North Wales Energy Strategy

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Contents

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Executive Summary

Executive summary

The North Wales Economic Ambition Board welcomed support from Welsh Government to develop a regional energy strategy. As such, the Welsh Government Energy Service drafted this strategy with support and input from the NWEAB, Welsh Government, and regional stakeholders.

The overall objective of this strategy is to develop a strategic pathway identifying key interventions to deliver on the region's ambitions for decarbonising its energy system and ensure the region benefits from the transition. An Energy Vision scenario has been modelled to set out a potential decarbonisation route that will put the region on track to achieve a net zero energy system by 2050.

Our vision for North Wales is:

Delivering maximum local economic, social, ecological and wellbeing benefits from transitioning to a net zero economy and becoming a net exporter of low carbon electricity through cross-border and regional cooperation.

Our priorities for achieving this vision are:

1. To harness the abundance of local low carbon resource to become a green powerhouse and diversify the energy mix
2. To become a world-leader in offshore wind and marine technologies
3. To improve the energy efficiency of the region's housing and accelerate the decarbonisation of North Wales' building stock
4. To achieve a shift to lower carbon transport

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

- North Wales currently consumes just under a quarter of all energy consumed in Wales, slightly higher than its 22% share of the population;
- Between 2005 and 2017, total energy consumption fell by ~5%, The associated greenhouse gas emissions have fallen by ~28% from 2005 to 2017;
- At 39%, commercial and industrial consumption represents the largest proportion of the region's energy use by sector, compared with 30% domestic and 30% transport;

- Commercial and industrial electricity consumption constitutes 71% of all electricity consumption in the region, nearly 10% higher than the Great Britain average;
- North Wales currently generates the equivalent of 82% of its electricity consumption from renewable sources located in the region;
- North Wales currently hosts over a third of Wales' renewable energy capacity, with 726MW of offshore wind, 98MW of onshore wind and 224MW of solar PV;
- Of the 1,183MW of renewable energy installed capacity in the region, 95MW (8%) is locally owned;
- North Wales has the second highest deployment of renewable heat installations in Wales. However, just 0.7% of homes have a heat pump or biomass boiler.
- The average EPC rating is D and 36% of homes are rated as EPC band E, F or G and there is an above average proportion of homes off the gas grid;
- 25,000 homes, 8% of all homes in the region, are currently heated by oil, LPG, coal or other solid fuels
- Transport in the region is dominated by private car use with ~0.1% of cars being pure electric, compared with an average of 0.6% of vehicles across Great Britain.

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 North Wales: to meet Welsh Government targets, and to be on track for net zero by 2050, North Wales needs to reduce emissions from its energy system by 55% by 2035, split by sector in the pathway modelled as follows:

- 57% reduction in domestic heat and power emissions;
- 54% reduction in commercial and industrial emissions;
- 55% reduction in road transport emissions.

Figure 1: Summary of the Energy Vision's emission reductions by sector. Source: WGES analysis

The energy vision scenario modelling assumes a significant shift away from business as usual across these three sectors by 2035. The assumptions of the modelled future vision include:

Domestic:

- 35% of all homes improved from EPC band G, F and E to D, C and B;
- 65,500 heat pumps installed;
- 30,000 houses fitted with internal or external wall insulation;
- 67,000 homes currently heated by fossil fuels to move to low carbon heating;
- No new gas connections for homes from 2025.

Commercial and industrial:

- A significant energy efficiency programme to reduce energy demand by 16%;
- A switch to alternative fuels, including hydrogen (from about 2032) and electrification of heating;
- Decarbonising the electricity network through renewables and behind the meter renewable generation.

Road transport:

- 55% of vehicles driven in North Wales in 2035 are electric, equivalent to 7,000 more electric vehicles per year by the mid-2020s, peaking at 40,000 per year in the 2030s. This is to be facilitated by the deployment of 2,000 public EV chargers;
- 2,600 gas HGVs and 1,000 hydrogen vehicles;
- A 15% reduction in private vehicle mileage by 2035;
- A slowing of the growth in total number of vehicles on the road, facilitated by increased use of public transport and active travel.

Renewable electricity generation:

- Over 2.8GW of offshore wind installed;
- 1GW tidal lagoon installed;
- 300MW of small scale modular nuclear reactors installed;
- 180MW of tidal stream installed;
- 310MW of onshore wind installed.

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 known 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 known and 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 system 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 approximately £11 billion of additional investment is needed to achieve the energy efficiency, electricity generation, and heat aspirations described in the energy vision between now and 2035. This represents approximately £732 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 250% more than is expected to be spent in the corresponding sectors under a business as usual scenario.

The energy system vision (ESV) scenario is estimated to result in an additional 24,400 net jobs, with an associated increase in GVA of nearly £2.4 billion, 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 1,200 more gross jobs associated with the provision of low-carbon heating technologies in the ESV scenario than the BAU scenario, associated with £192 million 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. 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 North 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 North Wales benefit from jobs associated with future 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 for details on data sources and limitations.

Table 0. 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*	17,700 (net) **(+38%)**	£1.9b **(+34%)**	£ 9.3b **(+824%)**
Domestic heat	1,200 (gross) **(+188%)**	£192m **(+298%)**	£301m **(+187%)**
Domestic energy efficiency***	6,600 (net) **(+45%)**	£397m **(+45%)**	£1.4b **(+45%)**
Total additional investment required to achieve the energy vision scenario			**£11b**

** Electricity generation jobs figures were calculated using direct job intensity indicators. Direct jobs are typically more likely to be held by residents local to an energy site. However, jobs related to manufacturing may be located outside of the region. Likewise, some jobs may be held by persons residing outside of the region who travel into the region to undertake these jobs. As such, it is not possible to comment on the geographic location of these jobs. The perceived experience of Wales to date is that many of the long term operational and maintenance jobs associated with these technologies are held my persons outside of the region who travel into Wales to perform their duties. In order help the region benefit from jobs associated with future 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.*

***Impact on jobs is presented as either net or gross jobs depending on the available data.*

****Data on the percentage change in jobs and GVA for domestic energy efficiency is unavailable.*

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 North 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 North 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 an action 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
BEIS	The Department for Business, Energy, and Industrial Strategy
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
EV	Electric Vehicle
GSHP	Ground Source Heat Pump
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 and Background

Regional energy strategy overview

The North Wales Economic Ambition Board welcomed support from Welsh Government to develop a regional energy strategy. As such, the Welsh Government Energy Service drafted this strategy with support and input from the NWEAB, Welsh Government, and a number of regional partners and stakeholders[1].

The Welsh Government Energy Service (WGES) supports the public sector and communities to generate benefit for Wales from the transition to a low carbon economy. Support is provided to develop and implement large scale energy efficiency and renewable energy projects as well as wider advice to achieve targets for decarbonisation.

The Welsh Government declared a climate emergency in 2019 and set a target to reduce 95% of greenhouse gas emissions by 2050 relative to 1990. Achieving this target will require substantial transformation of our energy system and will result in radical changes in the technologies we use to heat our homes, to travel and to generate electricity. Transitioning to a modern, decarbonised energy system fit for the twenty-first century poses plenty of challenges, but it also has the potential to bring great benefit, both for the environment and for the 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 North 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 reflection on past experience and would also benefit from an increased strategic focus.

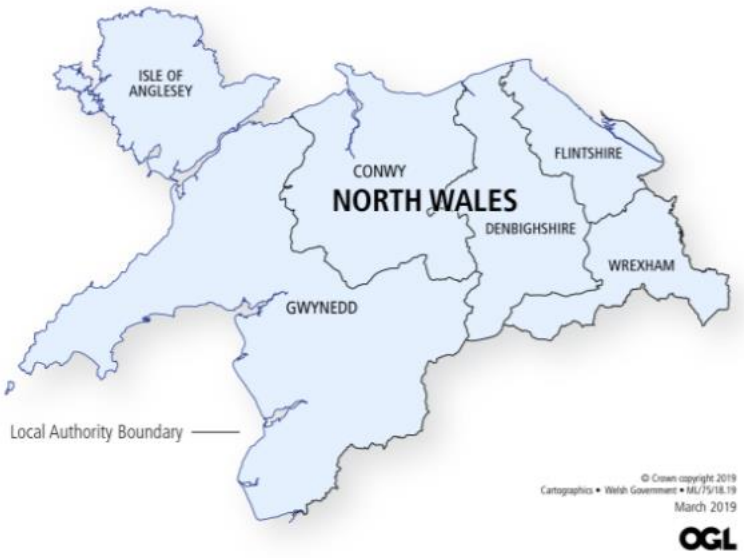


Figure 2: Map of North Wales' local authority boundaries (Source: OGL, March 2019)

[1] See full list in Appendix.

In this work, North Wales is defined as the geographic area which comprises the local authorities of Isle of Anglesey, Gwynedd, Conwy, Denbighshire, Flintshire and Wrexham as the map above illustrates.

The work has coincided with the agreement of the North Wales Growth Deal. In addition to other projects and initiatives, the Growth Deal's 'Low Carbon Energy Programme' will assist in delivering some of the actions outlined in this strategy and aims to unlock the economic benefits of low carbon energy projects and position North Wales as a leading UK location for low carbon energy generation, innovation and supply chain investment. Desired outcomes for the work include the identification of strategic projects that could be considered by the growth deal. More broadly, the plan provides a considered approach and an evidence base for North Wales, as a geographic and to move forward collaboratively towards a future decarbonised energy system. 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 North 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 North 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 North Wales energy system vision into reality.

Governance

Effective governance will be critical to take this strategy forward into implementation. There is still a long way to go to deliver results and bring projects to implementation and we need to consider how best to achieve this; from improving the evidence base, to assisting consenting relating to reinforcing the grid infrastructure as well as encouraging the UK Govt to provide adequate funding support and routes to market for emerging technologies etc.

Achieving the decarbonisation of the energy system will require collective action across government, the public, private sector and third sectors, and ongoing governance should reflect cross-sector participation and responsibility for action.

The next step for region, with support from the WGES team, will be to work with stakeholders to define the governance structure, establish how to turn the strategy into action, and identify the role of the region, the Welsh Government and stakeholders from across the public, private and third sectors. This will include areas where collaboration across government and key sectors is vital to the achievement of the vision.

The North Wales Economic Ambition Board (NWEAB) may be the most appropriate body to provide overall strategic direction and governance to the development and implementation of the regional energy strategy. The NWEAB directs, oversees and facilitates the delivery of the growth vision for North Wales and is comprised of the six local authorities in North Wales and representatives from the region's Higher Education and Further Education institutions.

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 North 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 North 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

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

underpinned by these cross-cutting principles to help put North 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.

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 social distancing and lockdown measures, and the process and timeframe through which the restrictions will be eased. We must therefore acknowledge the significant uncertainties that exist around how the North 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, North 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 North 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

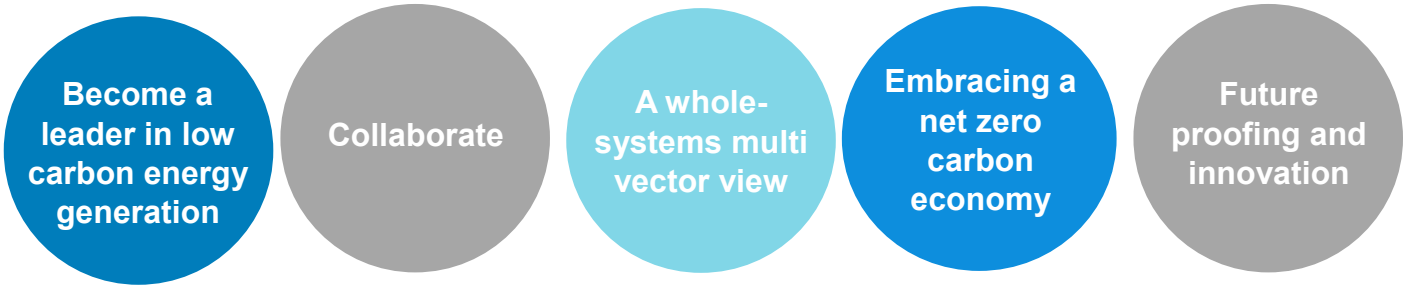
Our Energy Vision

Our 2035 Energy Vision statement

Delivering maximum local economic, social, ecological and wellbeing benefits from transitioning to a net zero economy and becoming a net exporter of low carbon electricity through cross-border and regional cooperation.

The principles behind the vision

Our vision is guided by five core principles



Core Principles

- **Become a leader in multi-scale low carbon energy generation from small community projects through to large developments** including nuclear, offshore generation, and other renewables capitalising on natural and local resources. This strategy should also rely on the existing infrastructure to accelerate Wales' ambition to increase local ownership of energy generation, making use of smart grid technologies to optimise the grid, and ultimately exporting low carbon electricity to other areas.

- **Collaboration** - Developing cross-sectorial and cross-regional collaboration - using existing working structures such as the Mersey Dee Alliance, the Cheshire Energy Hub, Bangor University, the North West Nuclear Arc and facilitating collaboration between public, private and third sectors for scaling up projects. The Anglesey Energy Island Programme could be used as a role model in the region for cross-sector collaboration across public and private sectors.

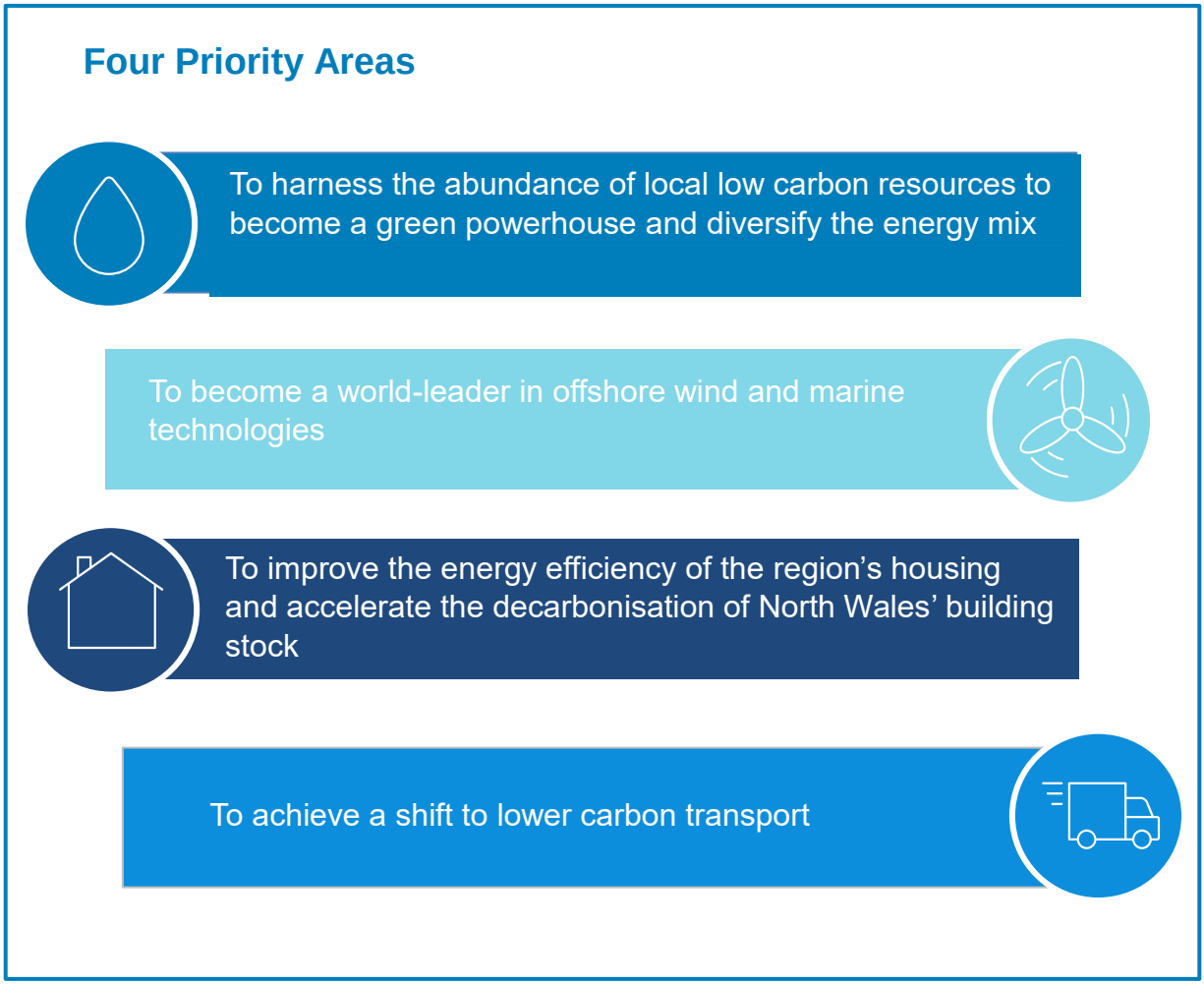
- **A whole-systems multi vector view** – which broadens the focus from solely electricity, power generation and energy efficiency to include heat and transport. An integrated approach that accounts for the interactions between all elements of the energy system and new technologies to maximise synergies and reduce the overall energy consumption level.

- **Embracing a net zero carbon economy** – whilst it is key to harness the opportunities to unlock cleantech growth and skilled job creation across the low carbon economy, decarbonising North Wales' existing strong economic sectors is as important. Enabling green growth in sectors that are key for the region such as manufacturing and exports can improve the attractiveness of these sectors and ensure they are competitive in the long run.

- **Developing future proofed and innovative solutions:** 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. Further develop energy R&D activity through local universities and research centres to become a Centre of Excellence for Low Carbon Energy.

Our priorities

To achieve our vision, we have defined the following four priority areas.



