Prifddinas Ranbarth Caerdydd | Cardiff Capital Region

Cardiff Capital Region Energy Strategy

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Contents

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Executive Summary

Executive summary

This regional energy strategy for the Cardiff Capital Region was commissioned by the Welsh Government and supported by the Welsh Government Energy Service. It has been developed by Cardiff Capital Region City Deal with additional support from regional stakeholders. In this report the use of "We" refers to this collective group of stakeholders.

The overall objective of the strategy is to develop a strategic pathway identifying key interventions to deliver on the region's ambitions for decarbonising its energy system. 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 Cardiff Capital Region (CCR) is:

To create the conditions for a transition to a carbon neutral economy and society in the CCR, using low carbon energy as an enabler of economic regeneration, growing our regional income whilst maintaining guardianship of our environment through a laser-focus on clean growth.

Our priorities for achieving this vision are:

1. Energy efficiency and heat
2. Electricity and flexibility
3. Decarbonise transport
4. Grow business and jobs
5. Coordination, planning, regional support and ownership of the plan

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

- Cardiff Capital Region currently consumes around 36% of all energy consumed in Wales, less than its 49% share of the population;
- Between 2005 and 2013, total energy consumption fell by 22% and since 2013, energy consumption in the region has remained relatively stable. The associated greenhouse gas emissions have fallen by 35% from 2005 to 2017;
- The region's total energy demand is split roughly into thirds across transport, domestic heat and power, and commercial/industrial heat, power and processes.

- Commercial and industrial electricity consumption constitutes 55% of all electricity consumption in the region, approximately 10% less than the Great Britain average;
- Renewable assets located in the Cardiff Capital Region currently generate the equivalent of 25% of the region's electricity consumption;
- Cardiff Capital Region currently hosts 22% of Wales' renewable energy capacity, with 311MW of solar PV and 299MW of onshore wind;
- Of the 709MW of renewable energy installed capacity in the region, 221MW (31%) is locally owned;
- 50% of renewable generation in CCR is from onshore wind projects and 18% is from solar PV;
- CCR has the lowest number of renewable heat installations with just 0.2% of homes having a heat pump or biomass boiler;
- 90% of homes are connected to the gas network, the highest of any Welsh region and above the GB average.
- Approximately 27,000 homes (~4%) are currently fuelled by oil, LPG, coal or other solid fuels;
- The average EPC rating is D and the region has the highest average energy efficiency ratings in Wales, with 75% of homes rated as EPC band D or above.
- Transport in the region is dominated by private car use with ~0.3% of cars pure electric, compared with an average of 0.6% of vehicles across Great Britain.
- CCR currently hosts 173 public charging devices, including 31 rapid public chargers.

Note on scope: the baseline assessment and strategy is focussed on the energy system only, covering power, heat and transport. Very large industry is excluded due to a lack of data availability, and it does not include greenhouse gas emissions or sequestration from non-energy related activity such as land use. The large industrial users should be included in the Zero2050: South Wales project led by National Grid.

Achieving our energy vision for Cardiff Capital Region: to meet Welsh Government targets, and to be on track for net zero by 2050, Cardiff Capital Region needs to reduce emissions from its energy system by 55% by 2035, split by sector as follows:

- 51% reduction in domestic heat and power emissions;
- 54% reduction in commercial and industrial emissions;
- 60% 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:

- 154,000 homes improved from EPC band G, F and E to D, C and B;
- Over 140,000 heat pumps installed;
- 42,000 suitable houses accurately fitted with internal or external wall insulation;
- Over 185,000 other insulation measures in homes;
- 112,000 homes currently heated by fossil fuels to move to low carbon heating;
- Replacing heating systems in oil, LPG and solid fuel heated homes prioritised;
- No new gas connections for homes from 2025.

Commercial and industrial:

- A significant energy efficiency programme to reduce energy demand by 13%;
- A switch to alternative fuels, including hydrogen and electrification of heating;
- Decarbonising the electricity network through renewables and behind the meter renewable generation.

Road transport:

- 64% of vehicles driven in Cardiff Capital Region in 2035 are electric, equivalent to 15,000 more electric vehicles per year by the mid-2020s, peaking at 70,000 per year in the 2030s. This is to be facilitated by the deployment of 10,000 public and on-street EV chargers;
- 3,300 gas and hydrogen HGVs and 1,000 hydrogen vehicles;
- A 20% 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:

- 532MW of onshore wind installed (233MW of new capacity);
- 830 MW of solar PV installed (520 MW of new capacity of which 190 MW is roof-mounted and 325 MW from solar farms.);

- Sufficient flexibility, including storage, and network infrastructure upgrades to enable low carbon generation and demand technologies to connect;
- The region to generate the equivalent of ~50% of its total energy consumption in 2035 from regional renewable sources.

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. One such alternative which has been developed is the Energy Network Association's "Pathways to Net Zero". The Pathways to Net Zero report focuses on a hybrid heat pump first approach. Wales and West Utilities has completed extensive research into its 2021-26 business plan which builds on this approach, the details of which are described in later chapters. What is clear is that different pathways all must achieve significant decarbonisation; should less action be achieved in any of the areas summarised 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 almost £3.4 billion of additional investment/spending is needed to achieve the energy efficiency, electricity generation, and heat aspirations described in the energy vision between now and 2035. This represents approximately £227 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 65% 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 16,700 net jobs, with an associated increase in GVA of nearly £1.7 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 3,000 more gross jobs associated with the provision of low-carbon heating technologies in the ESV scenario than the BAU scenario, associated with £361 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[1]. However, we are unable to comment on the specific location of the jobs estimated; a portion of the jobs are likely to be located in the Cardiff Capital Region 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 to help Cardiff Capital 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.

Note: please refer to the economic modelling chapter and technical annex for details on data sources, limitations and methodology.

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

Energy vision scenario for:	Jobs**	GVA	Investment required
Electricity generation*	7,400(net) **(+23%)**	£853m **(+21%)**	£748m **(+204%)**
Domestic heat	3,000 (gross) **(+311%)**	£361m **(+320%)**	£701m **(+277%)**
Domestic energy efficiency***	9,300 (net) (**+43%**)	£555m (**+43%**)	£1.9b **(+43%)**
Total additional investment required to achieve the energy vision scenario			**£3,405,554,659**
** 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 by persons outside of the region who travel into Wales to perform their duties. In order to 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.* ****Data on the percentage change across all indicators for commercial and industrial 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

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

economic and societal costs of the pandemic for Cardiff Capital Region 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 Cardiff Capital Region 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: Achieving a net zero energy system in Cardiff Capital Region presents many challenges including, but not limited to, tackling deep retrofit in a large number of homes, reducing private car miles and enabling the low carbon vehicle roll-out including electric and hydrogen vehicles. There is an urgent need for action, using the growth deal and more broadly engaging stakeholders from across the region to deliver transformational projects. However, decarbonisation also faces many potential benefits for the region, from enacting significant energy efficiency programmes to creating investment opportunities for local people and organisations. The transition to a decarbonised economy will also provide exciting opportunities in engineering, the digital and retrofit markets as well as local skills and employment.

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.

Acknowledgements: 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

In 2018, the Welsh Government commissioned the Welsh Government Energy Service to provide support to the Cardiff Capital Region City Deal and a number of regional partners and stakeholders such as the Economic Growth Partnership, the Business Council, Skills Partnership and Transport Authority to develop an energy strategy for the Cardiff Capital Region.[2] Similar regional energy strategies have also been developed with the remaining three economic regions of Wales.

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 accepted the recommendation from the Committee on Climate Change (CCC) to target a 95% reduction in greenhouse gas emissions by 2050 relative to 1990. After the Welsh Government accepted the CCC's recommended target, it presented in parallel an ambitious plan to go further and reach "net zero" by 2050. Wales had already announced in 2017 their ambitions for the Welsh public sector to be carbon neutral by 2030. The desire of the Welsh Government to aim for a more ambitious pathway than the one advised by the CCC is partly due to the unique legislative framework for climate policy that applies to Wales. The Well-being of Futures Generations (Wales) Act 2015 provides a ground-breaking legal framework for improving the social, economic, environmental and cultural well-being of Wales embracing the idea of a prosperous nation rather than an economic rich one. It mandates that all policy must contribute to sustainability and not undermine long-term goals.

