to GVA. This reflects that the energy system vision sees a more dramatic shift in the number of homes achieving higher EPC ratings and the larger number of energy efficiency improvements needed to achieve this outcome. These figures are presented in Table 9.

Table 9 shows that the energy system vision requires approximately 1.6 times the investment and jobs compared with the business as usual scenario. Additionally, it supports approximately 1.6 times the GVA associated with the business as usual scenario.

Table 9.. Domestic Energy Efficiency additional economic impact of the ESV scenario compared with the BAU scneario from 2020 -2035[26]

Scenario	Net jobs	Discounted GVA	Discounted Investment
Business as usual (BAU)	4,600	£277m	£976m
Energy system vision (ESV)	7,600	£450m	£1.6b
Difference between ESV and BAU	3,000	£174m	£612m
Difference between ESV and BAU (percentage)	+65%	+62%	+64%
* Figures are rounded.			

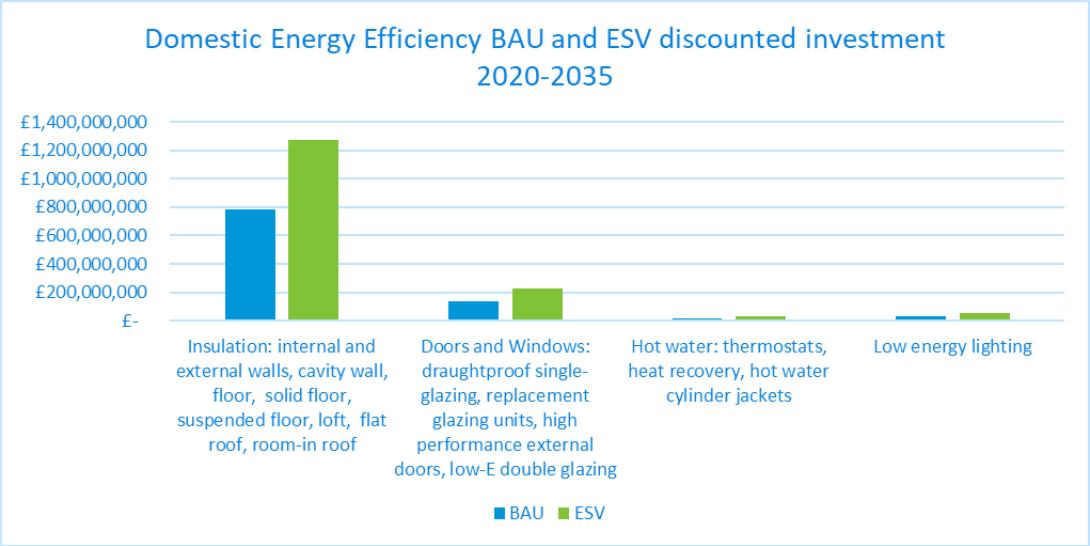
[26] A 3.5% discount rate was applied to calculate the GVA and Investment over the 2020 – 2035 time period.

** Net jobs figures do not include estimations of operation and maintenance jobs associated with the energy efficiency improvements.

Investment

The majority of investment required to install the energy efficiency measures described by the BAU and ESV scenarios is related to insulation measures. The investment requirements can be seen in Figure 31.