To harness the abundance of local low carbon resources to become a green powerhouse and diversify the energy mix

- Capitalise on North Wales's natural resources, maximising locally generated low carbon electricity to reduce fuel poverty and help local businesses to be more competitive, whilst allowing the surpluses to be exported to produce value for the region. This will contribute to the well-being goals of a prosperous, healthier and globally responsible Wales.
- Whilst capitalising on offshore wind (see next priority area), continue the deployment of land-based renewables such as onshore wind, hydro-electric, solar PV and hydrogen.
- Promote a smarter and local approach, building on local energy and sectoral strengths and opportunities, such as offshore wind and solar, to meet local needs.
- Explore community-led models such as the Ynni Ogwen Cyf hydro project in Bethesda and de-risk investment examining untapped opportunities and alternative stakeholders such as pension funds.
- Explore routes and identify incentives to safeguard local benefits of energy projects, setting up community-owned energy cooperatives, private wire Power Purchase Agreements, and developing local supply chains for the manufacture and support of low carbon energy projects which will contribute to the well-being goal of a Wales of cohesive communities.
- Build on the existing manufacturing base to grow a strong low-carbon energy sector encouraging collaborative work with particular sectors to improve the region's productivity and accelerate economic growth.
- Build on the Smart Living Initiative to encourage more trials in innovative solutions in Demand Side Response, storage, and publicly owned assets as well as explore opportunities for including bio-methane for energy provision.
- Support the restart of the Wylfa Newydd project that has the potential to generate 2.7GW of electricity on Anglesey as well as pursuing the development and deployment of small modular or advanced modular reactors at Trawsfynydd.
- Explore the role of CCS as a route to decarbonise power generation and potential to balance intermittency from renewables.

To become a world-leader in offshore wind and marine technologies

- Harness the existing efforts of Marine Energy Wales and encourage development of tidal zones and projects, such as Morlais and Minesto to help put North Wales at the forefront of the development of the marine energy sector at a global scale.
- Explore possibilities of increasing the viability of tidal stream projects with the integration of battery storage.
- Develop local energy networks / microgrids where grid capacity or connection costs are a barrier to project development (e.g. locations such as the western Llyn peninsula).
- Identify the tidal supply chain gaps with the aim of building local skills to deliver a local supply chain making use of existing marine expertise and relevant offshore wind skillsets.
- Support the extension of exiting offshore wind farms and the development of new offshore wind in future leasing rounds in the region.
- Support supply chain opportunities, in particular in operations and maintenance, building on the capabilities that exist from servicing offshore wind farms in the Irish Sea Site extensions.
- Explore how excess generation can be used to produce alternative energy types such as hydrogen through electrolysis and further support the synergies across the border with Merseyside to develop a North Wales-Merseyside Hydrogen Cluster.
- Identify the potential for energy synergies between offshore wind and the wider maritime sector recognising the role of ports in a low carbon offshore/maritime ecosystem.

To improve the energy efficiency of the region's housing and accelerate the decarbonisation of North Wales' building stock

- Improve the condition of the North Wales housing stock targeting older homes, and those with low level of energy efficiency to help tackle fuel poverty.
- Promote all forms of energy efficiency and renewable energy, and capitalise on the pilot mind-set of the region, such as the region's experimental approach to marine heat pumps, regarding how modern and cleaner technology can heat old houses.

- Proactively reinforce the distribution grid network to deliver decarbonisation and help homeowners to become prosumers.
- Prioritise off-gas properties by exploring the potential for different low carbon heating solutions in these homes, the innovation required to make them work better in local housing stock, and how to overcome technical, financial, and behavioural barriers to their installation.
- Facilitate behavioural change by improving education around domestic low carbon heating technologies.
- Build on existing local successes such as Arbed and other property improvement programmes and further encourage their deployment.
- Deliver energy efficiency retrofit such as external and internal wall insulation and window glazing to homes across the region particularly to improve living conditions of low-income households and reduce fuel poverty.
- Engage with Planning Authorities to support the adaption of Merton-style renewable energy requirements in all new developments and specify housing requirements for all future social housing to be developed to Passivhaus standards
- Ensure consistency between the Welsh Government National Development Framework (NDF) and the local planning policies to set the direction of travel on where investment, including major regional investment such as the Growth Deal, will take place.
- Maximise housing energy efficiency and integrating low carbon heating measures into homes. This will contribute to the well-being goals of a prosperous and globally responsible Wales.

To achieve a shift to lower carbon transport

- Encourage an ambitious shift to public transport, while accepting the rurality of North Wales will lead to continued relatively high use of cars.
- Support the roll out of electric vehicles (EVs) with future-proof charging/refuelling infrastructure, making sure that EVs are a viable option for remote communities.
- Ensure the effective low carbon transport networks, active travel options and EV charging are deployed to facilitate decarbonisation and green tourism.

- Explore the potential of alternative fuels for vehicles such as hydrogen and biofuels (e.g. slurry) to supply local vehicles and HGV transport related to Holyhead.
- Investigate the potential for excess low carbon electricity generation to be used for hydrogen production for HGV transport.
- Support research, development and demonstrators related to the use of hydrogen fuel cells for different applications on public transport such as hydrogen battery for buses and trains (i.e. Conwy Valley line) as well as freight following Stena's model of hydrogen car ferries.
- Encourage the creation of a hydrogen Hub in Holyhead (i.e pilot project at Parc Cybi) to support the logistics industry with particular respect to Euroroute E22 connecting Holyhead to Europe.
- Improve cycling infrastructure in urban areas and rural areas to link villages, while encouraging more active travel modes and healthier lifestyles that contribute to the well-being goal of a healthier Wales.

The Energy system, energy use & emissions

The Energy system, energy use and emissions

Modelling an Energy Vision scenario

Aims of undertaking scenario modelling

Scenario modelling has been undertaken to create a 2035 North Wales Energy Vision scenario that could deliver against the level of ambition set out in the Energy Vision statement. The modelling outcomes are unique to the region, taking advantage of local resources and opportunities, and input from local stakeholders.

The overall aim of the scenario is to set out a potential decarbonisation route that will put the region on track to achieve 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 technological 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 North Wales on a pathway consistent with achieving net zero emissions by 2050. However, this does not mean that activity around innovative new technologies should not also be pursued. The modelling takes a whole system approach to energy, considering the interactions between heat, transport and electricity demand. For example, the impact of decarbonising heat through electrification is reflected through an increase in electricity demand.

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

The Committee on Climate Change recommended in its 2019 report, Net Zero: The UK's contribution to stopping global warming, that Wales adopt an overall decarbonisation target reduction of 95%, against a 1990 baseline, by 2050[3]. 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 emissions from its agriculture and parts of its heavy industry.

However, Welsh Government has expressed an ambition to exceed this target and aim for 100% decarbonisation. Non-energy agriculture 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 and across Wales have expressed very strong support for ambitious energy system decarbonisation.

Methodology in brief

The modelling sets an indicative decarbonisation trajectory to 2035. It has been created using a methodology that reflects the high-level methodology used by the Committee on Climate Change in its 2019 progress report[4]. This absolute contraction method assumes a constant rate of decarbonisation is achieved between now and achieving net zero by 2050. This is used as a preliminary benchmark, pending 2020's more detailed assessment by the Committee on Climate Change, which will set out more detailed carbon budgets consistent with the new net zero target.

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

- Committee on Climate Change reports[5,6]
- National Grid's Future Energy Scenarios[7]
- The project team's past work on future energy scenarios for Wales & West Utilities and for Western Power Distribution[8]
- Engagement and workshops with local, regional and national stakeholders.

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

[3] Committee on Climate Change: Net Zero, The UK's contribution to stopping global warming. May 2019
[4] Committee on Climate Change (2019) 2019 Progress Report to Parliament
[5] Committee on Climate Change (2019) 2019 Progress Report to Parliament
[6] Committee on Climate Change (2018) Hydrogen in a low-carbon economy
[7] National Grid (2019) Future Energy Scenarios
[8] Regen: Local future energy scenarios
Regen: Wales and West Utilities - Regional future energy scenarios for gas

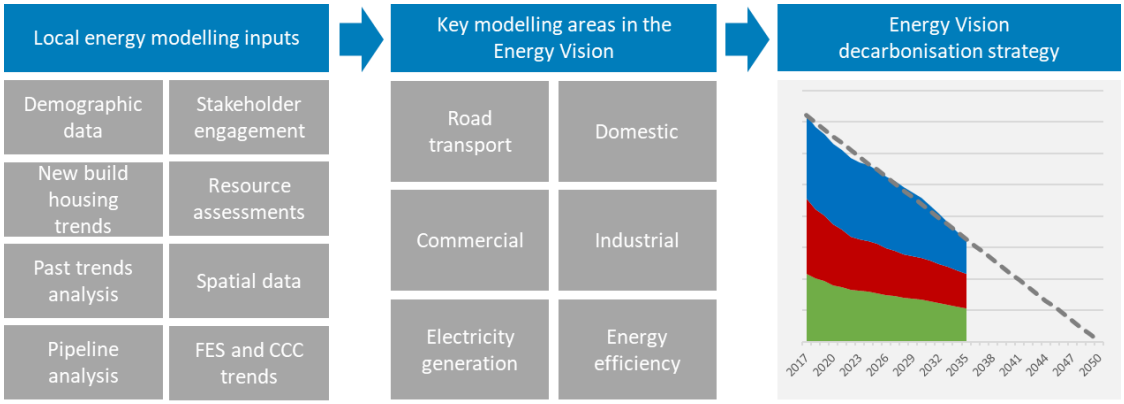


Figure 3: Modelling methodology

Worked example: The modelling approach for domestic heat

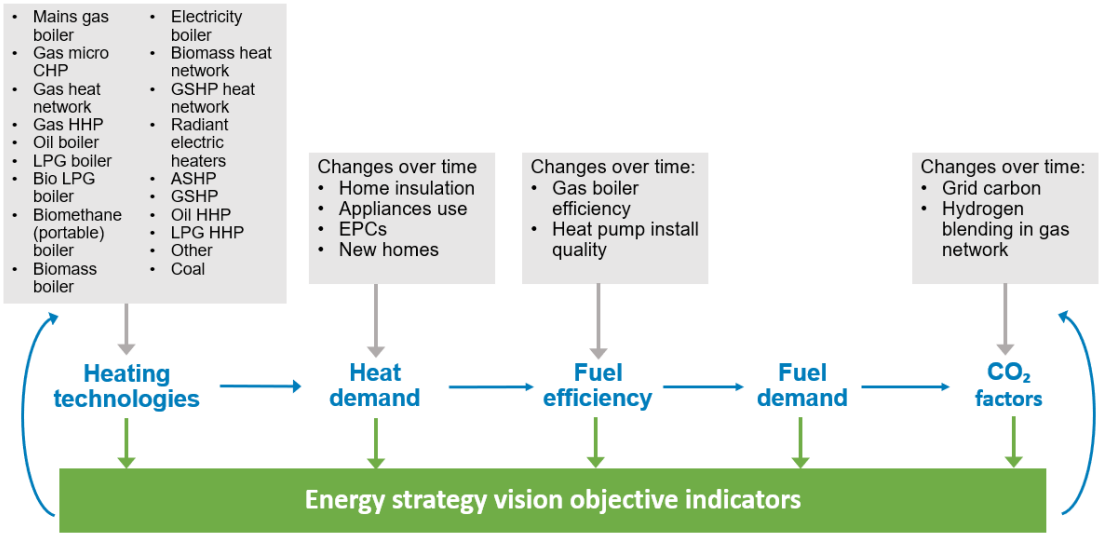


Figure 4:Modelling approach worked example

A note on scope

The strategy is focused on emissions associated with the energy system in North 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.

Baseline and modelling results: By sector

Our energy consumption

Baseline: energy consumption by sector

North Wales currently consumes around 23% of all energy consumed in Wales[9], which is slightly higher, on a pro-rata basis, than its 22% share of the Welsh population[10].

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

- Transportation consuming 30%
- The domestic sector – household heat and power use - consuming 30%
- The commercial and industrial sector consuming 39%[7].

Energy consumption in North Wales by sector and fuel

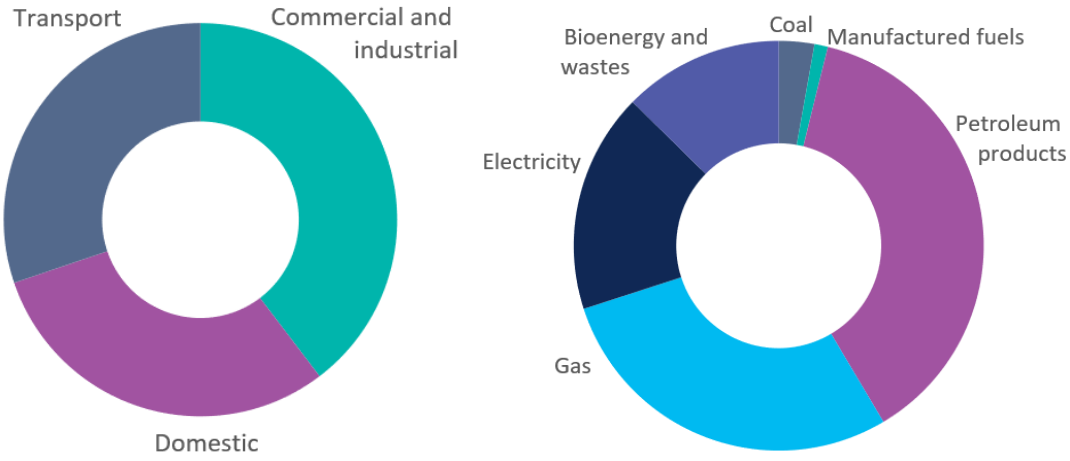


Figure 5: Breakdown of energy consumption in North Wales. Source: BEIS sub-national total final energy consumption, 2019.

[9] BEIS: Regional and local authority electricity consumption statistics, 2019
[10] StatsWales: Population estimates by local authority and year

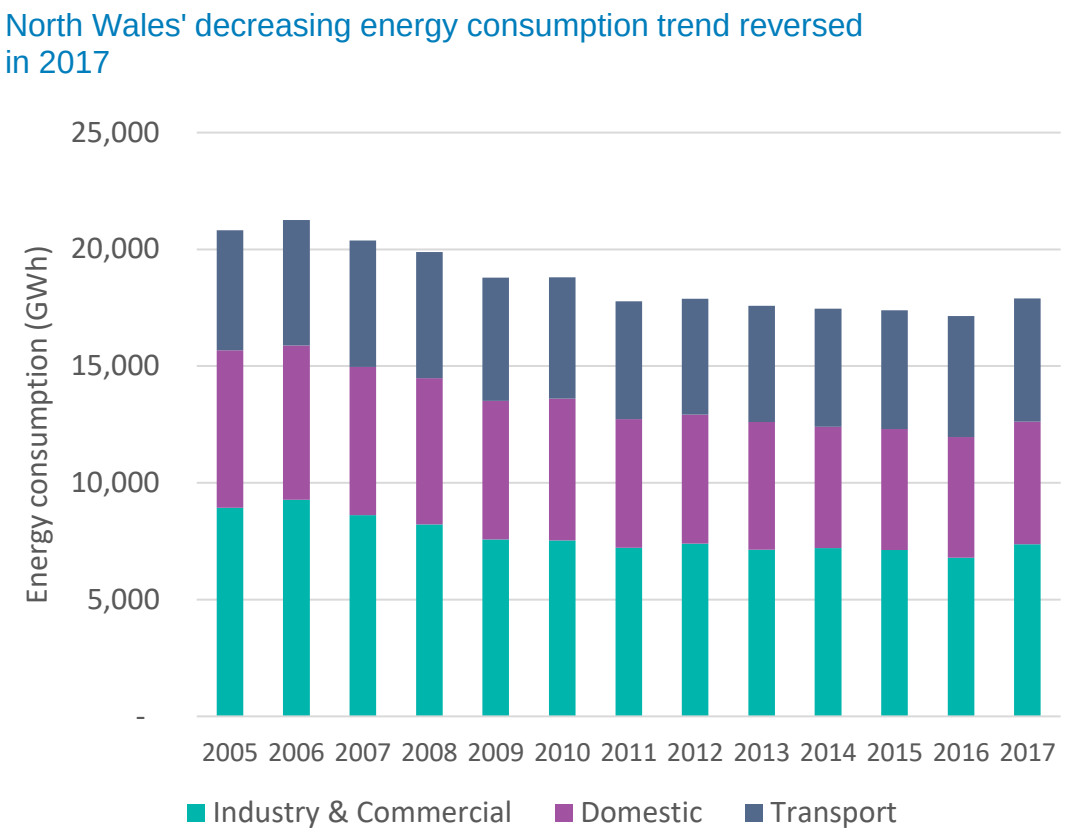


Figure 6: Trend of energy consumption in the North Wales region, by sector. Source: BEIS sub-national total final energy consumption, 2019

Analysis of BEIS sub-regional data[11] shows that total energy consumption has fallen by 5% since 2005, an average rate of about 0.4% per year. This is significantly less than the 20% reduction in energy demand experienced across Great Britain over the same period. This is predominantly due to the commercial and industrial sector's energy consumption not reducing in North Wales to the same extent as in the rest of Great Britain, at 18% and 36% respectively. This is likely to be the result of different trends in energy efficiency measures and rates of deindustrialisation.

Emissions from energy consumption reduced by around 28% from 2005 to 2017[12] as a result of falling demand and, more significantly, due to decarbonisation of the national electricity grid.

However, in 2017 there was an increase in industrial and commercial consumption in North Wales, resulting in an increase in overall consumption.