Achieving this climate change 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 Cardiff Capital Region. 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 experiences and would also benefit from an increased strategic focus.

The work has coincided with tremendous efforts that are underway to develop a City Deal for the region. Desired outcomes for the work include the identification of strategic projects that can be considered by the City Deal. More broadly, the plan

[2] Full list will be in the Appendix.

provides a considered approach and an evidence base for the region to move forward collaboratively towards a future decarbonised energy system through more tailored, detailed Local Area Energy Planning. 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 the Cardiff Capital Region. 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 Cardiff Capital Region 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 Cardiff Capital Region energy system vision into reality.

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 Cardiff Capital 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.

CCR have recently reconsidered and endorsed revised programme priorities in terms of reaction to COVID-19 and future economic adaptation. In this context, it is hoped that with the commitment to decarbonisation that CCR is making, that there will be acknowledgement that our economic recovery and growth plans need to be developed as part of driving down greenhouse gas emissions. We need to recognise the significant economic potential that a green recovery can contribute to rebuilding a sustainable economy in CCR.

The Committee for Climate Change (CCC)[3] has identified 6 key principles for a resilient recovery from the pandemic, and we must ensure that our strategy is underpinned by these cross-cutting principles to help put CCR 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

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

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 restrictions, and the process and timeframe through which the social distancing will be eased; or, indeed, whether we will encounter a subsequent lockdown in the future, whether at national or local levels. We must therefore acknowledge the significant uncertainties that exist around how the CCR 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, CCR 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 CCR 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

To create the conditions for a transition to a carbon neutral economy and society in the CCR, using low carbon energy as an enabler of economic regeneration, growing our regional income whilst maintaining guardianship of our environment through a laser-focus on clean growth.

The principles behind the vision

Our vision is guided by three core principles:

Core Principles

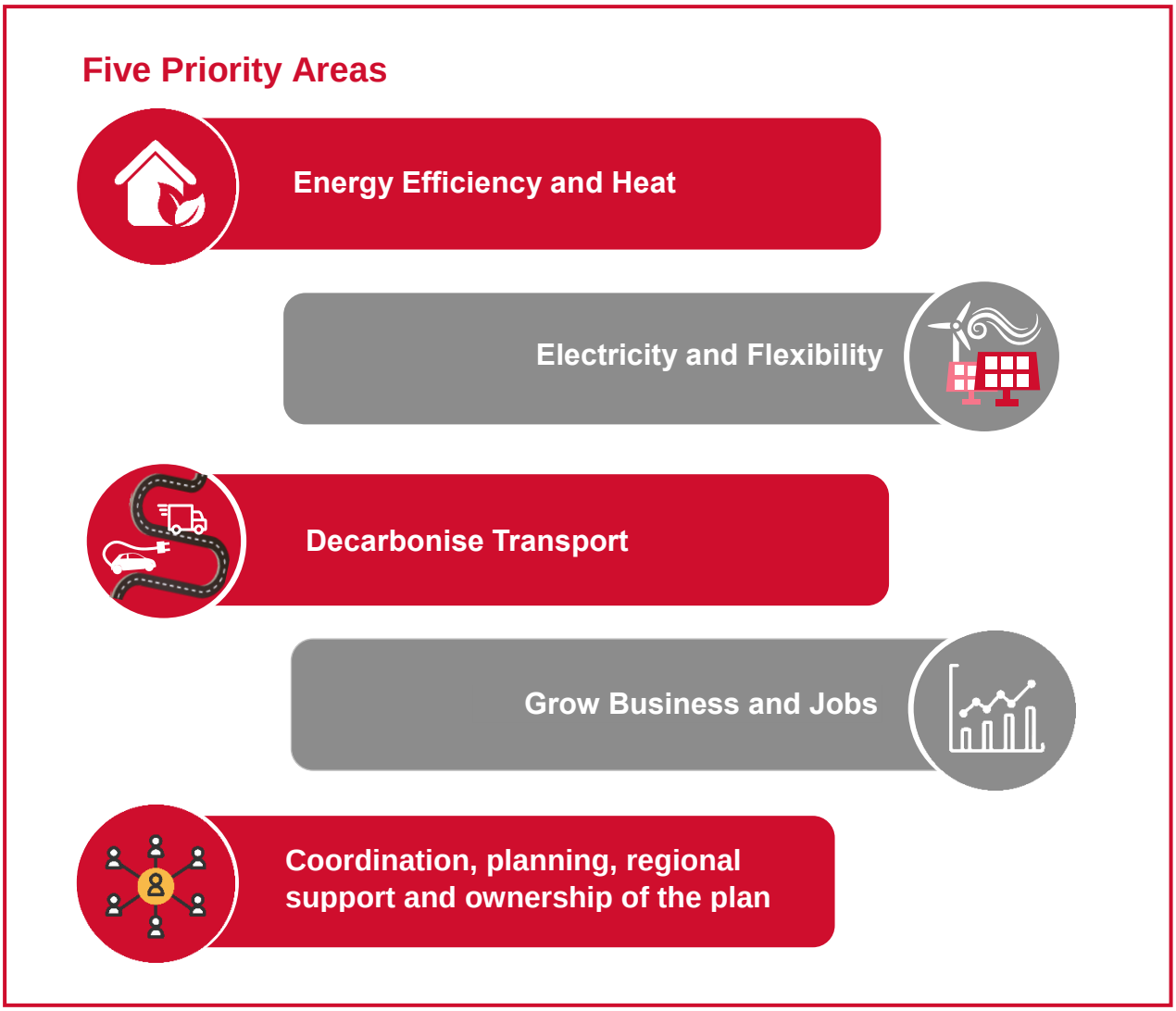
- **Act as an enabler to a sustainable regional economy:** deliver inclusive employment, profits and skills, lower costs and open up markets, and stimulate public and private investment in capital projects that deliver low carbon improvements across the region.

- **Contribute wider benefits to the region:** including alleviating fuel poverty, sparking innovation and developing local training and skills for people and businesses.

- **Decarbonise the energy system to meet national targets as a minimum**: make significant carbon reductions across all sectors, to have energy efficiency as a core focus, and to have a multi-vector system, that includes a range of low carbon technologies, that meets needs affordably and balances the best use of existing assets and resources.

Our priorities

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



Energy Efficiency and Heat

- Deliver fabric improvements (e.g. window glazing, internal wall and roof insulation) to the region's existing and new builds including delivering a whole house retrofit approach to the existing housing stock, to improve energy efficiency and deliver cost savings.
- Build new homes to align with evolving 'Part L building regulations' including developments currently with planning permission.
- Help homeowners understand the benefits of energy efficient housing including cost savings, improved comfort and health.
- Utilise alternative fuels for heat including hydrogen, bio-methane and solar thermal.
- Develop flexible and hybrid heating solutions e.g. hybrid heat pumps, building on the learnings from the Freedom project based in Bridgend.

Electricity and Flexibility

- Ensure there is a mix of generating technologies across the region to provide resilience and flexibility.
- Encourage local development of renewable energy projects by public bodies on publicly owned land to increase revenue generating potential for public bodies and to increase public ownership.
- Map renewable energy potential against upcoming developments, particularly developments of regional level scale.
- Pilot energy/battery storage projects to maximise renewable energy potential and build on previous trials in Cardiff and Bridgend.
- Encourage uptake of smart meters, ensuring the public sector has smart meters installed across its estate, to open up the potential of load shifting and access to balancing/flexibility markets.
- Adopt generation technologies, demand patterns and battery storage technologies which reduce loads on the distribution network and work with the DNO to maximise the capacity of the existing network.
- Encourage low carbon technologies e.g. LED lighting, and invest in behaviour change programmes to reduce consumption
- Encourage smart digital integration and support wider local innovative grid flexibility pilots for roll out across the region.