Figure 31. BAU and energy efficiency Investment requirements 2020- 2035

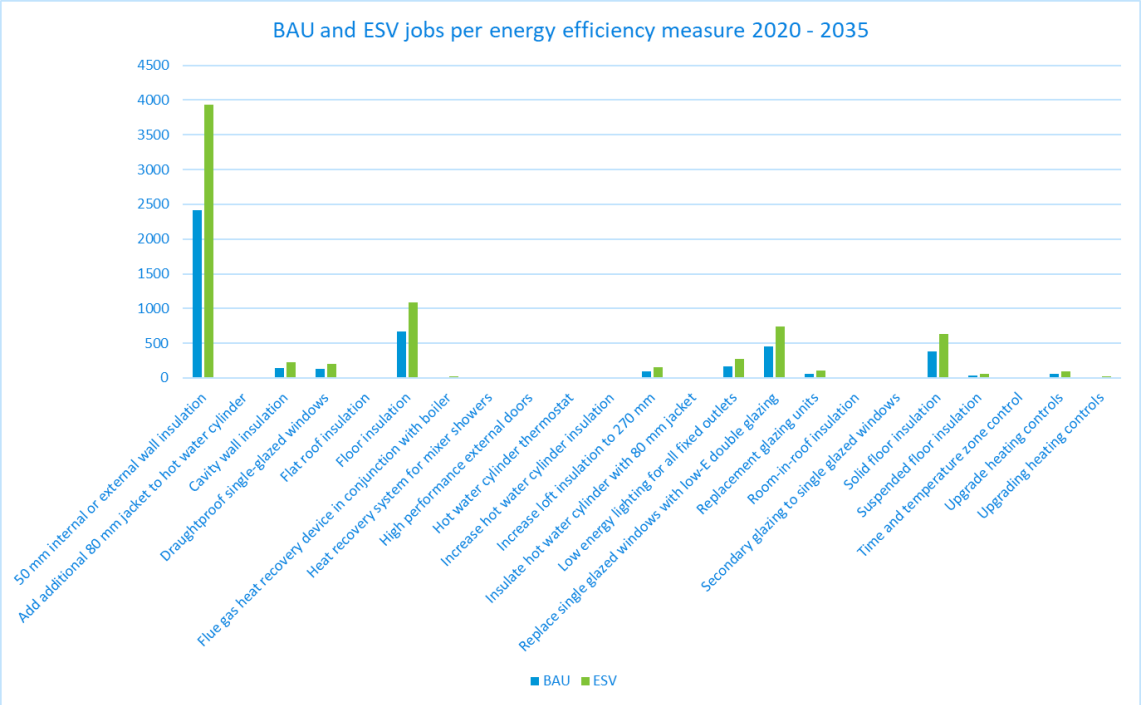


Jobs

3,000 additional net jobs are related to the energy system vision scenario in comparison with the business as usual scenario between 2020 and 2035. These are net direct jobs and take account of the fact that energy efficiency requires additional jobs to deliver and install the relevant technologies, but could also reduce jobs associated with the reduced need for energy production and supply. Like electricity generation, some energy efficiency jobs may be held by those residing in the region and other jobs may be held by people who travel into the region to perform these jobs.

The majority (52%) of the additional jobs in the ESV scenario relate to installation of 50 mm internal or external wall insulation, 14% of jobs relating to floor insulation and 10% of jobs relate to the replacement of single glazed windows with low-E double glazing. Figure 32 below show the estimated jobs required to implement the energy efficiency measures that relate to the EPC shift in the BAU and ESV scenarios.

Figure 32.Net BAU and ESV jobs per energy efficiency measure 2020 – 2035.



Domestic heat

The more intensive switch to low carbon heating in the energy system vision scenario requires additional investment, which increases the GVA associated with these activities. The GVA associated with hearing technologies is 302% greater than in the business as usual scenario while the energy system vision scenario requires over triple the level of investment compared with the business as usual scenario. The ESV scenario also requires more jobs related to low carbon heating. However, a lack of data on jobs associated with traditional heating technologies means a comprehensive comparison in the jobs impacts from the switch to low-carbon heating technologies is not possible. Table 10 below summarises the economic impact of both scenarios and also shows the difference between the scenarios. A comparison of the investment required in the BAU scenario and the ESV scenario is presented in Figure 33.

Table 10. BAU and ESV economic impact as well the difference between ESV and BAU economic impact 2020- 2035[27]