[11] BEIS: Regional and local authority energy consumption statistics, 2019
[12] BEIS: UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2017

North Wales' emissions from energy consumption have reduced by approximately 28% since 2005

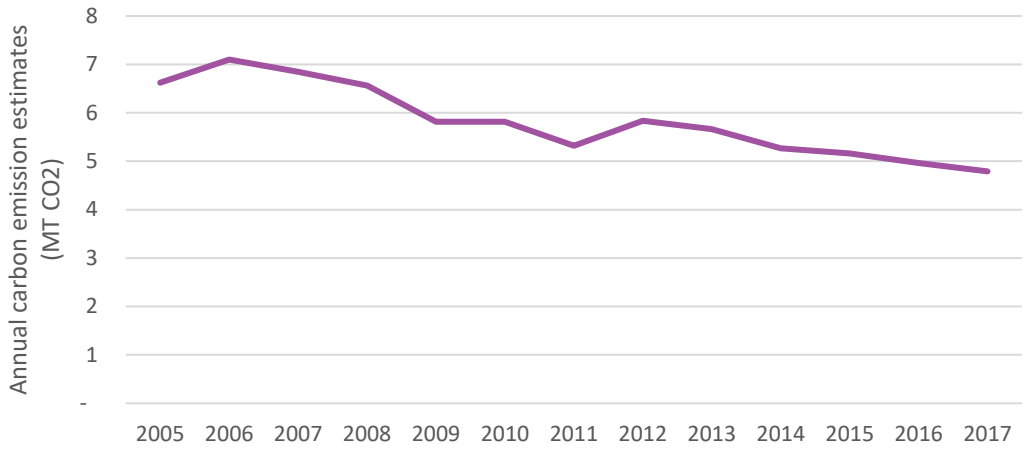


Figure 7: Estimated historic emissions in North Wales. Source: BEIS sub-national emissions

Energy system vision: energy consumption by sector

To be on track for net zero by 2050, North Wales needs to achieve 55% decarbonisation of its energy system by 2035.

North Wales' Energy Vision scenario decarbonisation trajectory

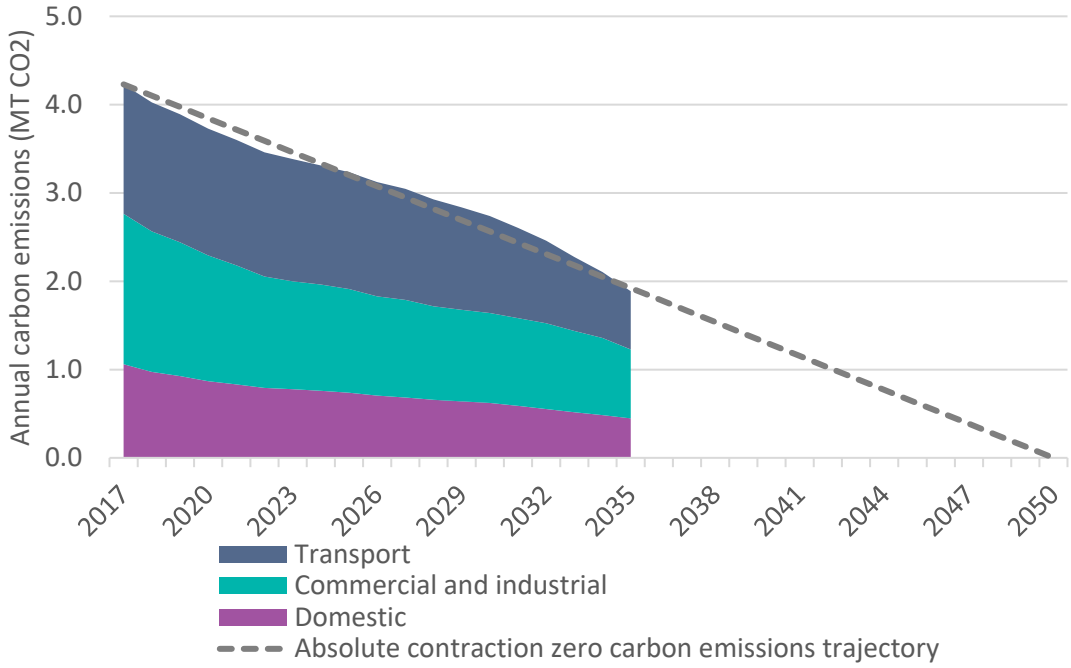


Figure 8: North Wales' Energy Vision decarbonisation trajectory by sector to meet net zero 2050 under an absolute contraction methodology. Source: WGES analysis

By reviewing the measures that could be implemented in North Wales by 2035, this 55% decarbonisation target can be split by sector into:

- 57% reduction in domestic heat and power emissions
- 54% reduction in commercial and industrial emissions
- 55% reduction in transport emissions.

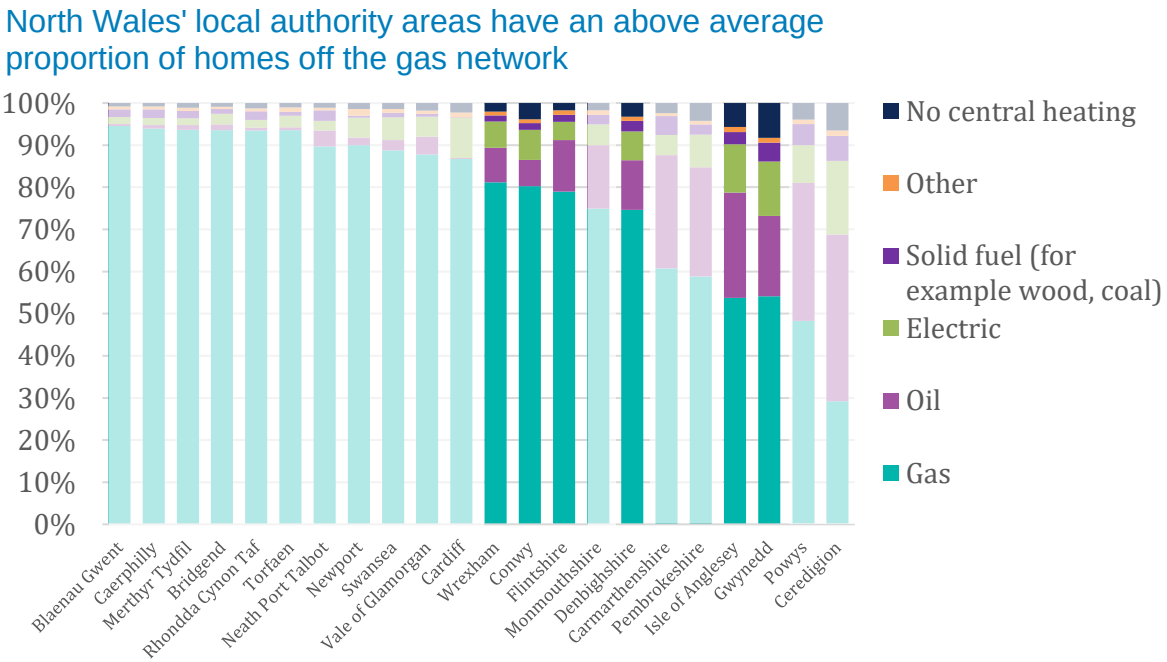
Figure 9: Summary of the Energy Vision's emission reductions by sector. Source: WGES analysis

Our domestic energy consumption

Baseline: domestic heating

North Wales is characterised by its mixture of urban, semi-urban and rural areas, with the majority of towns concentrated along the north coast and eastern border with England. As a result, there are large areas that are sparsely populated and not on the gas network. These areas contain a high proportion of solid fuel and electrically heated homes. In Gwynedd, 4% of homes are without any central heating, the highest proportion of any local authority in Wales.

Figure 10: Proportion of homes heated by each heating fuel type, by local authority. Source: Census,



2011. MHCLG, Energy Performance Certificates.

North Wales is the Welsh region with the second highest number of renewable heat installations

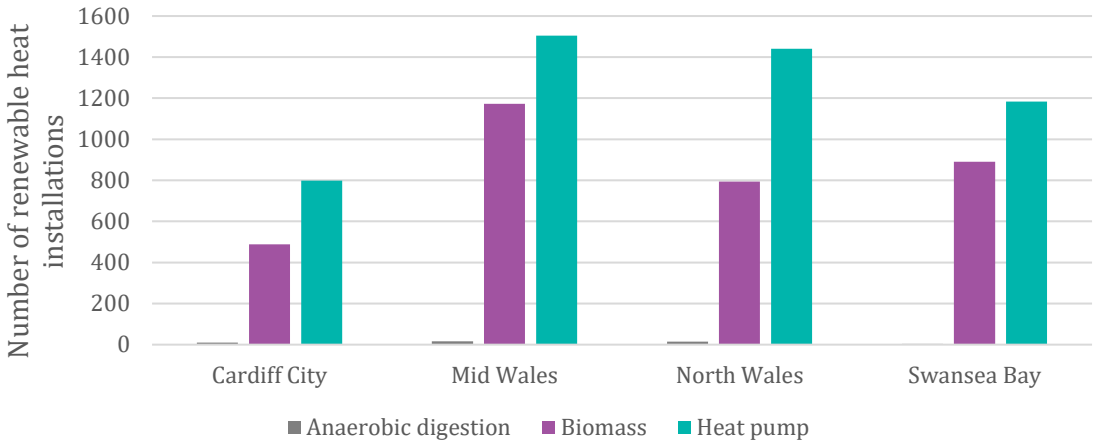
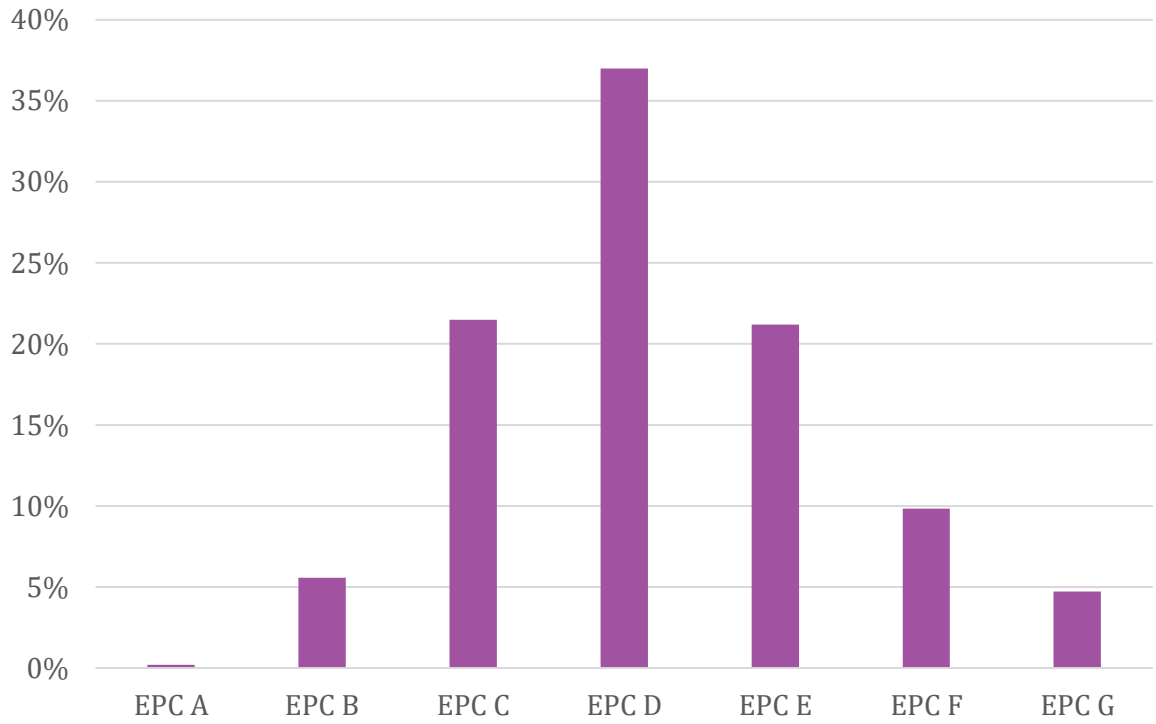


Figure 11: Renewable heat installations in Wales. Source: Energy Generation in Wales 2018

North Wales has the second highest deployment of renewable heat installations in Wales. However, this represent a small proportion of just 0.7% of homes with a heat pump or biomass boiler.

North Wales' domestic properties have an average EPC rating of D



Domestic energy efficiency is relatively poor in North Wales, with 36% of homes rated as EPC band E, F or G, compared to 23% in Great Britain. The average rating is a D, and there are virtually no A-rated properties.

Despite this, domestic energy demand has fallen by 22% since 2005, reflecting the national trend resulting from more efficient appliances and lighting combined with behavioural change.

Box 1: Assumptions regarding the decarbonisation of domestic heating in North Wales[13]

The North 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 North 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, predominantly air source or ground source heat pumps replacing more expensive oil, LPG or solid fuel heating.
- Hydrogen offers a number of significant opportunities for Wales, particularly through the development of industrial clusters in North Wales and extending into the Wirral, and in South Wales in Pembrokeshire, Port Talbot and industrial zones around Cardiff and Newport. A number of hydrogen projects are planned and there is a high likelihood that hydrogen for industrial and transport applications will be become an important fuel over the next decade. There is the potential that some hydrogen from these trial projects could be used to supply heat to adjacent homes and commercial buildings, however hydrogen is not expected to become economically viable or widely available for network distribution as a heating fuel before 2035.
- Biomethane from food waste and sewage in populous areas, alongside farm waste in more rural areas, could provide up to 5.1% of energy supplied by the gas distribution network in North Wales by 2035. The proportion of biomethane that is injected into the mains gas network will depend on the availability of feedstocks and level of demand from other biomethane uses such as power generation.
- 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.

These findings have been built on in developing the North Wales Energy Vision scenario.

Wales and 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. Net zero scenario shows higher potential for biomethane and hydrogen. For example, biomethane levels can exceed in some parts of the WWU network will reach over 20% by 2021. This would facilitate the decarbonisation of homes using smart hybrid heating systems.

[13] For more information about HyNet visit The HyNet webpage

Source: Regen (2019) Regional Growth Scenarios for Gas and Heat for Wales & West Utilities[14]

Table 1. Regional Growth Scenarios for Gas and Heat compared with energy modelling

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)		12%	20%	16% (including significantly higher proportion of hybrid heat pumps)	20%
Biomethane and bioSNG energy	Biomethane and bioSNG heat energy for domestic and C&I heating in 2035	171 GWh	332 GWh	283 GWh	227 GWh (note the scope excludes some large industrial sites)
	Biomethane and bioSNG percentage of heat delivered by the gas network	3% of gas network energy	5.1% of gas network energy	5% of gas network energy	5.1% of gas network energy

[14] Regen (2019) Regional Growth Scenarios for Gas and Heat for Wales & West Utilities

Hydrogen use for domestic and commercial heating **(Hydrogen for industrial processes and transport is modelled separately)**	1% of gas network energy	None modelled before 2035	3% of gas network energy	None modelled before 2035 although there is potential for some domestic heating associated with industrial clusters

Energy Vision scenario: domestic heating

Achieving a 57% reduction in domestic carbon emissions by 2035 requires a significant shift in the way homes are heated and their level of energy efficiency.

One pathway to achieve this would be to focus on improving the worst performing homes, eliminating all E, F and G ratings through improvements, as well as some improvements to homes with higher ratings. Under the Energy Vision scenario, 35% of all homes are improved from G, F and E to D, C and B, leaving just 1% of properties with an EPC rated E or worse.

Upgrades to nearly all homes rated E, F and G required to deliver North Wales' Energy Vision

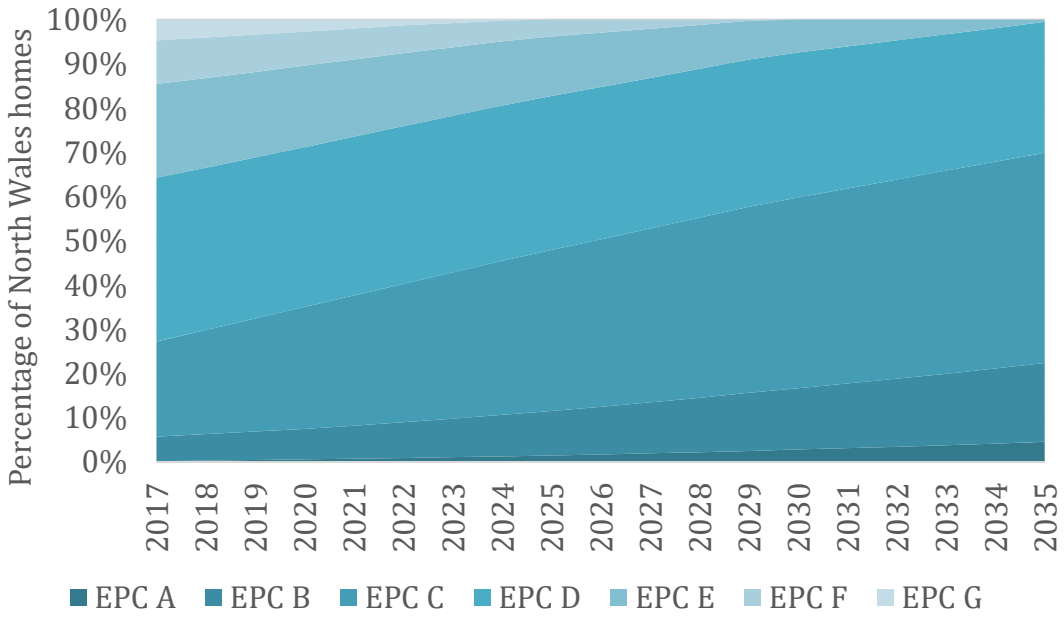


Figure 13: Estimated domestic EPC band changes to deliver the Energy Vision scenario. Source: WGES analysis

Around 67,000 homes (21% of existing homes), would need to move from using fossil fuel heating to low carbon heating. Of these, approximately 25,000 are currently fuelled by oil, LPG, coal or other solid fuels, with the remainder currently on mains gas.