Decarbonise Transport

- Prioritise investment in public transportation.
- Make public transport services more affordable and convenient to encourage a modal shift from private transport.
- Enable changes in people's travel methods capitalising on changing behavioural patterns as a result of the Covid-19 crisis.
- Promote electrification of public transport and build on trials including electric buses in Caerphilly and Cardiff, and the decarbonisation of the South Wales Metro.
- Encourage use of active travel modes e.g. walking and cycling.
- Develop an electric vehicle charging infrastructure, in collaboration with Transport for Wales and OLEV, taking a coordinated approach across the region e.g. the Gwent study, and encourage public sector fleet transitions to EVs.
- Lobby for additional Metro nodes to increase rural accessibility and connectivity.
- Ensure metro stations are integrated with other economic priorities and housing.
- Work with Welsh Government to identify a solution to the Newport/Cardiff trunk road bottleneck and consider addition of a dedicated bus lane.
- Consider hydrogen as an alternative fuel source where electrification is less suitable e.g. HGVs.
- Encourage the shift towards home-working created by Covid-19 especially in rural areas.

Grow Business and Jobs

- Create a commercial property strategy which incorporates access to renewable energy sources and access to public transport links
- Promote continued research into battery and hydrogen technologies, and continue to develop academic excellence in this field
- Develop supply chain opportunities for energy efficiency retrofit and renewable energy manufacturing
- Evaluate the region’s capacity and capabilities in retrofit and renewable energy deployment and develop training opportunities/incentives as necessary.

- Build on the region's strong reputation for research and innovation through engagement with Higher Education Institutes, including developing digital and "smart" solutions to energy transitions, as well as future proofing ongoing developments.
- Upskill and retrain the workforce to ensure the industrial sector needs are balances with local needs, and that it delivers support to those people and places that are most likely to lose out from economic and technical change.

Coordination, planning, regional support and ownership of the plan

- Deliver against a shared vision and approach.
- Demonstrate aligned ambition and leadership across the region with plans agreed and championed by Chief Executives and leaders.
- Maximise economies of scale potential through the facilitating role of the region and through collaboration with other regions.
- Governance to use the framework for the City Deal Investment operations and will consult with the Regional Economic Partnership, Regional Business Council and Regional Skills Partnership. This will provide an enduring organizational structure which will secure the long-term delivery objectives of the plan.

Our energy system, energy use & emissions

Our 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 Cardiff Capital Region 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 describe a potential decarbonisation pathway 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 rapid evolution of technologies and pathways means there are uncertainties and varying opinions about the precise route forward. One such alternative is the Energy Network Association's "Pathways to Net Zero" which proposes pathways for decarbonising heat. Wales and West Utilities has completed extensive research into its 2021-26 business plan which builds on this alternative, the details of which are described in more detail in the chapter below. What is clear from research is that different pathways all must achieve significant decarbonisation.

The energy system vision pathway modelled 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 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 CCR 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[4]. 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 to Parliament[5]. 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 CCR 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[6,7]
- National Grid's Future Energy Scenarios[8]
- The project team's past work on future energy scenarios for Wales & West Utilities and for Western Power Distribution[9]
- Engagement and workshops with local, regional and national stakeholders.

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

The methodology results in a bottom-up, stakeholder-informed Energy Vision for CCR

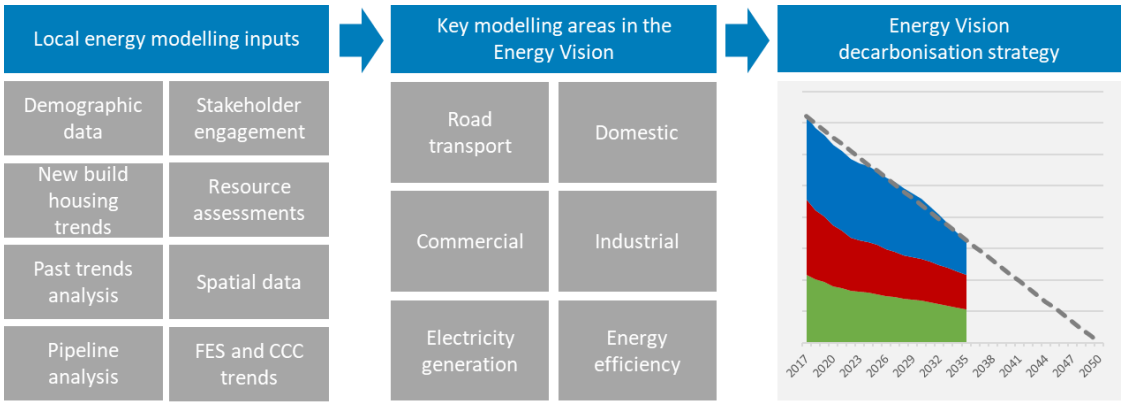


Figure 2: Outline modelling methodology

Worked example: The modelling approach for domestic heat

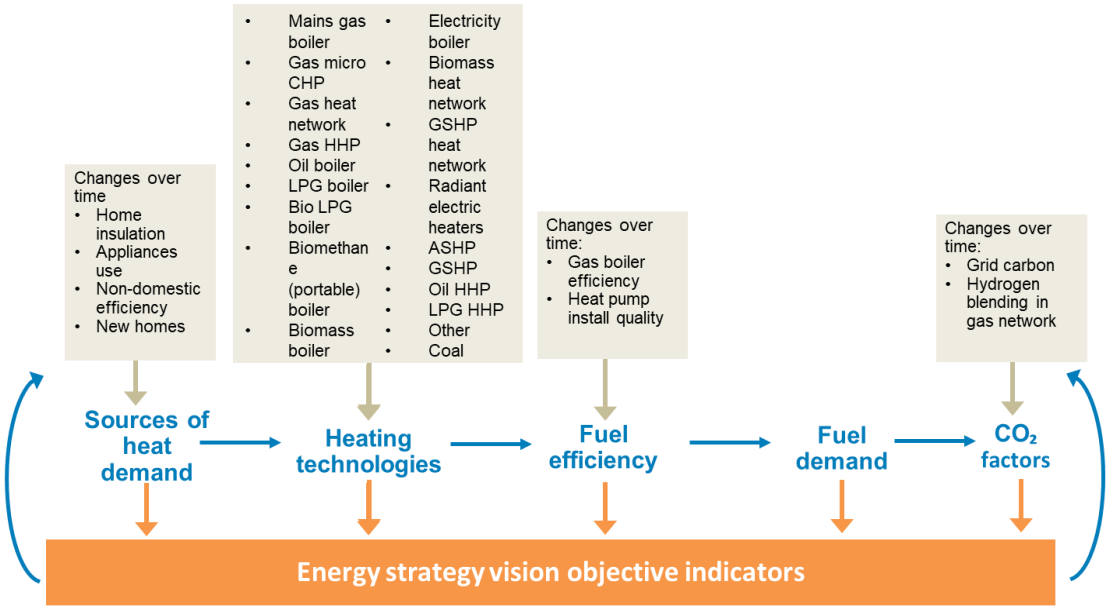


Figure 3: Diagram of the modelling approach for domestic heat

A note on scope

The strategy is focused on emissions associated with the energy system in CCR. 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 such as the SWIC, as expanded on in the introduction.

Baseline and modelling results: by sector

Our Energy consumption

Baseline: energy consumption by sector

CCR currently uses around 32 TWh of energy[10]. The region accounts for around 36% of all energy consumed in Wales[10], which is less, on a pro-rata basis, than its 49% share of the Welsh population[11]. Fuels used to generate electricity are not included in this analysis, which is focussed on final consumption.

The region's total energy demand is split roughly into thirds across transportation, domestic heat and power, and commercial/industrial heat, power and processes[7].

CCR is the most urban region of Wales with the highest proportion of buildings connected to the gas network and so is the Welsh region with the highest consumption of gas, but also the lowest emissions per household due to the low number of homes heated by other, high carbon fossil fuels.