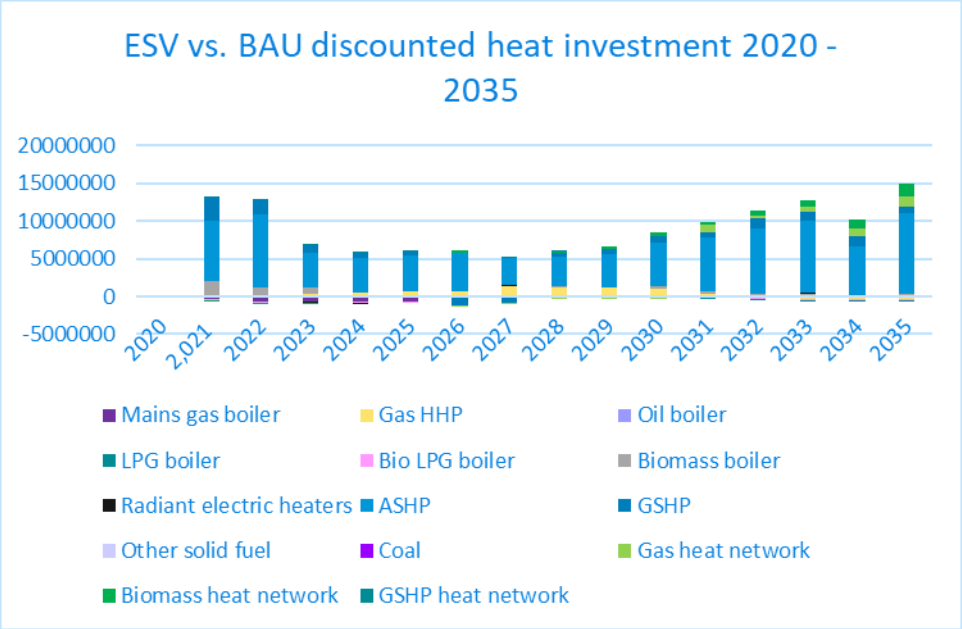
Scenario	Gross jobs associated with low carbon heating	Discounted GVA associated with all heating technologies	Discounted Investment associated with all heating technologies
Business as usual (BAU)	220	£ 24m	£ 60m
Energy system vision (ESV)	760	£ 96m	£ 187m
Difference between ESV and BAU	537	£72m	£ 127m
Difference between ESV and BAU (percentage)	+243%	+302%	+213%
*All figures are rounded.			

[27] A 3.5% rate is applied to GVA and investment to calculate these figures over the 2020-2035 time period.

Investment

Figure 33 shows that the shift to low carbon heating in the ESV scenario happens faster and to a greater scale than in the BAU scenario. For example, between 2020 and 2035, the ESV sees approximately £8 million of additional investment per year in heat pumps and hybrid heat pumps, biomass boilers and radiant electric heaters compared with the business as usual scenario. At the same time, the ESV requires approximately £212,000 less investment per year in gas boilers during this period compared with the business as usual.

Figure 33. ESV vs. BAU discounted heat investment 2020 – 2035. Discounted at a rate of 3.5%.



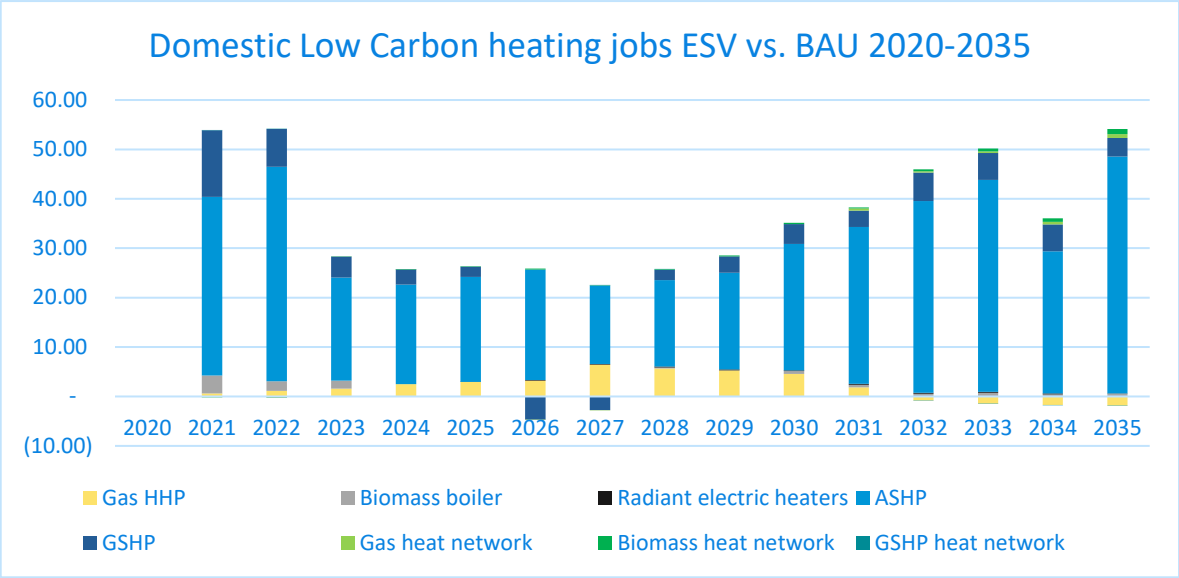
Jobs

The job figures calculated for domestic heat differ from those calculated for electricity generation. Fewer studies quantify the jobs related to the installation of heating technologies than for electricity generation technologies. Given the paucity of studies, we use a jobs/£m turnover for non-heat network technologies, like heat pumps and biomass boilers but have to rely on permanent jobs/annual GWh of heat generated for heat networks.