The Energy Vision scenario assumes that the transition to low carbon heating will be dominated by a shift to air source heat pumps, with a smaller role for ground source heat pumps, biomass and bio-LPG heating options. By 2035, over 65,500 heat pumps have been installed in North Wales. Heat networks have a limited role in North Wales due to the rurality of the area, with around 1,200 homes estimated to connect to a heat network by 2035. The development of heat networks is concentrated in the urban areas of Flintshire and Wrexham.

The scenario relies on new homes being built with low carbon heating and high standards of energy efficiency from 2025, as broadly set out in the recent Welsh Government consultation on Building Regulations Part L that was closed in March 2020[15]. At the time of writing, consultation responses are being reviewed.

Air source heat pumps are the dominant new low carbon heating source introduced by 2035 under the North Wales Energy Vision scenario

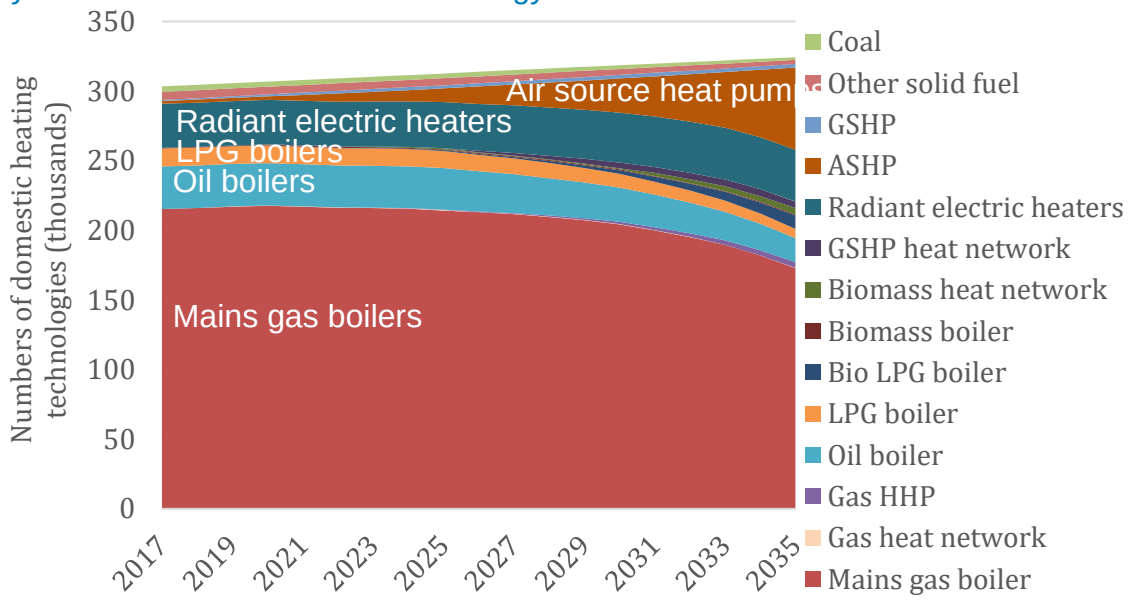


Figure 14: Breakdown of domestic heating technologies in the North Wales Energy Vision scenario, including existing and new build houses. Source: WGES analysis

[15] Welsh Government: All new homes in Wales to be heated and powered from clean energy sources from 2025

Box 2. Alternative Domestic energy and heat Pathway – 'balanced' scenario

The Energy Networks Association's 'Pathways to Net Zero' report explores the role of gas networks in a future Net Zero energy system, producing cost-optimised scenarios out to 2050. The Pathways to Net Zero report presents an alternative pathway called the 'balanced scenario' for a decarbonized heating system that can also be applied to the Cardiff Capital Region.

The "balanced scenario" describes a future where low carbon and renewable gases are used in a *balanced* combination with low carbon electricity, where electrification plays a less dominant role and renewable gas grid conversion is prioritized. It highlights the significant role of renewable gas in meeting net zero by 2050, especially in cases where existing homes can't be renovated or all-electric heat pumps are not an appropriate solution. However, it also identifies current barriers to achievement, for example, a significant reliance on timely Carbon Capture Use and Storage implementation and accompanying policies to support this.

WWU have considered these principles into its 2021-26 business plan, consulting over 20,000 stakeholders and consumers in the process.

<u>'Balanced scenario' overview for domestic energy and heat:</u>

- Deployment of hybrid heat systems becomes main heat source in buildings not suitable for all-electric heat pumps and where connecting to a district heating network is not an option
- Heat supply is mostly hydrogen and biomethane
- Moderate renovation in existing buildings

The key difference between the balanced scenario and the energy system vision scenario modelled for this report concerns the level and timing of the installation of heat pumps versus hybrid heat pumps. The balanced scenario, when applied to the Cardiff Capital Region would focus on hybrid heat pump installation first. Another key difference between the balanced scenario and the energy system vision scenario are timelines. The balanced scenario models out to 2050, whereas the energy system vision modelling has modelled out to 2035.

Detailed energy planning is required to provide certainty on the pathway and short-term actions required in CCR to decarbonise not just heating, but the wider energy system. The gas and electricity DNOs, and the local authorities in the region, are vital to this process. Electrification is currently one of the few proven scalable options for decarbonising heat, with heat pumps playing a substantial role in any Net Zero scenario. Local area energy planning will identify the preferred combination of technological and system changes needed to the local energy system, to decarbonise heat, and local transport, and realise opportunities for local renewable energy production.

Table 2: Scenario summary: domestic

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Domestic heat and energy efficiency	30,000 houses fitted with internal or external wall insulation Over 120,000 other insulation measures in homes Over 65,500 heat pumps Replacing heating systems in oil, LPG and solid fuel heated homes prioritised No gas in new homes from 2025, to avoid retrofitting at a later date	17% reduction in gross thermal energy demand 32% net decrease in domestic heating energy consumption, taking into account demand reduction and improved heat technology efficiencies, including the impact of heat pump performance.	499 kt CO_2 (57% reduction)

Our commercial and industrial energy consumption

Baseline: commercial and industrial

Industrial energy demand has decreased by 18% since 2005 and emissions have decreased by 28%. The more significant reduction in emissions, compared to the reduction in energy demand, is largely due to the decarbonisation of the UK's electricity grid.

46% of commercial and industrial demand is met by gas, reflecting the mix of on and off gas locations in the region.

North Wales' commercial and industrial energy demand has declined steadily since 2005, with an increase in 2017

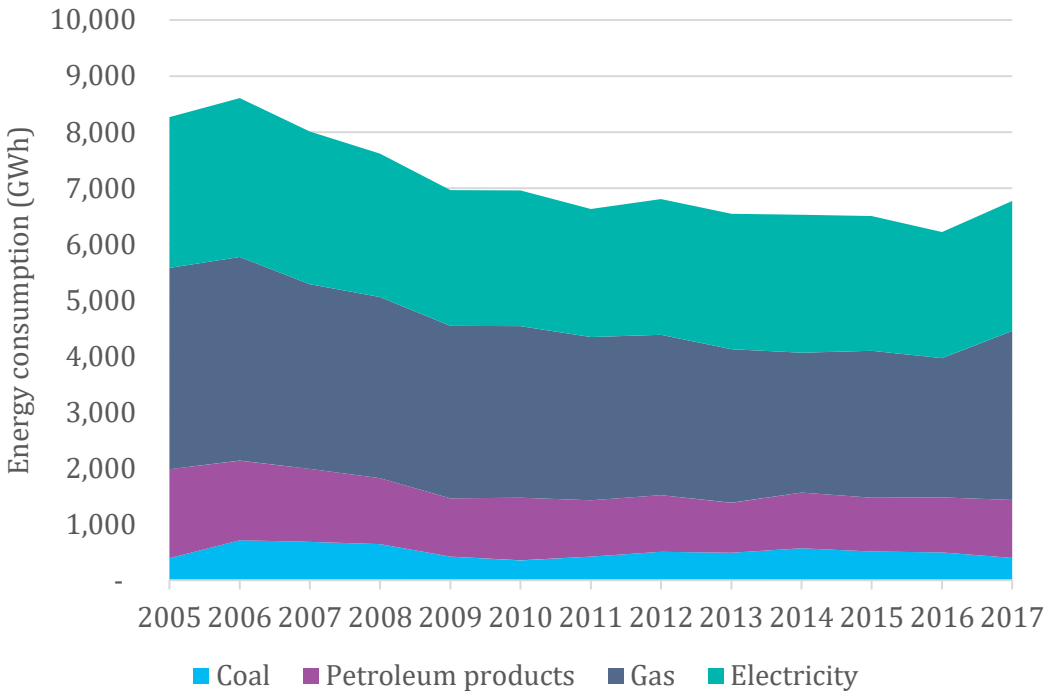


Figure 15: North Wales' historic commercial and industrial energy consumption, by fuel. Source: BEIS total final energy consumption (2019)

Energy Vision scenario: commercial and industrial

The Energy Vision scenario sets out a pathway to achieve a further 54% reduction in commercial and industrial emissions by 2035 through:

- A 16% decrease in energy demand
- Some use of low carbon hydrogen in industrial processes
- Significant further decarbonisation of the electricity grid through renewable generation.

Reaching a grid carbon factor of 30 gCO_2 per kWh[16], for example, achieves on its own a 57% reduction in all commercial and industrial emissions in North Wales. This very low grid carbon factor would depend on significant installation of new low carbon generation capacity both in North Wales and across the UK.

Feedback from North Wales stakeholders was that there is strong support for hydrogen use in industrial clusters in the region. The Energy Vision scenario therefore assumes that hydrogen use in industrial processes is introduced in a North Wales cluster around 2032. To be in line with the region's net zero carbon ambitions, hydrogen needs to produced either using excess renewable energy to power electrolysis or through steam methane reformation with effective carbon capture and

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

storage. To be viable, cost reduction and further technology development is needed. Hydrogen for use in North Wales could potentially be sourced from the Hynet North West project, based in the Liverpool region, which is aiming to produce hydrogen from methane with carbon capture and storage for use by energy intensive industrial organisations[17].

North Wales' Energy Vision scenario includes a 16% decrease in commercial and industrial energy consumption by 2035

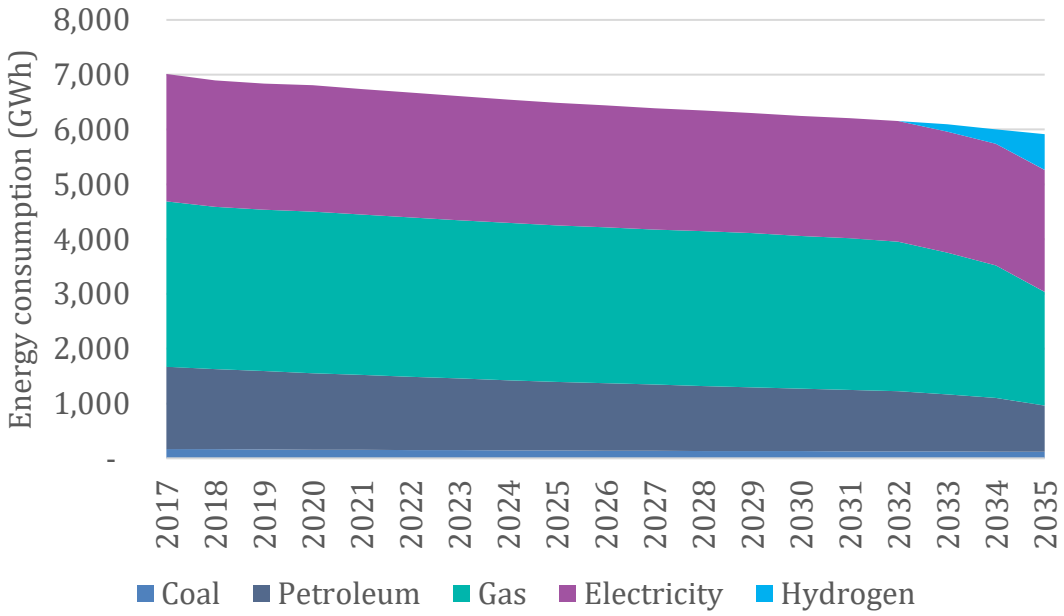


Figure 16: Energy Vision scenario commercial and industrial energy consumption, by fuel. Source: WGES analysis

North Wales' Energy Vision scenario results in a 54% decrease in commercial and industrial energy emissions by 2035

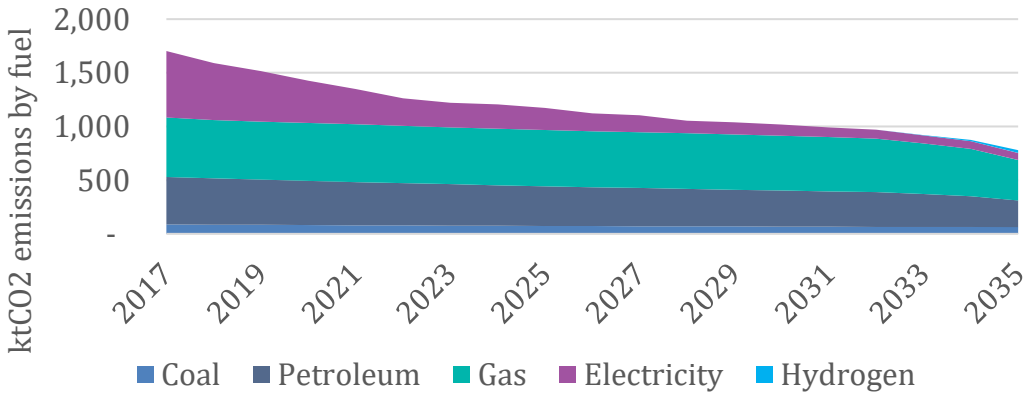


Figure 17: Energy Vision scenario commercial and industrial emissions estimates, by fuel. Source: WGES analysis

[17] HyNet FAQs

Table 3: Scenario summary: commercial and industrial

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Commercial and industrial energy demand	Significant energy efficiency programme A switch to alternative fuels, including hydrogen and electrification of heating Decarbonisation of electricity network through renewables and behind-the-meter low carbon generation	42% reduction in coal and petroleum energy consumption 31% reduction in gas consumption 11% of demand supplied by hydrogen through industrial clusters 4% reduction in electricity demand	922 kt CO_2 (54% reduction)

Our transport

Baseline: transport

North Wales has a high dependence on private cars for transport. Average annual vehicle miles in North Wales are similar to those in other Welsh regions at 9,184 per car**Error! Bookmark not defined.**. Less than 1% of road miles are driven by buses and c oaches in North Wales[18]. North Wales 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[19].

To date, North Wales has seen a slow uptake of electric vehicles. Approximately 0.1% of cars registered in the region are pure electric, compared with an average of 0.6% of vehicles across Great Britain. Similarly, despite a surge in charger installations in 2019, North Wales currently hosts only 148 public charging devices, including 14 rapid public chargers[20]. This is relatively low, as is the case across Wales, where there are half the number of public EV chargers per capita compared to Scotland.

Marine transport, such as ferries and cruise ships, was not in the scope of emissions covered by this analysis. However, this area is likely going to be important for North

[18] DFT Road traffic statistics (TRA) and Regen transport model
[19] Personal travel in Wales – 2012 statistical bulletin (2013)

[20] DFT, Electric Vehicle Charging Device Statistics, 2019

Wales, particularly given the importance of Holyhead port. Holyhead is also noteworthy due to its position as part of Euroroute E22 which poses a specific decarbonisation need and challenge. The appropriate infrastructure in this area will need to be rolled out to be compatible Europe wide technology adoption in Logistics.

Wales has far lower bus utilisation rates than England or Scotland

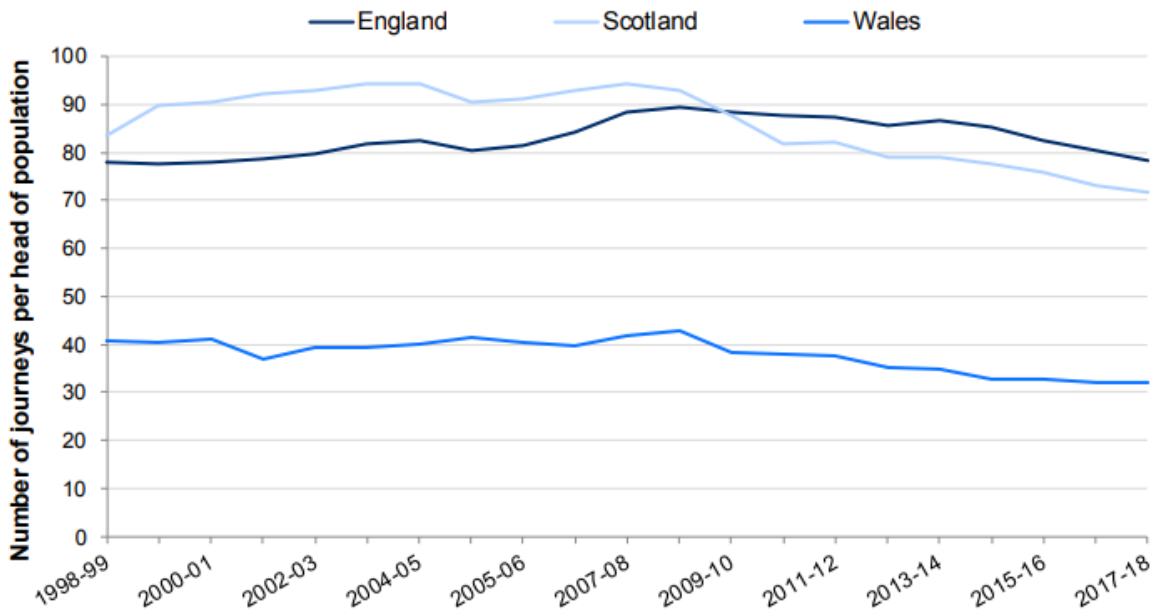


Figure 18: Passenger journeys per head on local bus services by country, 1998-2018. Source: Public service vehicles statistical bulletin, 2019

Energy Vision scenario: transport

Achieving a 55% reduction in transport emissions by 2035 is a significant challenge for North Wales with its high dependency on private vehicles. The Energy Vision scenario assumes:

- 55% of vehicles driven in North Wales in 2035 are electric, with the ban on fossil fuel vehicle sales brought forward to 2030
- A 15% reduction in private vehicle mileage in 2035
- A slowing of the growth in total number of vehicles on the road, facilitated by increased use of public transport and active travel.