Energy consumption in CCR by sector and fuel

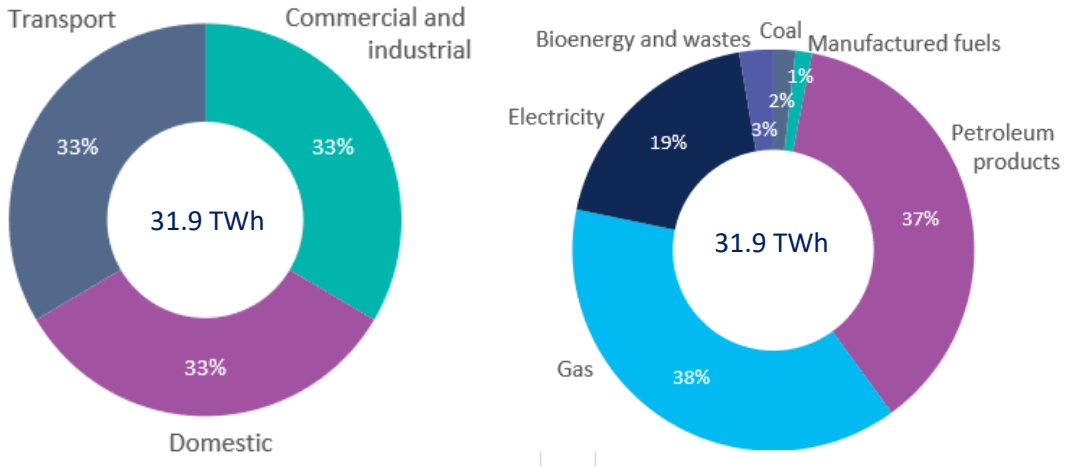


Figure 4: Breakdown of energy consumption in Cardiff Capital Region. Source: BEIS sub-national total final energy consumption, 2019.

[10] BEIS (2019) Regional and local authority electricity consumption statistics 2005 to 2018

[11] StatsWales (2019) Population estimates by local authority and year

CCR's trend for decreasing energy consumption has plateaued in recent years

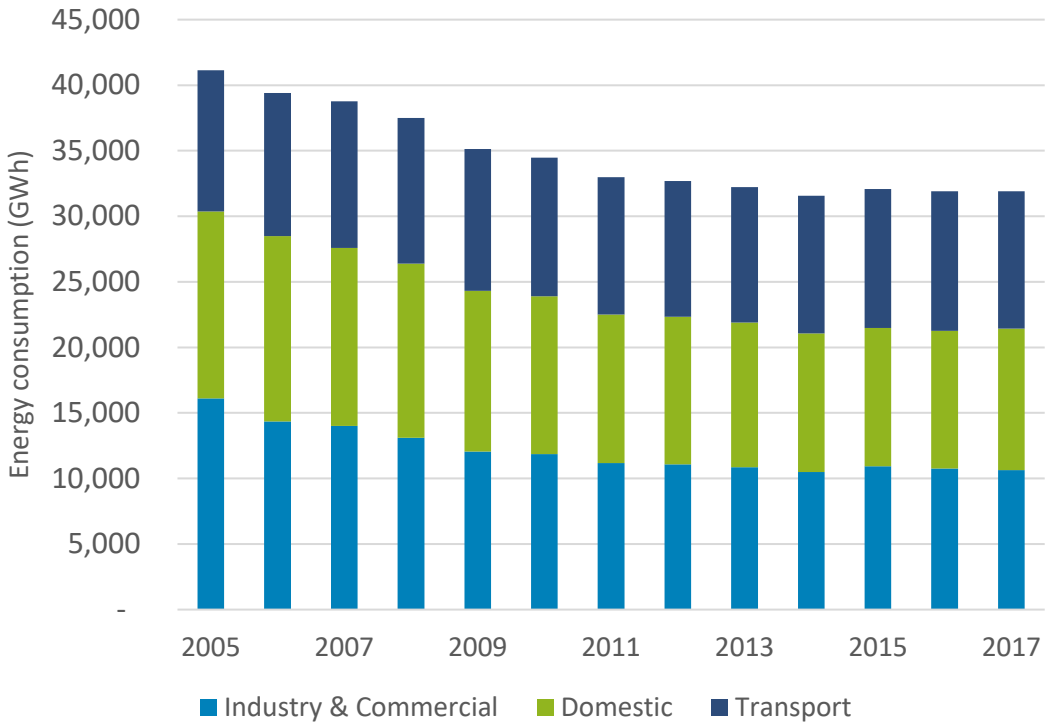


Figure 5: Trend of energy consumption in the Cardiff Capital Region, by sector. Source: BEIS sub-national total final energy consumption, 2019. (Excludes bioenergy and wastes)

Analysis of BEIS sub-regional data[12] shows that total energy consumption fell by 22% between 2005 and 2013, an average rate of about 2.4% per year. This is slightly greater than the 18% reduction in energy demand experienced across Great Britain over the same period. This is predominantly due to a significantly greater reduction in commercial and industrial energy consumption in CCR compared to Great Britain.

The 22% reduction in CCR's energy demand is predominantly due to the commercial and industrial sector's energy consumption reducing by 34%, while the domestic sector's energy consumption reduced by 24%. This is likely to be the result of deindustrialisation and behavioural change/energy efficiency measures in each sector respectively. Since 2013, energy consumption in the region has been relatively stable.

[12] BEIS (2019) Regional and local authority electricity consumption statistics 2005 to 2018

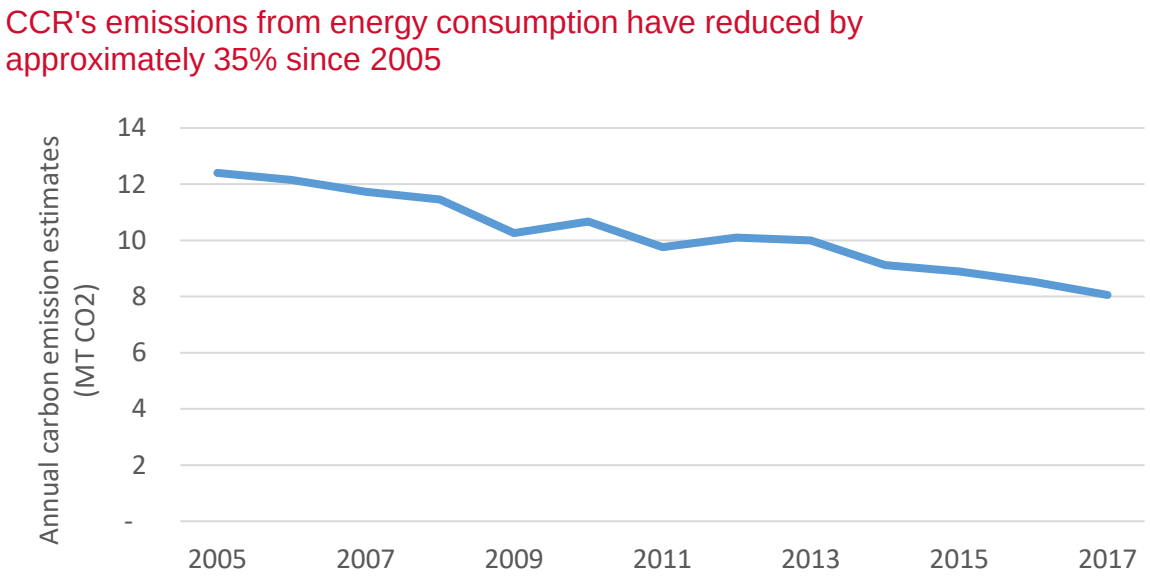


Figure 6: Estimated historic emissions in CCR. Source: BEIS sub-national emissions

Emissions from energy consumption reduced by around 35% from 2005 to 2017[13] as a result of falling demand and decarbonisation of the national electricity grid.