Moreover, due to a lack of available high-quality data, our estimate of jobs related to heating technologies only relates to low carbon heating and does not include changes in jobs associated with the installation of more traditional heating technologies such as gas boilers.

Figure 34 below shows the difference in low carbon heating jobs between the ESV scenario and the BAU scenario. Like with electricity generation and energy efficiency, some of the jobs presented may be held by residents of Mid Wales while other jobs may be held by those residing outside of the region.

Figure 34. Domestic Low Carbon heating jobs ESV vs. BAU 2020-2035



Summary

Across all technologies, the higher level of effort related to decarbonisation and the energy transition in the energy system vision scenario requires more investment/spending when compared against the business as usual scenario. The economic analysis demonstrates that almost £1 billion of additional investment/spending is needed to achieve the energy efficiency, electricity generation, and heat aspirations described in the energy vision between now and 2035. This represents approximately £66 million per year and will need to be financed from a range of sources including the private sector, households, and national and local government.

In terms of jobs, the ESV scenario is estimated to require an additional 5,200 net jobs to deliver the accelerated deployment of renewable electricity generation technologies and the enhanced levels of energy efficiency. These additional jobs are associated with around £430m more GVA (discounted at 3.5% over the period 2020-2035). In addition, it is estimated that there will be over 530 more gross jobs associated with the provision of low-carbon heating technologies in the ESV scenario than the BAU scenario, associated with £72m of GVA.

Next steps

Next steps

The Mid Wales Energy Strategy has undertaken several important first steps towards addressing the climate emergency in Mid Wales. This work sits along other important work that is being done throughout the region and highlights the importance of local energy planning. While creating this strategy, we have developed a collaborative vision for the future energy system in Mid Wales and defined key priority areas that are essential to achieving that vision. The assessment of current energy sector emissions, has enabled a deeper understanding of the progress that has been made in decarbonisation to date as well as the gap between our current activities and a net zero energy system.

Building on this, the energy modelling demonstrates a potential pathway to 2035, that is consistent with the long term aim of achieving net zero by 2050. This is coupled with an assessment of the economic benefits associated with transforming our energy system in alignment with this trajectory. This will be critical in communicating the benefits of action and demonstrating the potential for far greater local economic benefits than could be by return to business as usual, particularly in the context of a green, economic recovery from the COVID-19 pandemic.

There are three crucial next steps that we will now take to transition from a strategy to real world action in the delivery of our Mid Wales energy system vision:

1) **Defining the strategy governance.** We will establish a robust and formal governance structure for the Mid Wales Energy Strategy. This will include defining a structure of cross-sectoral governance, powers, roles and responsibilities for overseeing the implementation of the strategy, and the monitoring and evaluation of its progress. This is essential to coordinate and unlock action, and to ensure momentum going forwards.
2) **Communicating and socialising the strategy.** We will undertake a series of engagement activities to communicate, socialise and build support for the final strategy amongst key political, corporate and community stakeholders throughout Mid Wales. This activity will help to align a diverse stakeholder group to the Mid Wales energy vision and raise awareness of insights arising from the analysis and engagement undertaken as part of the strategy development.
3) **Establishing a delivery plan.** We will create a delivery plan for addressing the challenges identified in the energy modelling work, and for defining the processes and actions that could be taken forward to realise the energy system vision. We anticipate that the delivery plan will be a living document that is regularly reviewed and updated, and may be influenced by future local area energy planning or other relevant developments and research.

The energy modelling presented has shown that significant action is required for Mid Wales to be on track for a net zero future and that we have the tools and technologies to make progress now. The economic assessment confirms that the challenge is large and will require investment from households, businesses, investors, and the public sector. This challenge is matched with a highly ambitious vision that reflects the spirit and values demonstrated by stakeholders throughout the development of this strategy.

The economic assessment also illustrates that the energy system transition may bring benefits to Mid Wales in the form of jobs, however additional investigation is required to maximise these benefits. Likewise, the energy vision clearly sets out the intention that the future energy system should support the wellbeing of communities wherever possible. These next steps will help to scale

up the existing decarbonisation and energy transition efforts in the region and turn the vision into action.