North Wales' Energy Vision scenario requires a significant decrease in the number of petrol and diesel vehicles

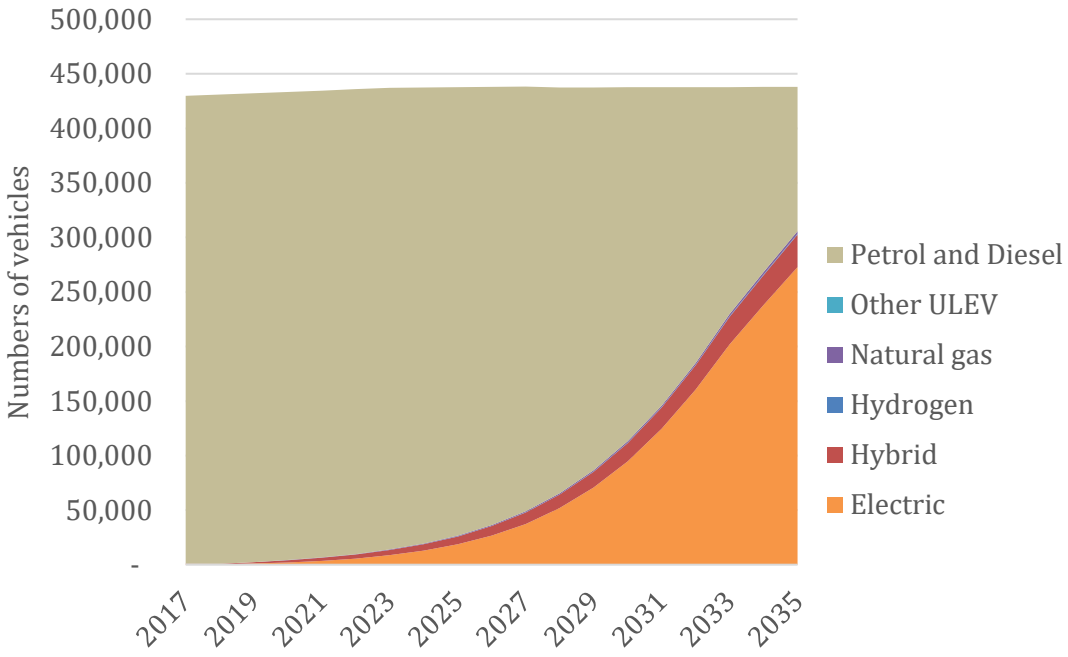


Figure 19: North Wales' Energy System Vision road vehicle numbers, by vehicle fuel. Source: WGES analysis

North Wales' Energy Vision scenario results in road transport emissions reducing by around 55%

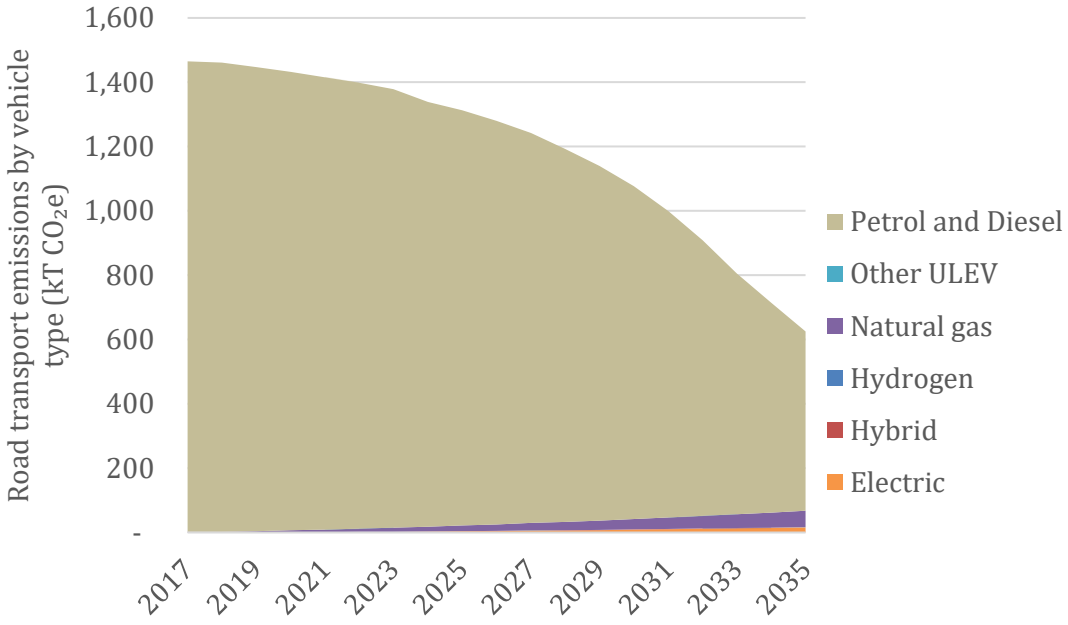


Figure 20: Energy System Vision road vehicle emissions, by vehicle fuel. Source: WGES analysis

Table 4: Scenario summary: transport

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Road transport	260,000 electric cars 2,600 gas HGVs 1,000 hydrogen vehicles 2,000 public EV chargers 15% reduction in private vehicle mileage	3.2 TWh reduction in petrol and diesel energy consumption 0.6 TWh increase in electricity consumption	660 kt CO_2 (55% reduction)

Achieving these outcomes requires 7,000 EV sales per year by the mid-2020s, peaking at 40,000 per year in the 2030s before reducing to 30,000 per year. Peak sales of fossil-fuelled cars in North Wales have historically reached 30,000 per annum[21]. 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 40,000 EV sales per year in the 2030s.

This level of EV sales will require a supportive, area-wide EV charging network. Similarly, the switch to gas and hydrogen heavy good vehicles and buses is reliant on the fuelling infrastructure being in place.

Baseline and modelling results: Electricity

Our annual electricity demand

Baseline: annual electricity demand

Annual electricity demand in North Wales is currently approximately 3.6 TWh[22]. It has fallen steadily since at least 2005 when electricity demand was nearly 4.2 TWh**Error! Bookmark not defined.**.

As a result of a concentration of commercial and industrial activity in Flintshire and Wrexham, commercial and industrial electricity consumption constitutes 71% of all electricity consumption, nearly 10% higher than the Great Britain average.

Energy Vision scenario: annual electricity demand

The scenario projects a 10% increase in annual electricity demand for North Wales by 2035, compared to 2017. 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.

[21] DFT Road transport statistics and Regen analysis
[22] BEIS: Regional and local authority electricity consumption statistics, 2019

In the North Wales Energy Vision scenario, decreasing base annual electricity demand is outweighed by increasing demand from electrified heat and transport

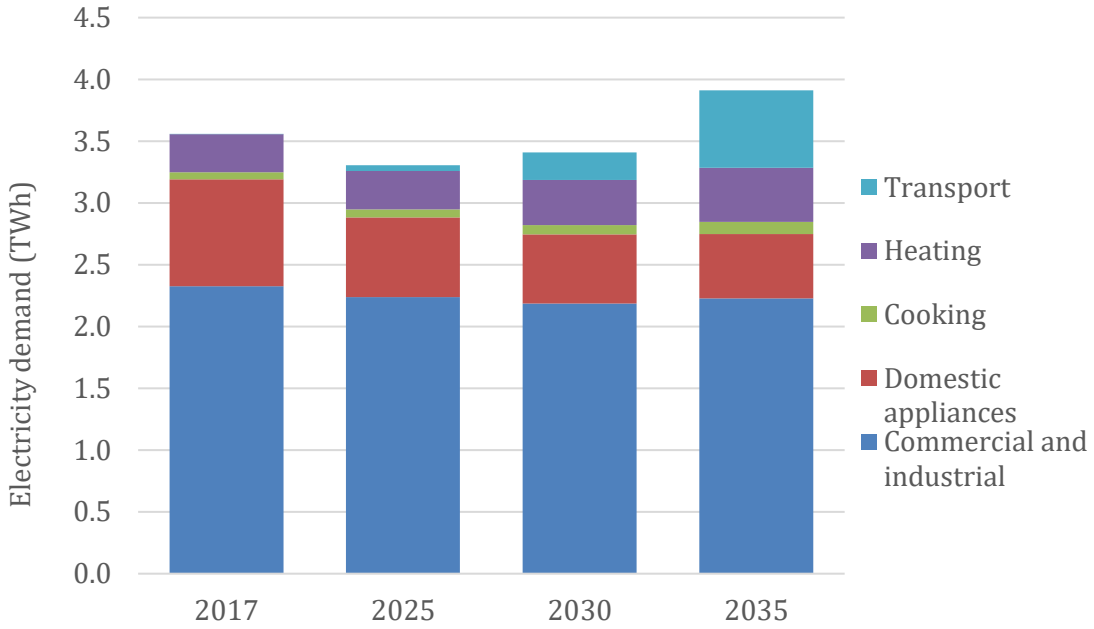


Figure 21: North Wales' Energy Vision scenario demand by sector. Source: WGES analysis

Our electricity generation

Baseline: electricity generation

726 MW of offshore wind, 98 MW of onshore wind projects and 224 MW of solar PV currently installed in North

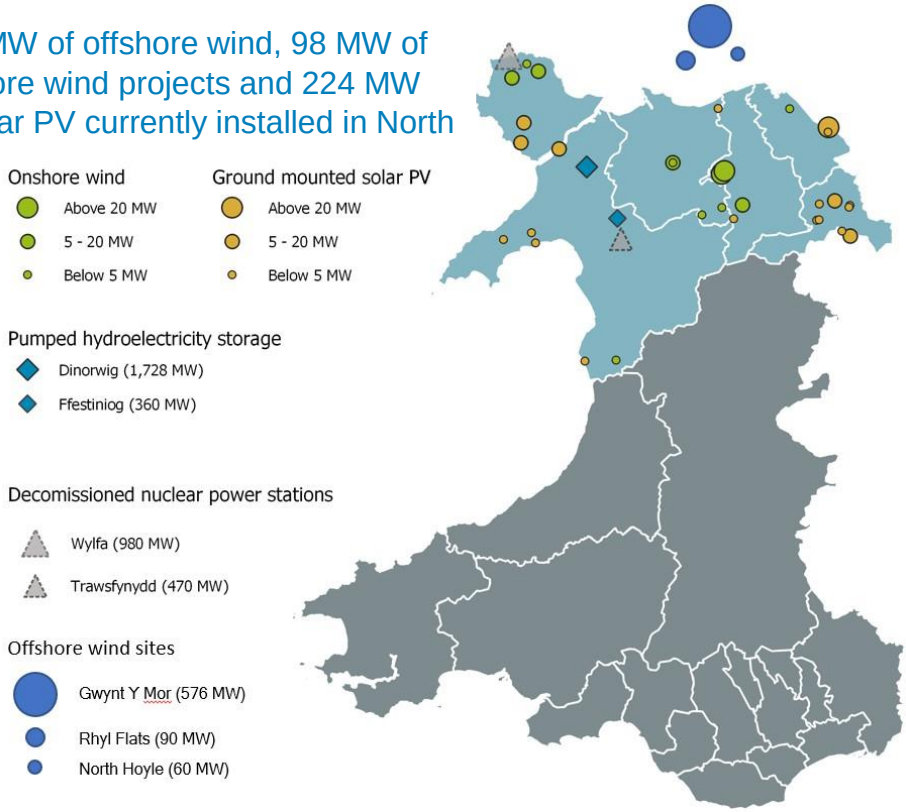


Figure 22: Offshore wind. solar PV and onshore wind projects (>1MW) currently generating in Wales. Source: BEIS Renewable Energy Planning Database, 2019

There is a total of 1,183 MW of installed renewable electricity capacity in the region, with 95 MW locally owned[23].

Renewable electricity generation in North Wales is dominated by offshore wind, which makes up 72% of generation and 61% of capacity. Solar PV has a relatively high installed capacity with 224 MW, but, due to a lower capacity factor, provides around 7% of renewable energy generation in the region.

The Gwynt Y Mor offshore wind farm commissioned in 2015, more than doubled the region's renewable generation capacity

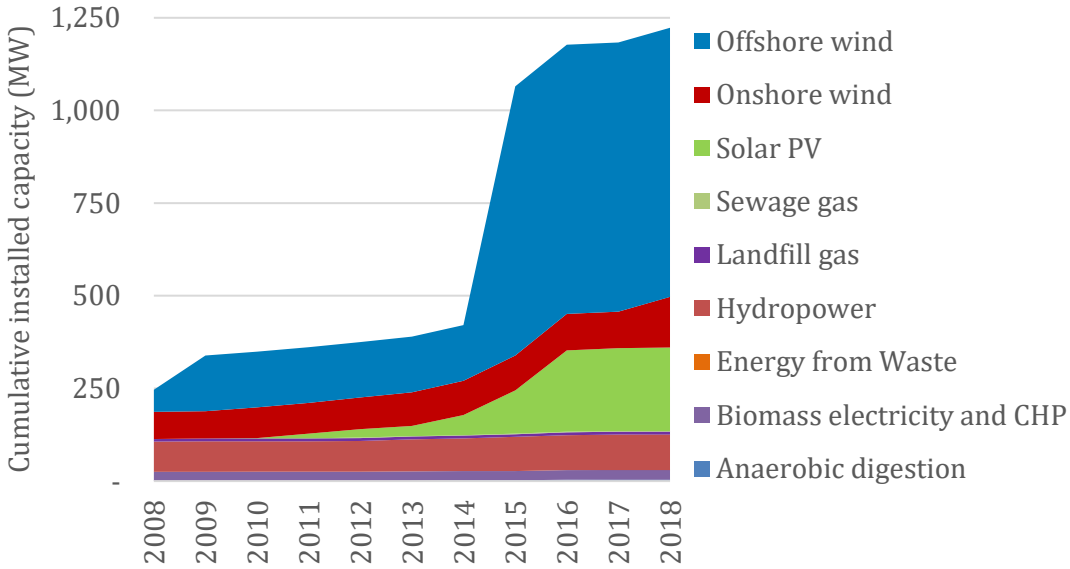


Figure 23: North Wales' renewable electricity generation trends 2008-2018. Source: WGES analysis, Energy Generation in Wales 2018

[23] Welsh Government: Energy Generation in Wales, 2017

North Wales currently hosts over a third of Wales' renewable energy capacity, largely due to 726 MW of offshore wind capacity.

North Wales hosts all of the current Welsh offshore wind capacity

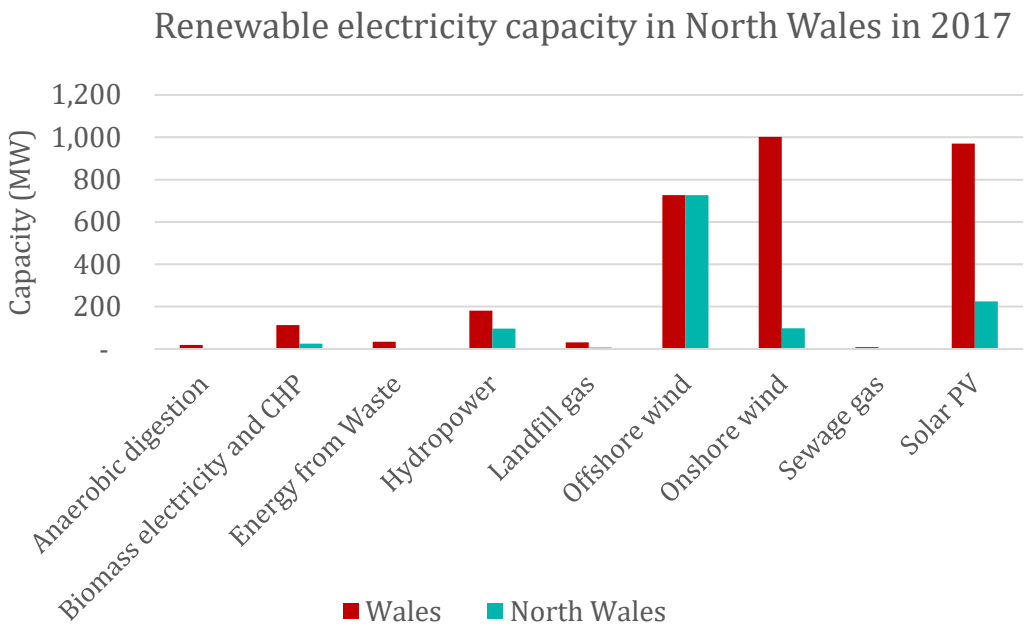


Figure 24: Renewable electricity capacity in North Wales region, 2017. Source: WGES analysis, Energy Generation in Wales 2018

North Wales currently generates the equivalent of 82% of its electricity consumption from local renewable sources

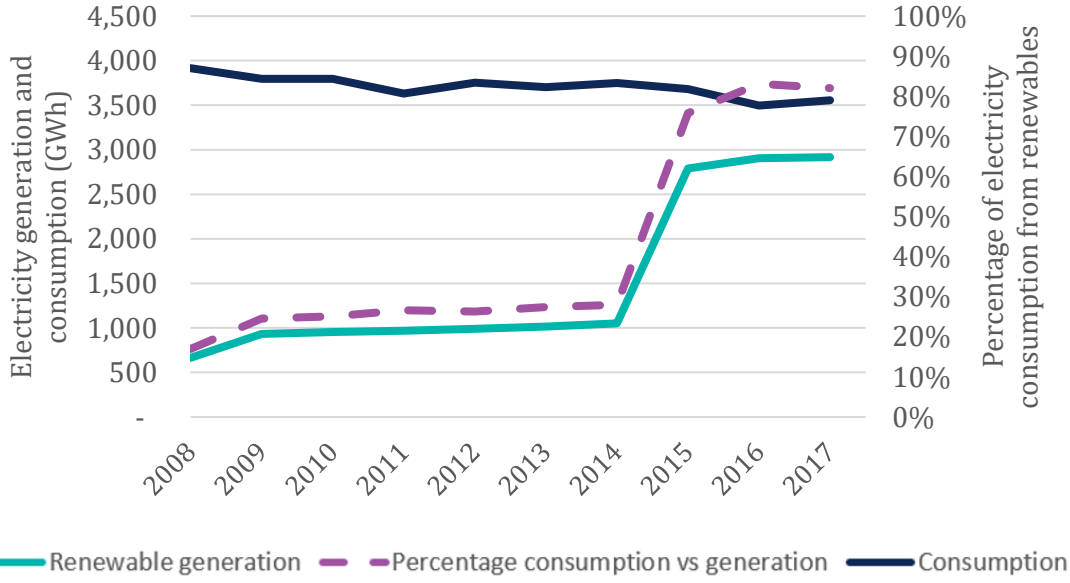


Figure 25: Percentage of electricity consumption from renewables in North Wales. Source: WGES analysis, Energy Generation in Wales 2018

Energy Vision scenario: electricity generation

Box 3: A note on grid carbon factors

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, 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 assumptions used by National Grid's 2019 Future Energy Scenarios. In order to achieve this level of grid decarbonisation, National Grid's Community Renewables and Two Degrees scenarios require a net increase of 68 and 74 GW of low carbon electricity capacity respectively, across the UK by 2035. North Wales has the natural resources and the ambition to play a significant role in delivering renewable energy deployment.