Energy system vision: energy consumption by sector

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

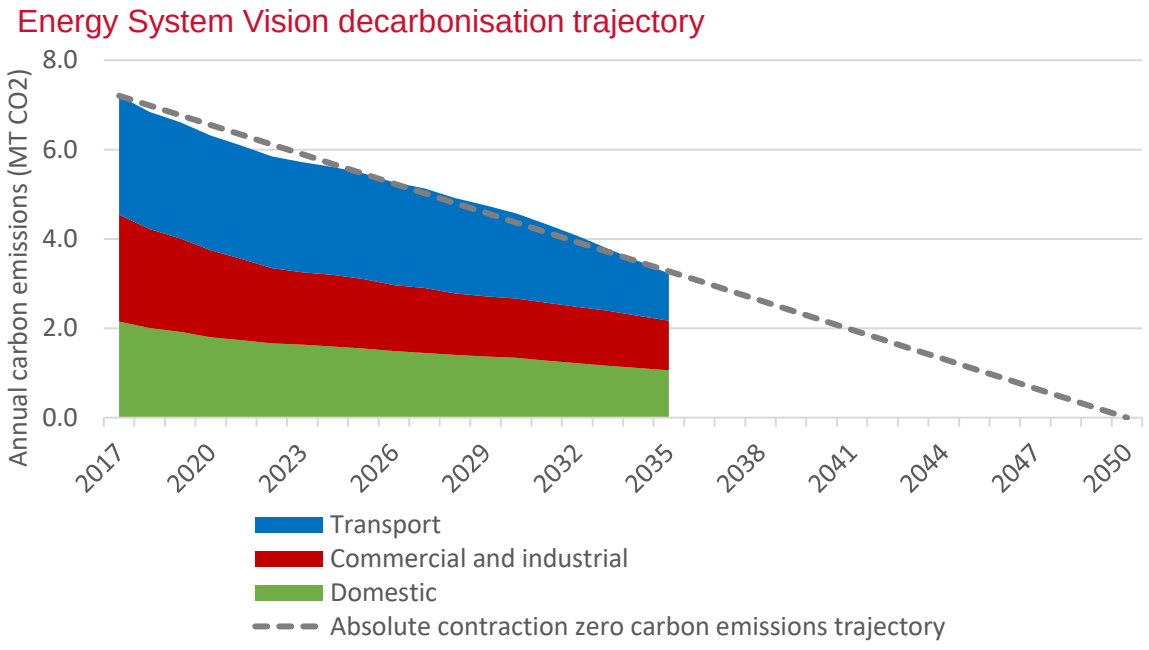


Figure 7: CCR's Energy Vision decarbonisation trajectory by sector to meet net zero 2050 under an absolute contraction methodology. Source: WGES analysis

[13] BEIS (2019) UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2017

- By reviewing the measures that could be implemented in CCR between the baseline year (2017) and 2035, this 55% decarbonisation target can be split by sector into:
    - 51% reduction in domestic heat and power emissions
    - 54% reduction in commercial and industrial emissions
    - 60% reduction in transport emissions.

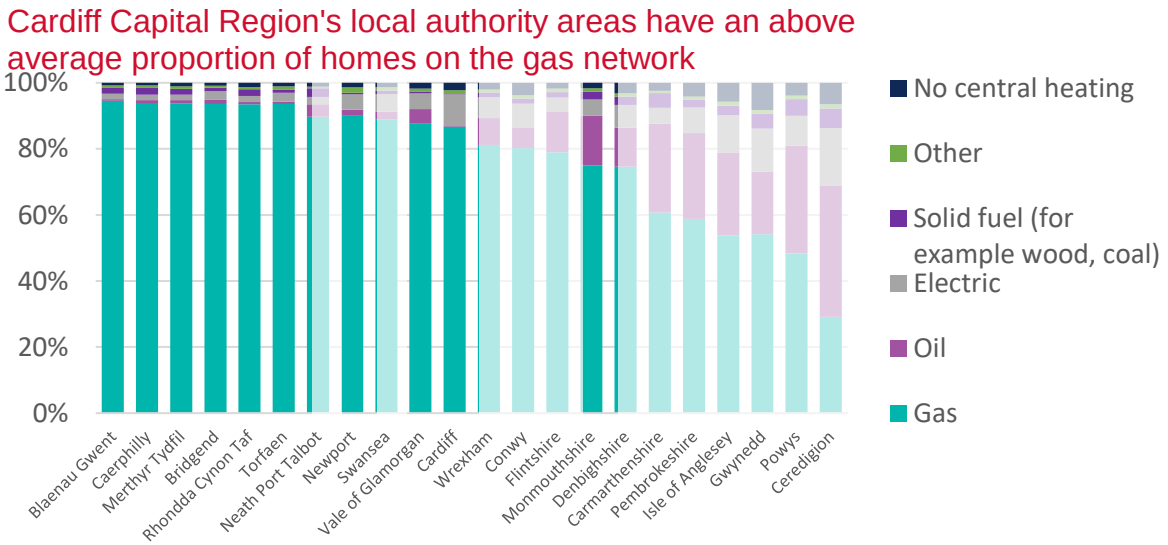
The industrial decarbonisation will be addressed from decarbonising electricity, transferring heating from fossil fuel to electricity and rely on a small uptake of hydrogen.

Figure 8: Summary of the Energy Vision's emission reductions by sector. Source: WGES analysis

Our domestic energy consumption

Baseline: domestic heating

Around 50,000 new homes have been built in the region[14] since 2005, but despite this, domestic heating demand has fallen by 31% since then, reflecting the national trend resulting from more efficient homes, appliances and lighting, and behavioural change.



[14] Welsh government, Household estimates for Wales - households by type by local authority, 1991 to 2017

Figure 9: Proportion of homes heated by each heating fuel type, by local authority. Source: Census, 2011. MHCLG, Energy Performance Certificates.[15]

Cardiff Capital Region is the Welsh region with the lowest number of renewable heat installations

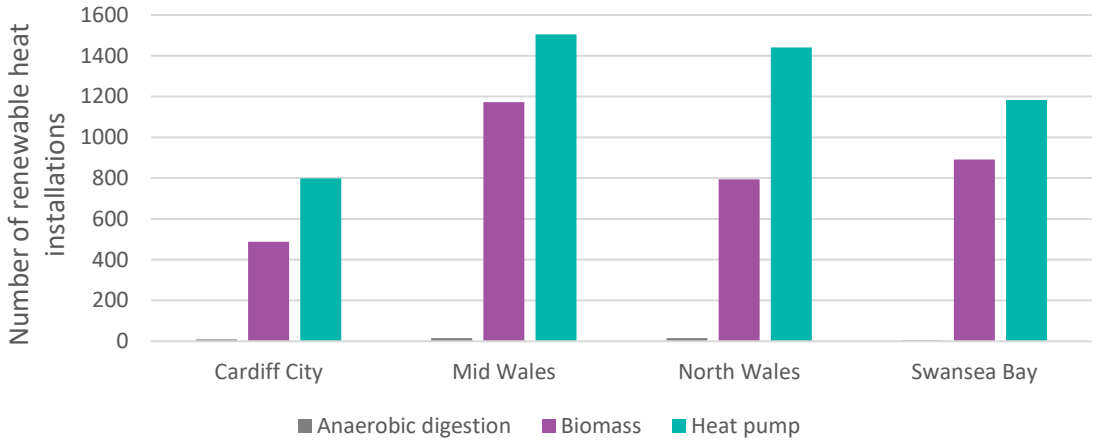


Figure 10: Renewable heat installations in Wales. Source: Energy Generation in Wales 2018

Despite hosting nearly half of all homes in Wales, CCR has the lowest number of renewable heat installations; it can be assumed this is due to the high proportion of on gas properties, meaning it is difficult for renewable heat technologies to compete against the low cost of natural gas. Just 0.2% of homes have a heat pump or biomass boiler.

Cardiff Capital Region's domestic properties have an average EPC rating of D

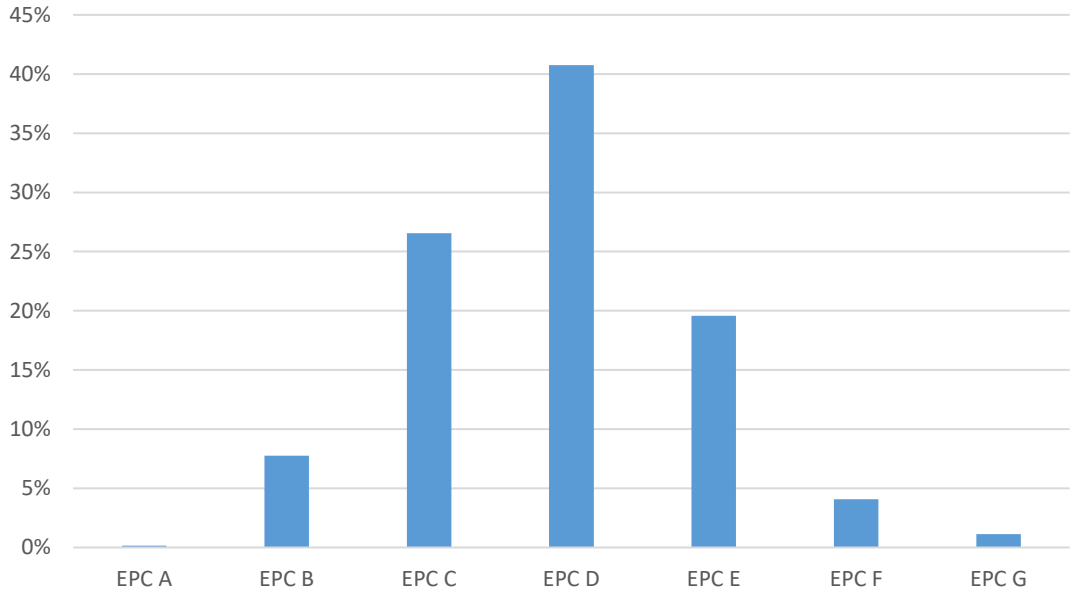


Figure 11: Proportion of homes in CCR in each EPC band. Source: MHCLG, Energy Performance Certificates

[15] To note, the Census data is now nearly 10 years old but EPC data and data on renewable heat shows little shift in heating types over that time.

CCR has the highest average energy efficiency ratings in Wales, with 75% of homes rated as EPC band D or above. This is, however, still below the Great Britain figure of 77% band D and above. The average rating (mean, median and mode) is a D, and there are virtually no A-rated properties; there is a significant need to improve energy efficiency to decarbonise the energy system.

Energy Vision scenario: domestic heating

Box 1: Assumptions regarding the decarbonisation of domestic heating in CCR[16]

The Cardiff Capital Region 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 Cardiff Capital Region 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 4% of energy supplied by the gas distribution network in Cardiff Capital Region 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 Cardiff Capital Region 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.

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

Table 2. 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%	19%	17% (including significantly higher proportion of hybrid heat pumps)	19%
Biomethane and bioSNG energy	**Biomethane and bioSNG heat energy for domestic and C&I heating in 2035**	324 GWh	436 GWh	380 GWh	362 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	4% of gas network energy	3% of gas network energy	4% of gas network energy
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	2% of gas network energy	None modelled before 2035 although there is potential for some domestic heating associated with industrial clusters

Existing homes

Achieving a 51% reduction in domestic carbon emissions by 2035 requires a significant shift in the way homes are heated and their level of energy efficiency. This is recognised in Prosperity for All: a low carbon Wales, Proposal 10, which looks at the challenges and opportunities around low carbon heat, and Proposal 11, which considers increasing the use of waste heat and low carbon heat.

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. For example, a 51% reduction could be achieved if 154,000 homes were improved from G, F and E to D, C and B, leaving just 1% of properties with an EPC rated E or worse. This should take account of the

balance between the cost of building fabric improvements against the cost of gas and electricity grid decarbonisation.

Upgrades to nearly all homes rated E, F and G required to deliver Cardiff Capital Region's Energy Vision

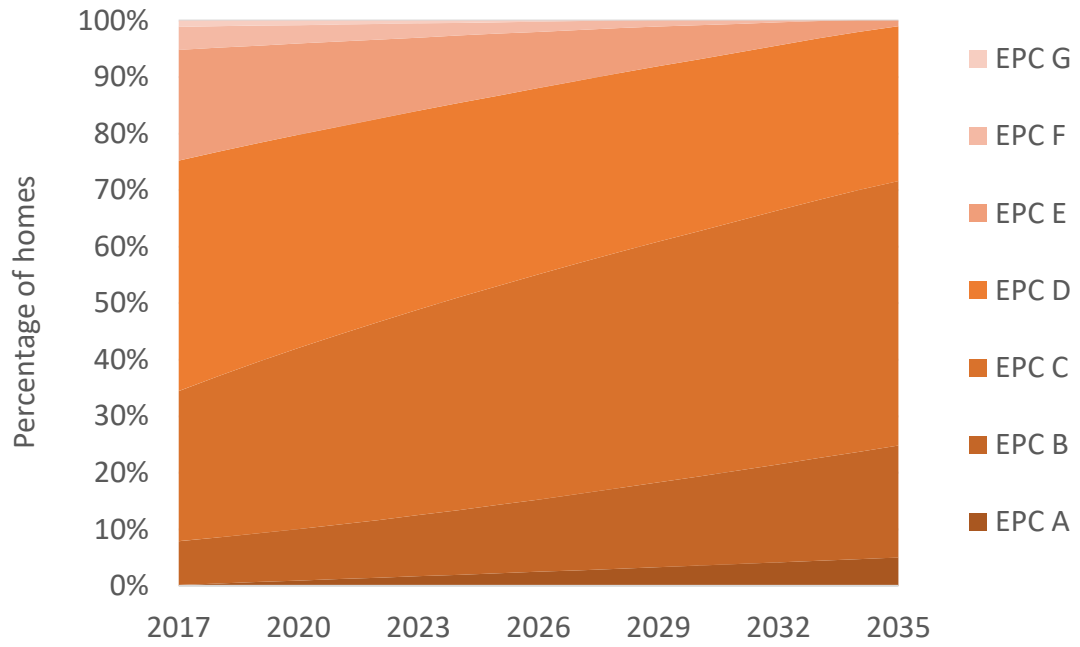


Figure 12: Estimated domestic EPC band changes to deliver the Energy Vision scenario. Source: WGES analysis

Around 112,000 homes, 17% of existing homes, need to move from using fossil fuel heating to low carbon heating by 2035, looking at cost effective solutions which consider fuel poverty, as heat pumps may not be affordable for all. Of these, approximately 27,000 (~4%) 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 supporting role for individual ground source heat pumps and shared ground loops. By 2035, over 140,000 heat pumps are assumed to have been installed in CCR, including over 28,000 heat pumps in new homes and around 8,000 homes connected to heat pump-fuelled heat networks. The Vision includes a smaller role for biomass and bio-LPG heating options.

Air source heat pumps are the dominant new low carbon heating source introduced by 2035 under the Cardiff Capital Region's Energy Vision scenario

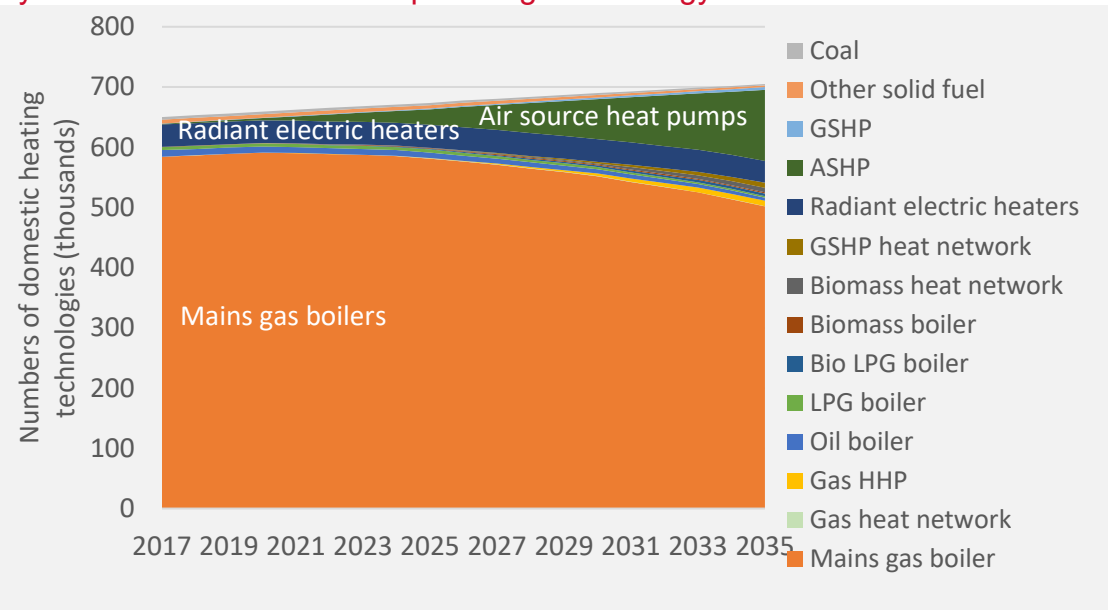


Figure 13: Breakdown of domestic heating technologies in the CCR Energy Vision scenario, including existing and new build houses. Source: WGES analysis

Despite these significant shifts to low carbon heat sources, gas boilers remain the dominant technology in existing homes in 2035; post 2035, there will need to be a focus on fully decarbonising these remaining on-gas homes.