Stakeholders engaged throughout the development of this strategy were keen that the region becomes a significant net exporter of renewable electricity. This reflects high ambition in the region and also a desire for the energy sector to contribute to the region's wellbeing including in terms of jobs. The Energy Vision scenario developed is based on the region generating around four and a half times 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. 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.

To enable North Wales to meet 450% of its 2035 electricity consumption from local renewables requires a significant increase in generation

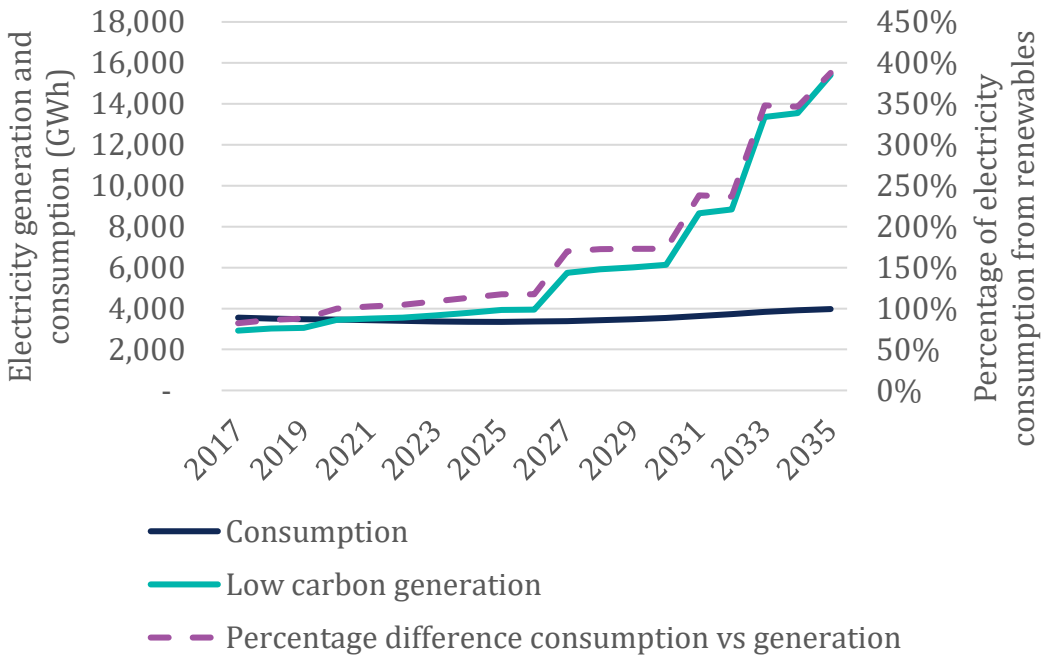


Figure 26: North Wales' Energy Vision scenario low carbon electricity consumption vs generation. Source: WGES analysis

Figure 27 shows one pathway to achieving this level of electricity generation in the region. The modelling produced two sensitivities: a high offshore sensitivity and a high onshore sensitivity. Feedback from stakeholders in the region strongly favoured the high offshore sensitivity. If the proposed marine and offshore wind projects are not developed, further onshore renewable development would be needed to result in the same renewable generation outcome.

Offshore wind is the technology likely to provide the majority of the capacity increase needed to deliver North Wales' Energy Vision scenario

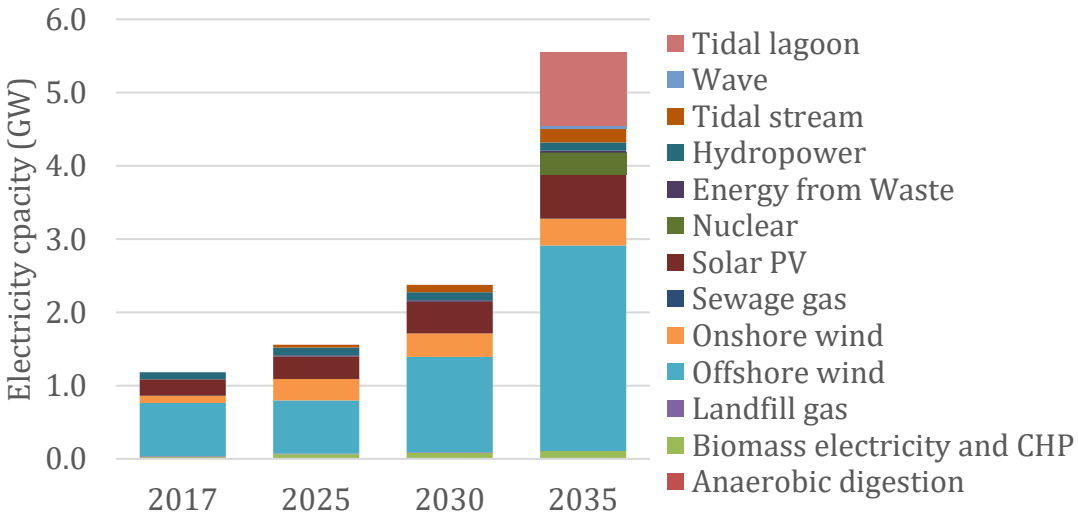


Figure 27: Low carbon energy capacity increases under North Wales' Energy Vision scenario. Source: WGES analysis

Offshore wind

There is currently 726 MW of offshore wind connected to the North Wales' coastline. The Energy Vision scenario includes a 576 MW increase in offshore wind capacity in the late 2020s as a result of a proposed extension to Gywnt Y Mor.

In addition, The Crown Estate's proposed new projects under Round 4 include sites off the coast of North Wales that could connect in the 2030s. The Carbon Trust's 2018 report for the Welsh Government on the Future Potential for Offshore Wind in Wales estimates the opportunity for 1-3 GW of new offshore wind from the 4th leasing round in North Wales' waters. However, part of the area that contributes to this estimation has not proceeded to the bidding stage. Therefore, the Energy Vision scenario contains an ambition to develop 1.5 GW of offshore wind within the Crown Estate's 4th leasing round. Whether or not sites progress in this area will depend on the outcome of the 4th leasing round, followed by investable sites being developed and obtaining planning permission.

No assumptions have been made regarding what portion of the 1.5GW of offshore wind is floating or fixed. However, it is worth noting that Wales is taking a leading role in bringing floating wind technology to commercial readiness, thanks to the 90-180 MW Pembrokeshire Demonstration Zone, which is aiming to commission floating wind starting from 2024.

Significant new offshore wind capacity could be developed under the Energy Vision scenario within existing and upcoming Crown Estate allocations

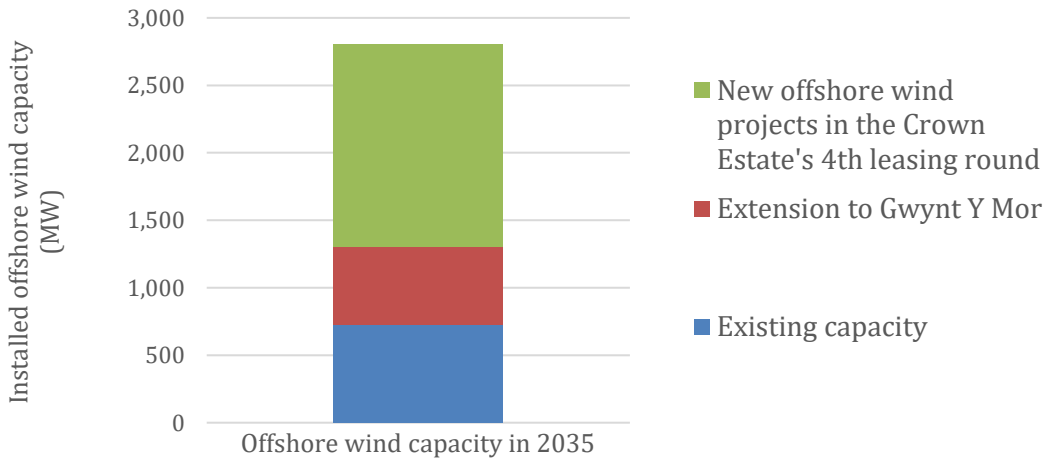


Figure 28: North Wales' Energy Vision scenario for offshore wind. Source: WGES analysis

Onshore wind

The Energy Vision scenario includes an increase in onshore wind capacity of 213 MW. This increase is made up of projects currently in development, 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[24], and a number of small-scale projects.

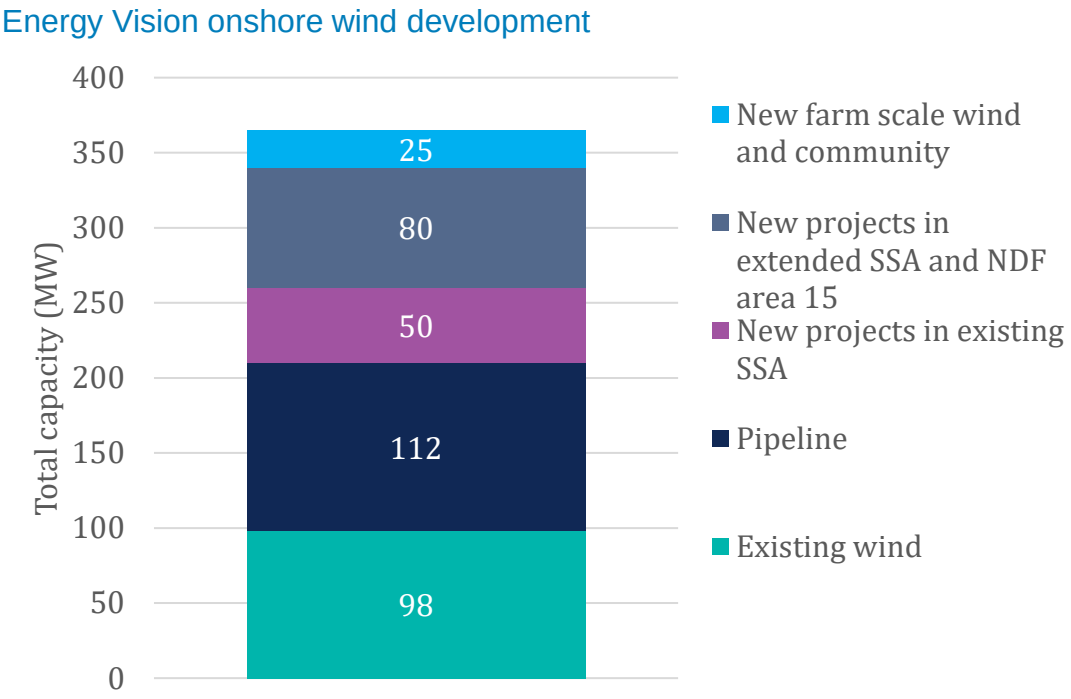


Figure 29: North Wales' Energy Vision scenario for onshore wind. Source: WGES analysis

Nuclear

The scenario includes the development of a small modular reactor on the site of the former nuclear power station at Trawsfynydd. Small modular reactors at Trawsfynydd could make use of existing grid capacity and other site infrastructure, in addition to making use of the existing skill base in the region.

Plans for a large-scale power station at Wylfa have been suspended, having been unsuccessful in reaching a suitable financing model following negotiations between Horizon Nuclear Power, Hitachi and UK government. The process for securing a Development Consent Order for the project has also been withdrawn. However, Welsh Government continue to liaise with UK Government and other key stakeholders to consider future options for the site given its continued strategic offer.

The UK Government's Energy White Paper also outlines a role for nuclear in trying to deliver net Zero ambitions, with a firm commitment to bring at least one large-scale nuclear project to the point of Final Investment Decision (FID) by the end of this Parliament, (subject to clear value for money and all relevant approvals) and approximately £500m in progressing Small and Advanced Modular reactor technology and capability. Responses to its Regulated Asset Base model

[24] At the time of the analysis, the NDF consultation area 15 related to North Wales, however the area numbers are subject to change as a result of the responses to the consultation.

consultation, suggest that UK Government believe it is a credible model and as part of other possible options will progress with further work to consider future financing models.

Figure 30 shows the additional generation that could be achieved if a 3 GW Wylfa Newydd reactor is developed.

A 3 GW reactor at Wylfa would add significantly to North Wales' low carbon generation capacity

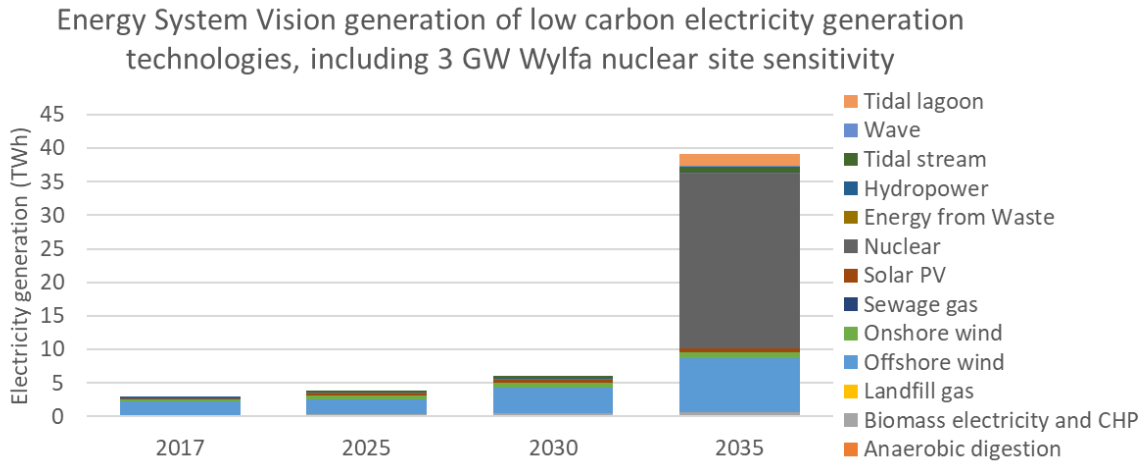


Figure30: Low carbon energy capacity increases including Wylfa Newydd under North Wales' Energy Vision scenario. Source: WGES analysis

Marine

The North Wales coastline has significant opportunities and resources for wave, tidal stream and tidal lagoon technologies. A priority for the region has been to maximise opportunities for offshore and marine renewables, supported by Marine Energy Wales. For example, North Wales hosts a marine energy demonstration zone, the Morlais Demonstration Zone, and the Anglesey Enterprise Zone[25].

There are early-stage plans to develop a tidal lagoon in Colwyn Bay, which adds 1 GW of renewable capacity to the Energy Vision scenario[26]. In addition to the tidal lagoon, the Energy Vision scenario sees the development of 180 MW of tidal stream generation capacity within the Morlais Demonstration Zone, previously known as the West Anglesey Tidal Demonstration Zone. This site has good tidal resources, a 45-year lease from the Crown Estate, and good access to the electricity grid.

[25] Marine Energy Wales Brochure, 2018
[26] It's worth noting that after the modelling was undertaken, plans for the Mostyn Tidal Lagoon (128 MW) were unveiled. Due to timing, this lagoon does not feature in any of the modelling.