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.

Box 3: The Freedom Project

The Freedom Project, a joint innovation project between Western Power Distribution and Wales & West Utilities, installed and ran 75 gas hybrid heat pumps in Bridgend between 2016 and 2019. The project investigated the carbon and cost impacts of using an air source heat pump for the majority of heat demand, with a gas boiler providing heat during the coldest months of the year.

Hybrid heat pumps could provide significant reductions in emissions from domestic heating in the near-term and the project found the potential for lower system costs from a hybrid approach rather than through electrification alone.

In a net zero scenario, homes heated by a hybrid heat pump with a fossil gas backup would either have to transition to a fully electrified heat pump or be supplied by a low carbon gas such as hydrogen or biomethane.

New homes

The recent consultation from Welsh Government on Building Regulations Part L (responses from which are currently being reviewing) is looking to establish the standards for housing construction for 2020 to 2025 and give industry notice by exploring the expected standards that will be in place from 2025. The current proposals for 2020 are to improve the target emission rate for new build homes by raising the fabric standards, and introducing renewable energy technology into the notional building that sets the target emission rate. To meet the new target, developers may, for example, choose to install low carbon heating but if not, will be required to future proof so that low carbon heating can be easily retrofitted in the future. The target outcome is that homes built in 2025 will emit 75% to 80% less carbon than those built to the 2014 Part L requirements[17]. The challenge will be to close the remaining gap to true zero carbon development.

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

Table 3: Scenario summary: domestic

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Domestic heat and energy efficiency	42,000 suitable houses accurately fitted with internal or	18% reduction in gross thermal energy demand	666 kt CO_2 (51% reduction)

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

	external wall insulation. Over 185,000 other insulation measures in homes Over 140,000 heat pumps installed. 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	30% net decrease in domestic heating energy consumption, taking into account demand reduction and improved heat technology efficiencies, including the impact of heat pump performance.	

Our commercial and industrial energy consumption

Baseline: commercial and industrial

Industrial energy demand has decreased by 34% since 2005 and emissions have decreased by 49%. The greater reduction in emissions, compared to the reduction in energy demand, is largely due to the decarbonisation of the UK's electricity grid. This has been achieved through the increase of low carbon and renewable electricity generation, such as wind and solar PV, and the decrease of traditional fossil fuel plants, such as coal and gas. As noted above, due to data limitations some very large industrial energy users are not included in this analysis.

Cardiff Capital Region's commercial and industrial energy demand declined rapidly between 2005 and 2011, before levelling out

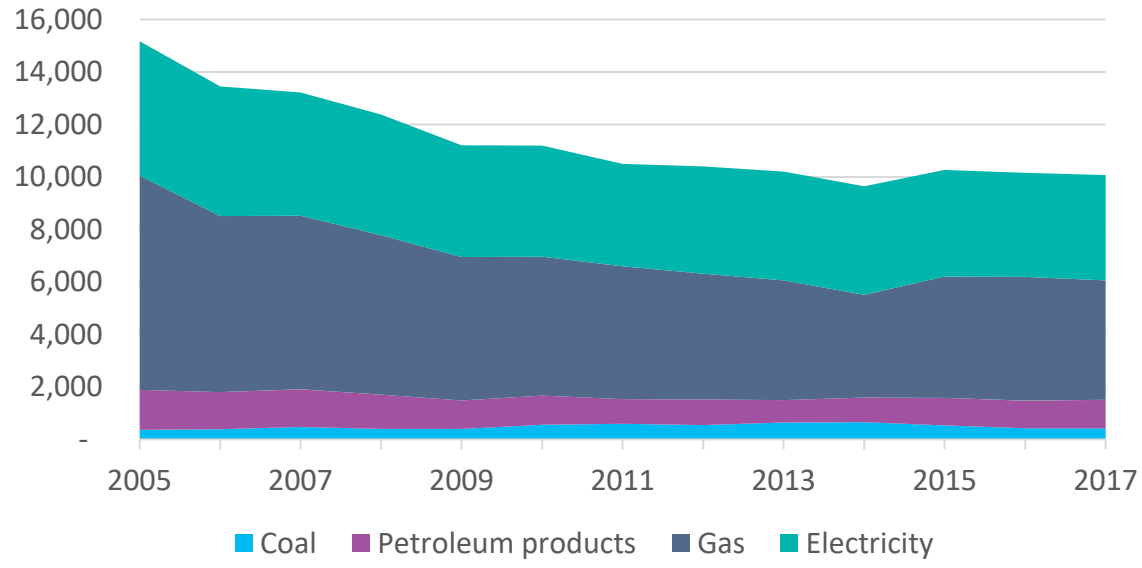


Figure 14: Cardiff Capital Region's historic commercial and industrial energy consumption, by fuel. Source: BEIS total final energy consumption (2019)

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 13% decrease in energy demand through energy efficiency measures and electrification of heat and process demand
- Switching to low carbon fuels and heating, including electrification and some use of low carbon hydrogen in industrial processes
- Significant further decarbonisation of the electricity grid through renewable generation.

CCR's Energy Vision scenario includes a 13% decrease in commercial and industrial energy consumption by 2035

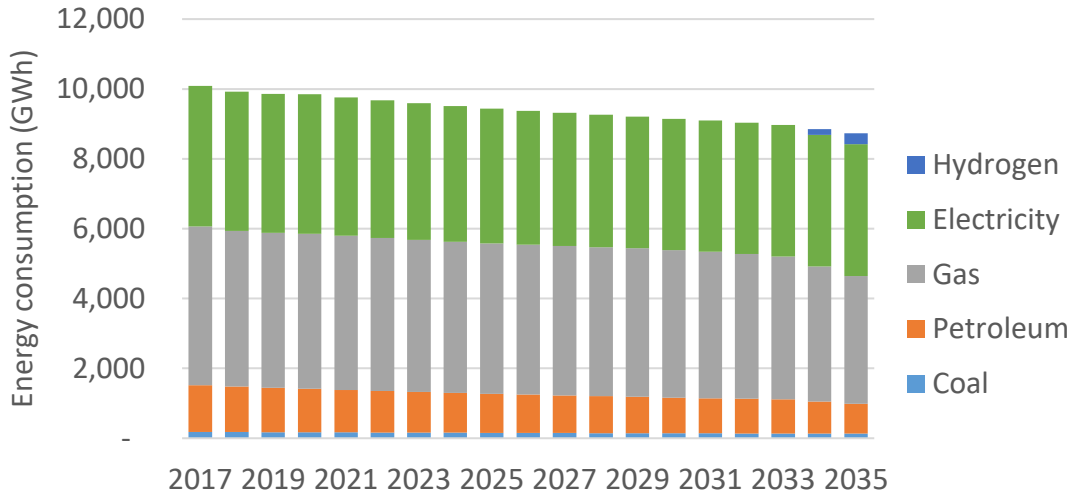


Figure 15: Energy Vision scenario commercial and industrial energy consumption, by fuel. Source: WGES analysis

Existing effort in this area can be built on, through the work of the South Wales Industrial Cluster (SWIC), which brings together a group of major industrial companies in CCR and other parts of South Wales to share knowledge, co-ordinate funding and collaborate on decarbonisation projects. It's focus areas include energy efficiency, carbon dioxide avoidance, the hydrogen economy, carbon capture, utilisation and storage (CCUS) and low carbon power generation.