Morlais Demonstration Zone

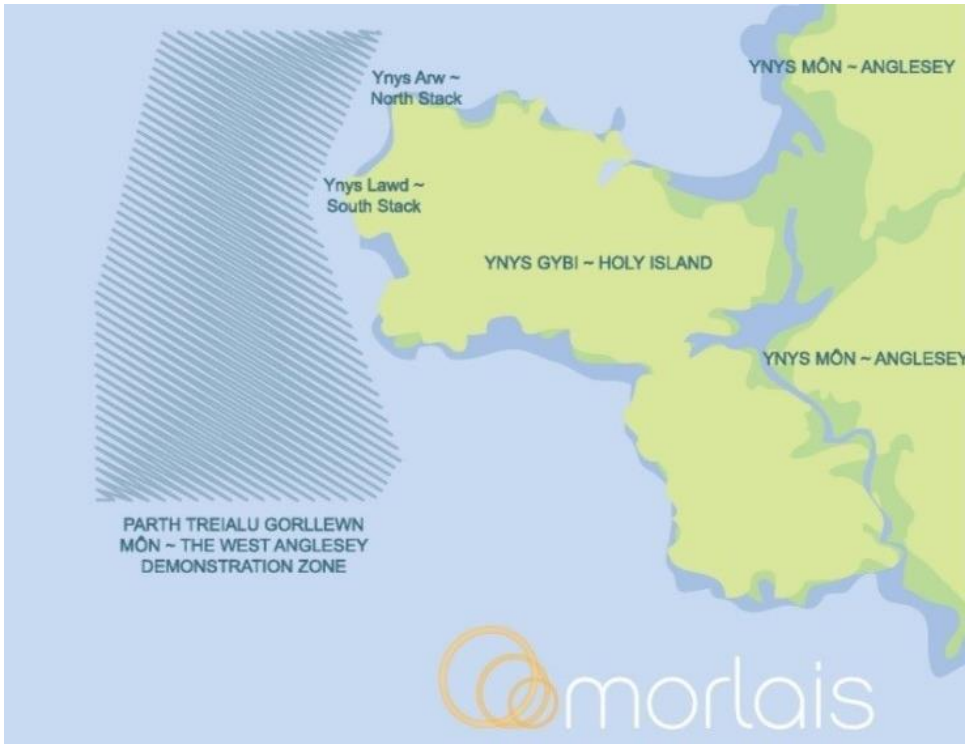


Figure 31: Morlais Demonstration Zone off the coast of the Isle of Anglesey

Other renewables

The Energy Vision scenario also includes increases in the deployment of ground-mounted solar PV, 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.

Storage and flexibility

No large-scale batteries have been installed to date in North Wales; however, North Wales hosts two pumped hydropower sites totalling 2,088 MW capacity. Pumped hydropower is an essential part of the UK's electricity network and has been a feature of the North Wales energy landscape since the 1960s. The Dinorwig power station runs on a Short-Term Operating Reserve (STOR) contract to meet rapid changes in electricity demands, while the Ffestiniog storage plant is used primarily to meet peak loads.

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

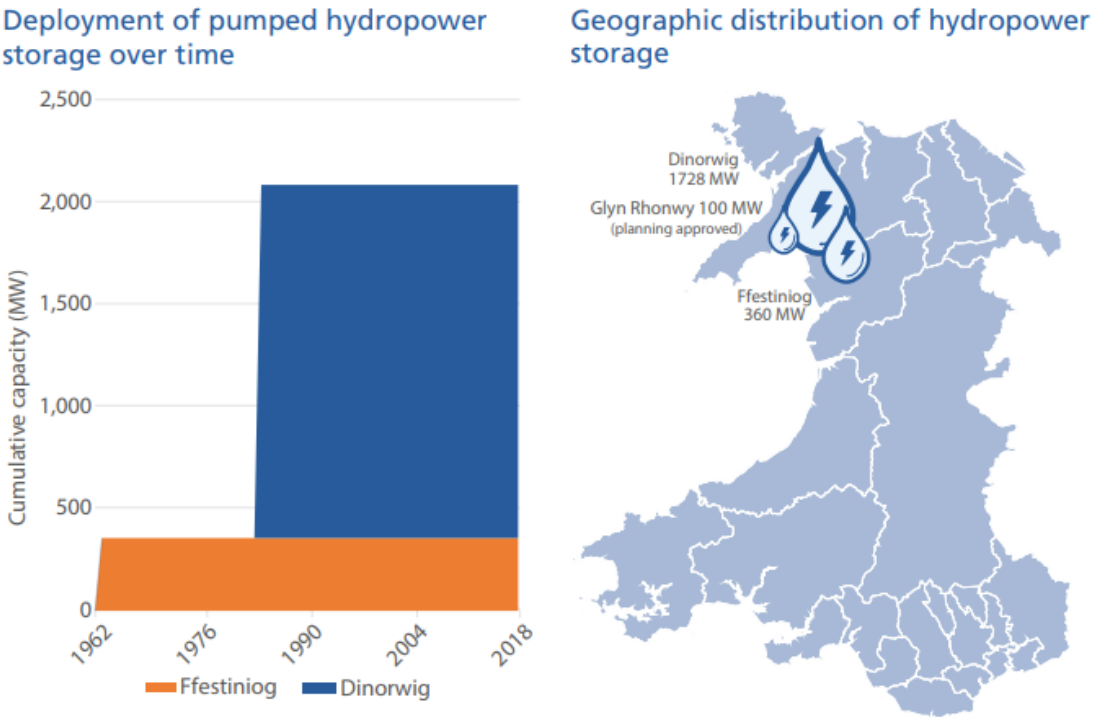


Figure 32: Pumped hydropower storage in North Wales. Source: Energy Generation in Wales, 2018

Table 5: Scenario summary: electricity generation

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Renewable generation	Over 2.8 GW of offshore wind 1 GW tidal lagoon 300 MW of small scale modular nuclear reactors 180 MW of tidal stream 310 MW of onshore wind	Generating the equivalent of over 388% of electricity consumption in 2035	Significant contribution towards reduction in UK grid carbon factor

Future progress

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

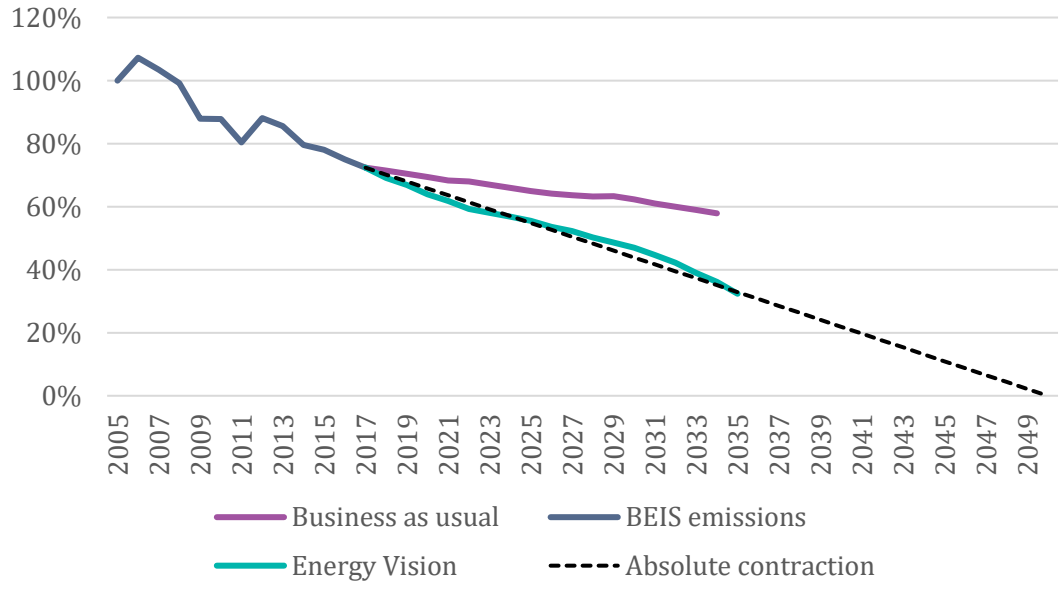


Figure 33: Decarbonisation trajectories in North Wales. Source: WGES analysis

Under a Business as Usual scenario, North Wales is expected to achieve only 22% decarbonisation by 2035, approximately half of the 55% needed to be on track for net zero. 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.

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[27] and the Committee on Climate Change[28], the scenario prioritises "clear, urgent, no regrets" actions. The modelling sets out the following key challenges to be achieved by 2035:

- Domestic: how can North Wales achieve deep energy efficiency retrofits on almost all of its worst performing stock, support energy efficiency measures in the remaining stock and install renewable heat technologies in 67,000 homes?
- Non-domestic: how can North Wales reduce energy demand from its commercial and industrial organisations by 16%?
- Transport: how can North Wales ramp up the rate of electric vehicle sales, install around 2,000 public EV chargers and invest in electrified public transport and low carbon HGV fuelling networks?
- Renewable electricity generation: how can North Wales support the deployment of further offshore wind and the development of small modular reactors?

Post-2035 challenges and innovation

Beyond 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

- How can North Wales support the role for hydrogen in industrial clusters?
- Where would low carbon hydrogen be sourced from and what is the role of the HyNet North West project?
- What is the role for carbon capture and storage technologies in supporting the decarbonisation of heavy industry?

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

Transport

- How can North Wales go further in reducing in its per capita road miles and support a shift to greater use of public transport?

Low carbon generation

- How can the region work together to overcome network infrastructure issues?
- Is there a role for large-scale nuclear in the region in the longer 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,
- in the job intensity required to produce electricity because this is unique to each generation technology,
- in how expensive new technologies are to install, construct, and operate, and
- in how cash 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 energy prices are not included in analysis. Where possible, we have sought to estimate the specific changes to the North Wales economy.

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 below visualises these concepts.

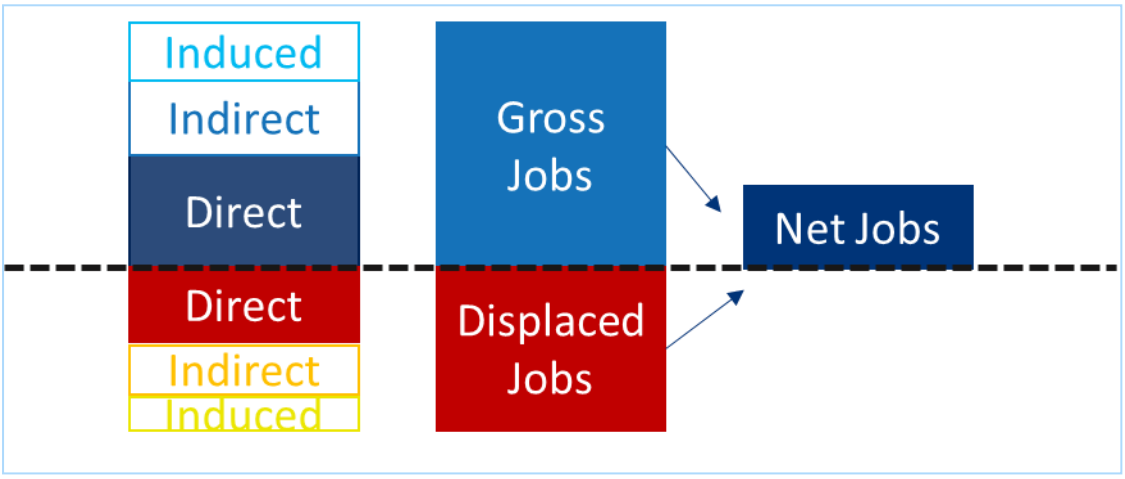


Figure 34. Shows the relationship between gross, displaced, and net jobs. Indirect direct and induced jobs are also shown. Indirect and induced jobs have not been filled with colour because these jobs are not taken into account in this analysis. [29]

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 *North Wales*; other jobs may be held by those who travel into the region to perform their roles.

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

Electricity generation

The results from assessing the economic impact related to the change in energy generation technologies estimate that achieving the energy system vision scenario will require nearly £750 million of additional investment, equivalent to approximately £50 million per year, compared against the business as usual scenario. This spending 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 7,400 additional annual jobs and contribute nearly £850 million more in GVA than the business as usual scenario between 2020 and 2035. The location of these additional jobs is an important question and a difficult one to answer with a precise number. Construction, operation and maintenance jobs will occur locally – however manufacturing jobs may occur inside of outside of the region. Likewise, persons could travel into the region to provide operational support while being based elsewhere. Ultimately, a portion of the jobs figures presented are likely to be located within North Wales however other jobs will be held by persons resident outside of the region. In order help the region benefit from jobs associated with future local electricity generation it will be important to fist understand the reason why operation and maintenance jobs may be located outside of the region in order to develop a policy response.

summarises the additional investment, jobs, and GVA associated with the Energy System Vision (ESV) scenario.

Table 6 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 7 summarises the additional investment, jobs, and GVA associated with the Energy System Vision (ESV) scenario.

Table 6. BAU and ESV economic impact2020- 203530

Scenario	Gross Jobs including losses*	Discounted GVA	Discounted Investment
Business as usual (BAU)	46,600	£ 5.9b	£1.1b
Energy system vision (ESV)	64,400	£ 7.8b	£10.4b
**Gross and annual 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. Non-manufacturing direct electricity generation jobs are typically more likely to be held by residents local to an energy site. The experience of Wales to date is that many of the long term operational and maintenance jobs associated with these technologies are held my persons outside of the region who travel into Wales to perform their duties.*			

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

Table 7. Difference between the ESV and BAU scenarios 2020-2035[31]

Scenario	Net Jobs	Discounted GVA	Discounted Investment
Difference between ESV and BAU	17,700	£1.9b	£9.2b
Difference between ESV and BAU (percentage)	+38%	+34%	+824%

Investment

In terms of investment, the energy system vision scenario requires substantial additional investment, largely associated with the amount of new electricity generation included in the scenario, as well as the specific technologies involved. Two areas of greater uncertainty in the estimated investment are worth noting. First, the energy system vision scenario includes 1 GW of tidal lagoon capacity in 2035. Tidal lagoon costs represent £3 billion of the energy system vision costs, representing 30% of the total energy system investment, the second largest additional investment compared to the business as usual. It should be noted that the capital and development cost estimates for tidal lagoon are more uncertain than for other technologies because there is less cost data available. This is due to the fact that no tidal lagoon powerplants have been developed in the UK. The second area with more uncertainty revolves around the investment required with small modular nuclear reactor development which is the third largest ESV investment area by technology, accounting for ~£1.3 billion of investment or 13% of the ESV investment costs. Traditional nucelar costs/MW have been used to estimate the investment associated with nucelar technology. Small Modular Nuclear reactors are a nacent technology with less well defined cost data available. The economic assessment shows that Offshore wind requires the largest additional investment to achieve the energy system vision ahead of the tidal lagoon and small modular nuclear reactor. Figure 35 shows the breakdown of the additional estimated investment required by technology area to achieve the energy system vision scenario compared with the business as ususal scenario.

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

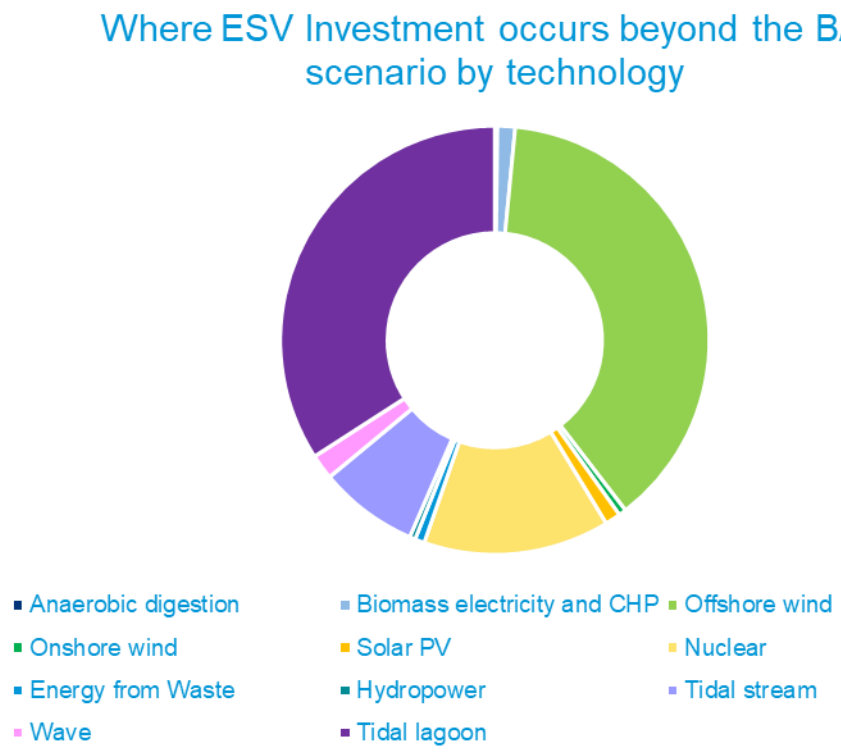


Figure 35. Where ESV Investment occurs beyond the BAU scenario by technology

Jobs

The jobs figures presented in table 6 include both the jobs associated with increases in capacity and output from some generation technologies (for example offshore wind) as well as the fact that some jobs will be lost as the capacity and output from fossil-fuel based generation technologies falls.

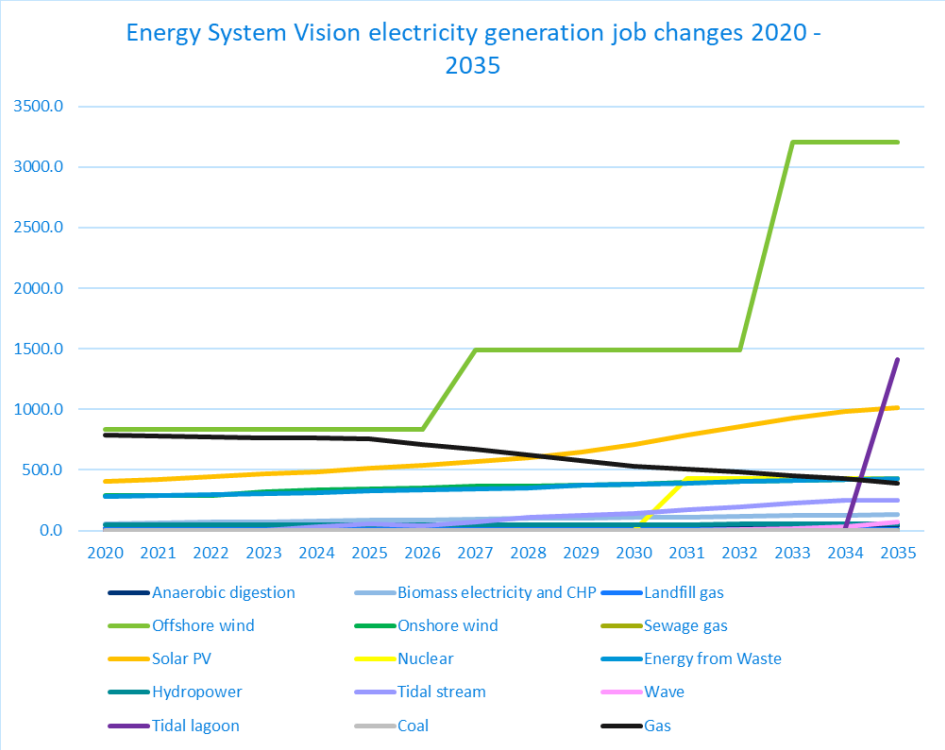


Figure 36. ESV Gross Jobs including job losses

It is estimated that in the energy system vision scenario electricity generation is responsible for 64,407 direct gross jobs from 2020 to 2035.

Figure 37 looks at which technologies in the energy vision scenario supports additional jobs in comparison with the business as usual scenario. The difference between the two scenarios (known as net jobs) represents the net additional jobs supported by the energy system vision in comparison with the business as usual. Onshore represents that largest difference in jobs between the two scenarios, followed by solar PV and nuclear.

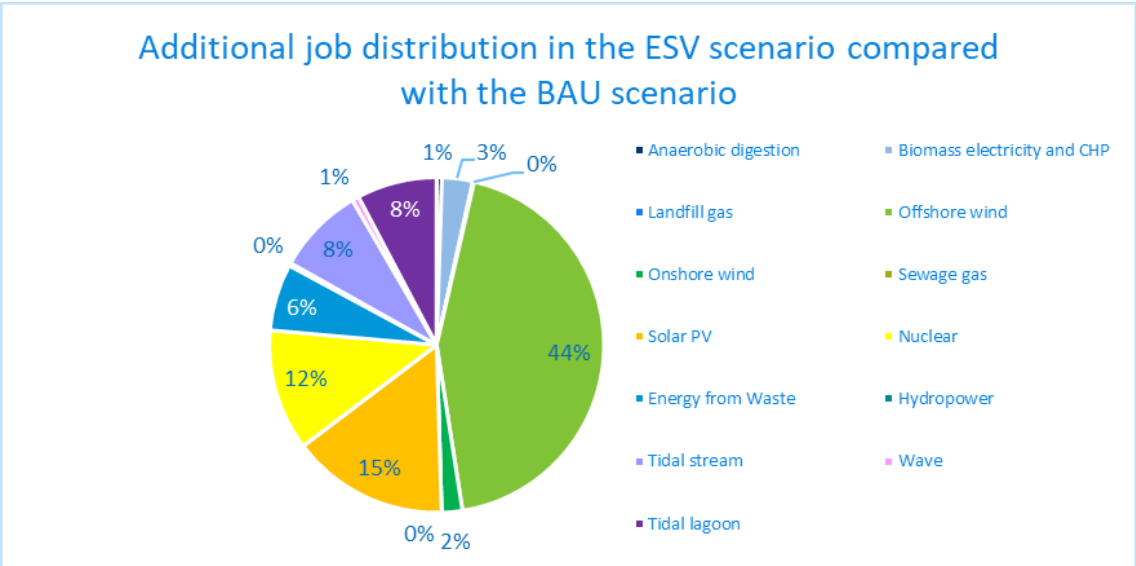


Figure 37: Additional Job distribution in the ESV scenario compared with the BAU scenario

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 8.

Table 8 shows that the energy system vision requires approximately 1.45 times the investment and jobs compared with the business as usual scenario. Additionally, it supports approximately 1.45 times the GVA associated with the business as usual scenario.

Table 8. Domestic Energy Efficiency additional economic impact of the ESV scenario compared with the BAU scneario from 2020 -2035[32]

Scenario	Net jobs	Discounted GVA	Discounted Investment
Business as usual (BAU)	14,800	£880b	£3.1b
Energy system vision (ESV)	21,500	£1.3b	£4.5b
Difference between ESV and BAU	6,600	£397m	£1.4b
Difference between ESV and BAU (percentage)	45%	45%	45%
* Figures are rounded. ** 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 38.

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

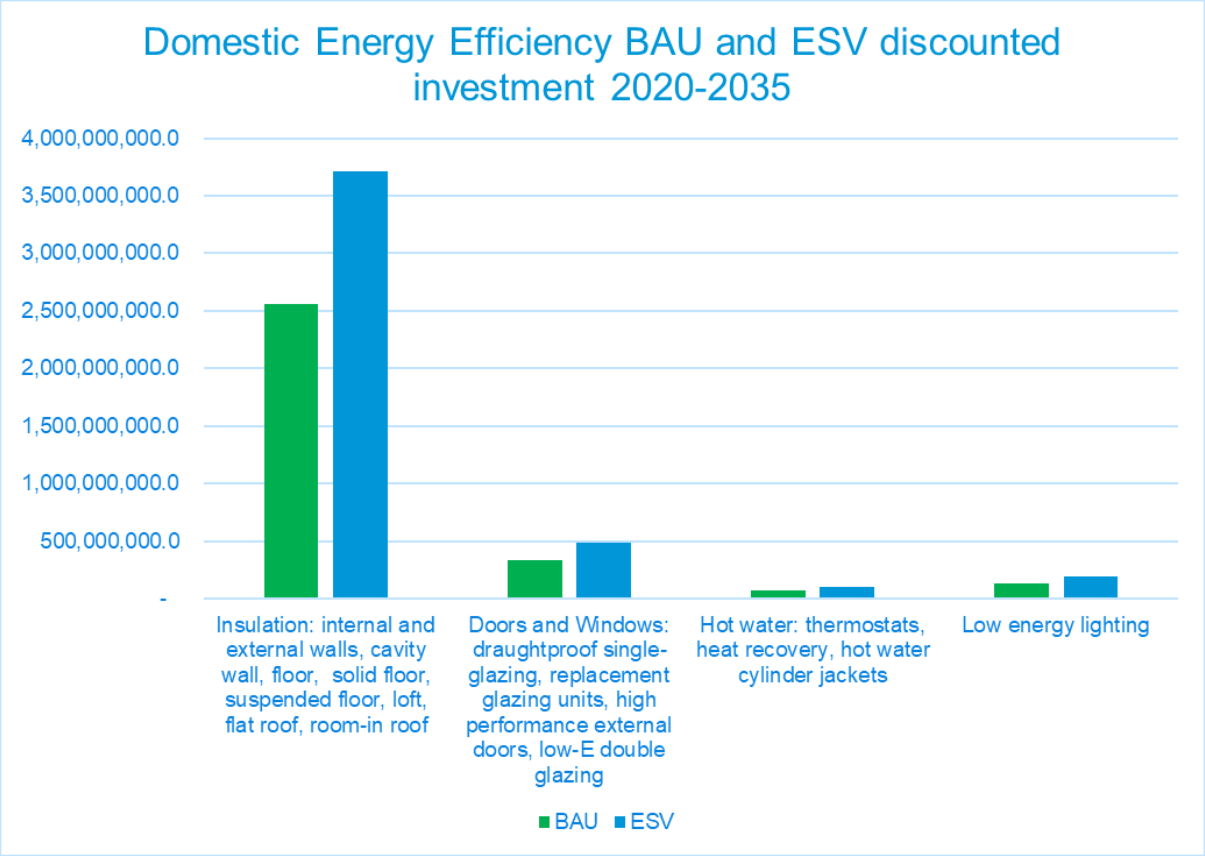


Figure 278. BAU and energy efficiency Investment requirements 2020- 2035

Jobs

Approximately 6,700 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 (51%) of the additional jobs in the ESV scenario relate to installation of 50 mm internal or external wall insulation, 17% of jobs relating to floor insulation and 6% of jobs relate to the replacement of single glazed windows with low-E double glazing. Figure 39 below show the estimated jobs required to implement the energy efficiency measures that relate to the EPC shift in the BAU and ESV scenarios.

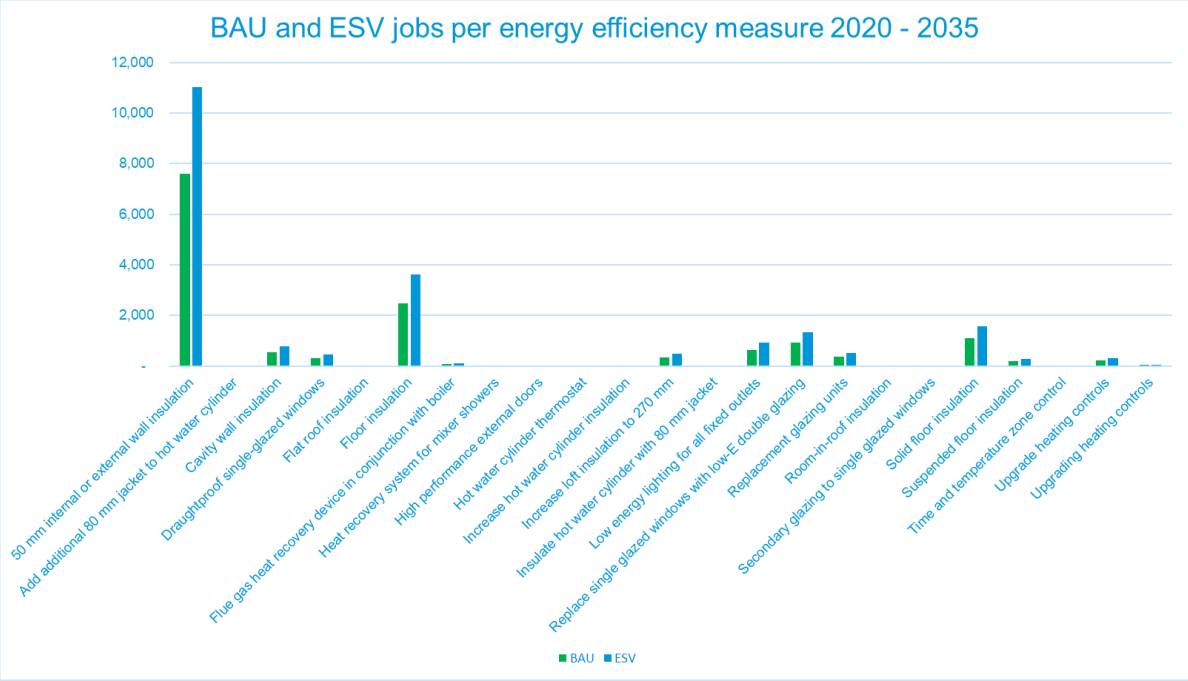


Figure 3928. Net BAU and ESV jobs per energy efficiency measure 2020 – 2035.

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 heating technologies is 298% greater than the BAU while the energy system vision scenario requires nearly 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 9 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 40.

Table 9. BAU and ESV economic impact as well the difference between ESV and BAU economic impact 2020- 203533

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)	650	£65m	£161m
Energy system vision (ESV)	1,800	£257m	£463m

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

Difference between ESV and BAU	1,216	£192m	£301m
Difference between ESV and BAU (percentage)	+188%	+298%	+187%
*For domestic heat it is difficult to link jobs to the local economy. This is because the jobs calculated are related to the manufacturing of heating technologies and products as well as their installation. A portion of these jobs is likely to be located within North Wales; however other jobs will be held by persons resident outside of the region.			

Investment

Figure 40 reflects that the shift to low carbon heating in the ESV scenario happens faster and at largest scale than the BAU scenario. For example, between 2020 and 2025, the ESV see less investment in gas boilers reflecting a faster shift away from this technology. The most predominant trend is across all year is that a substantial amount of additional investment is required in air source heat pumps. Investment particularly increases from 2028 in relation to air source heat pumps. Additionally, the BAU and ESV scenarios reflect different ground source heat pump installation pathways. The ESV scenario has less ground source heat pump investment from 2026 onward.

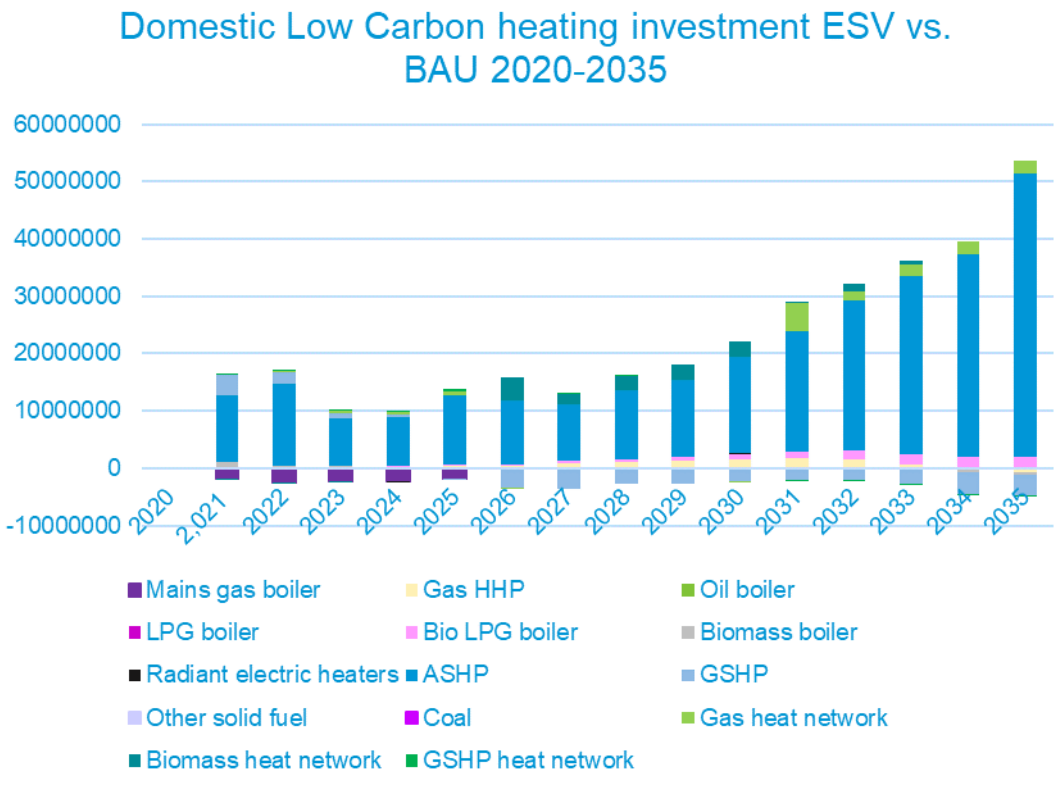


Figure 40. ESV vs. BAU discounted heat investment 2020 – 2035. Discounted at a rate of 3.5%.

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 41 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 North Wales while other jobs may be held by those residing outside of the region.

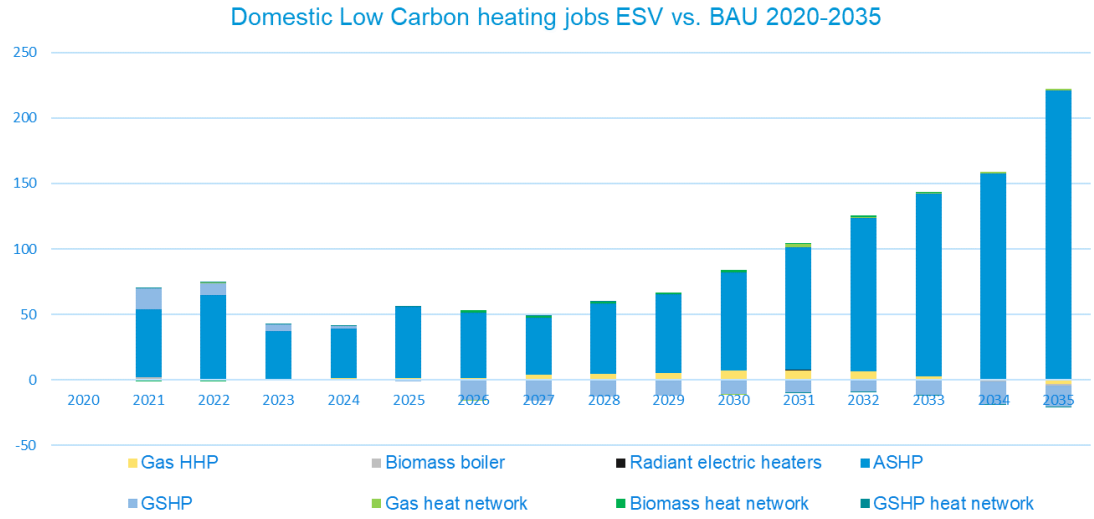


Figure 41. Domestic Low Carbon heating jobs ESV vs. BAU 2020-2035

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 when compared against the business as usual scenario. The economic analysis demonstrates that £10.9 billion of additional investment is needed to achieve the energy efficiency, electricity generation, and heat aspirations described in the energy vision between now and 2035. This represents approximately £732 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 24,400 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 £2.4b more GVA (discounted at 3.5% over the period 2020-2035). In addition, it is estimated that there will be 1,216 more gross jobs associated with the provision of low-carbon heating technologies in the ESV scenario than the BAU scenario, associated with £192m of GVA.

Next Steps

Next Steps

The North Wales Energy Strategy has undertaken several important first steps towards addressing the climate emergency in North Wales. We have developed a collaborative vision for the future energy system in North 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 achieved 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 for the region to take forward, with the support of WGES, in order to transition from a strategy to real world action in the delivery of our North Wales energy system vision:

1) **Defining the strategy governance.** North Wales will establish a robust and formal governance structure for the Energy Strategy with support from WGES. 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.** The region with support from WGES 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 North Wales. This activity will help to align a diverse stakeholder group to the North Wales energy vision and raise awareness of insights arising from the analysis and engagement undertaken as part of the strategy development.

3) **Establishing an action 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 North 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 vision that reflects

the values demonstrated by stakeholders throughout the development of this strategy.