Reaching a grid electricity average carbon intensity of 30gCO_2 per kWh[18] would in itself (with no additional demand reductions) achieve a 40% reduction in all commercial and industrial emissions in CCR, as shown in Figure 15. This very low electricity carbon factor would depend on significant installation of new low carbon generation capacity both in CCR and across the UK.

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

Cardiff Capital Region's Energy Vision scenario results in a 51% decrease in commercial and industrial energy emissions by 2035, dependent in large part on decarbonisation of the electricity network.

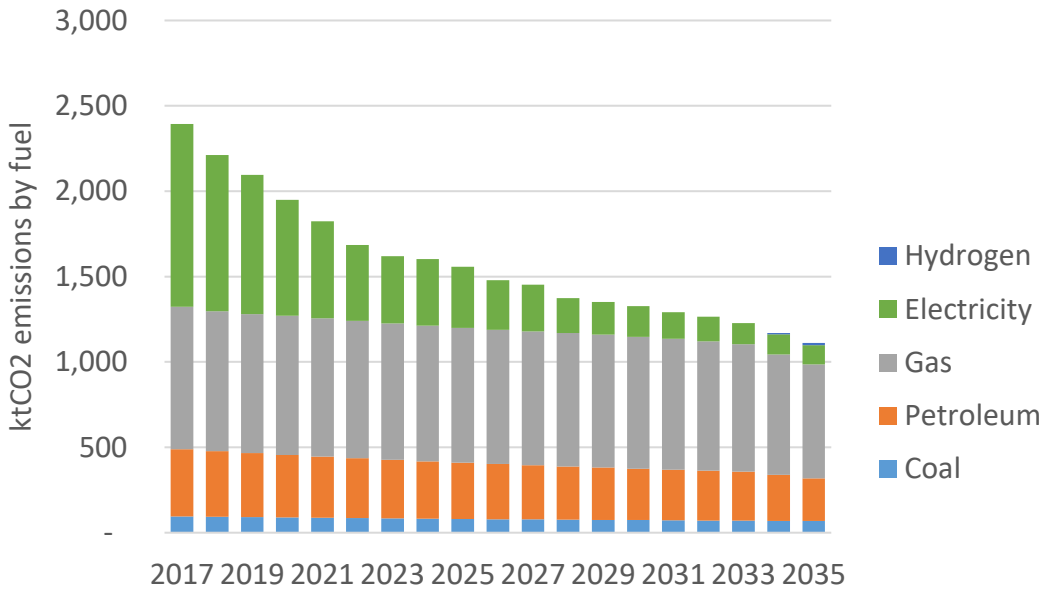


Figure 16: Energy Vision scenario commercial and industrial emissions estimates, by fuel. Source: WGES analysis

The future impact on energy utilities' networks and whole system decarbonisation in the CCR and beyond are beginning to be addressed through the Zero2050: South Wales initiative led by National Grid.

Use and production of hydrogen

Feedback from CCR stakeholders was that there is strong support for the region to lead the way on the development of hydrogen production, storage and use technologies. It is key to prioritise the use of hydrogen based on regional cost-effectiveness in the industrial sector before transport and then heating. Regen's (see **Box 1**) found that before 2035, under some scenarios, there could be some use of hydrogen in the region in industrial clusters. Based on stakeholder interest and detailed scenario analysis, the Energy Vision scenario assumes early hydrogen adoption, beginning with its use in industrial processes in a CCR cluster around 2033.

To achieve the region's net zero carbon ambitions, hydrogen should be produced either using excess renewable energy to power electrolysis or through other methods such as steam methane reformation with effective carbon capture and storage. To be viable for widespread hydrogen use, further pilots will be required to help with realising cost reduction and further technology development.

Research has already begun in this area in the region with the collaboration between the University of South Wales, Cardiff University and Swansea University for the FLEXIS project. The FLEXIS project, which has a demonstration area in Neath Port Talbot, includes work packages on hydrogen, syngas, BIOH2 and BIOH4, on subjects such as storage, sustainable production, efficient use and purification.

Table 4: 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	35% reduction in coal and petroleum energy consumption 19% reduction in gas consumption 4% of demand supplied by hydrogen through industrial clusters 6% reduction in electricity demand	1,284 kt CO_2 (51% reduction)

Our energy demand from transport

Baseline: transport

CCR has a high dependence on private cars for transport. Average annual vehicle miles in CCR are similar to those in other Welsh regions at 9,330 miles per car, 17% higher than the UK average[19]. Less than 1% of road miles are driven by buses and coaches in CCR[19].

The £738 million Metro project – the cornerstone of the £1.2billion City Deal - will create a credible mass transport infrastructure that is likely to drive a modal shift from private vehicle use to public transport.

To date, CCR has seen a slow uptake of electric vehicles. Approximately 0.3% 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, CCR currently hosts 173 public charging devices, including 31 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.

Wales has significantly lower bus utilisation rates than England or Scotland

[19] DFT (2019) Road traffic statistics (TRA) and Regen transport model
[20] DFT (2019) Electric Vehicle Charging Device Statistics

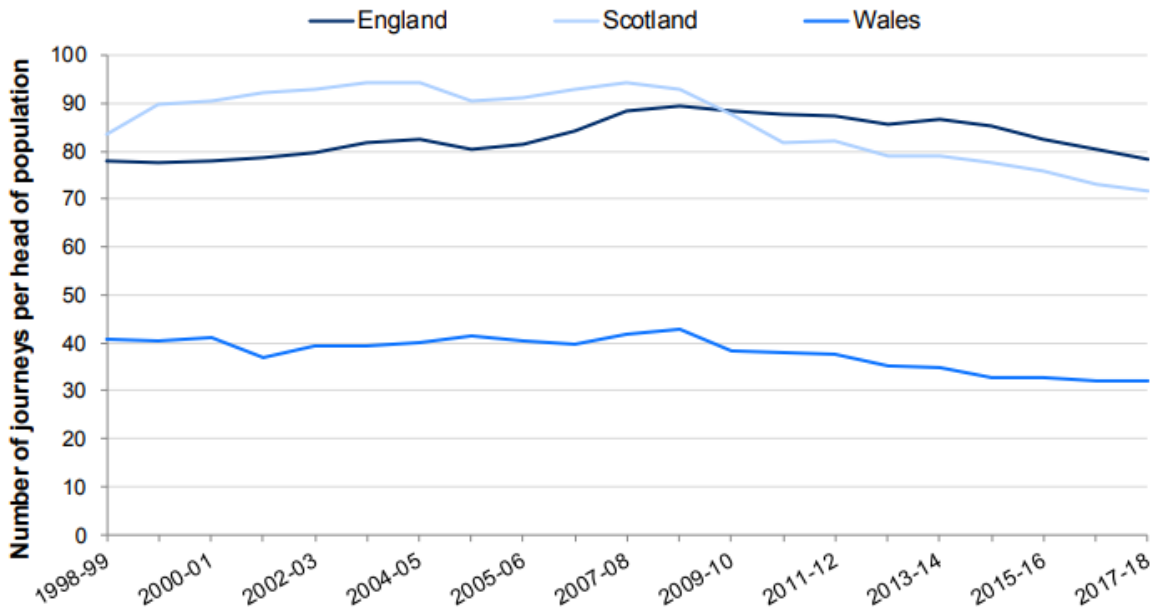


Figure 17: Passenger journeys per head on local bus services by country, 1998-2018. Source: Public service vehicles statistical bulletin, 2019

Energy Vision scenario: transport

Achieving a 60% reduction in transport emissions by 2035 is a significant challenge for Cardiff Capital Region with its high dependence on private vehicles. The Energy Vision scenario assumes:

- 64% of vehicles driven in Cardiff Capital Region in 2035 are electric, with the ban on fossil fuel vehicle sales brought forward to 2030.
- A 20% reduction in private vehicle mileage in 2035 facilitated by significantly increased use of public transport and active travel.
- A slowing of the growth in total number of vehicles on the road, facilitated by increased use of public transport and active travel.

The reduction in private vehicle mileage was originally set at 15%. However, feedback from stakeholders in the region was that the urban environment and projects such as the current Metro and Metro Plus projects should inspire the region to aim for a greater percentage reduction. The reduction in transport-related emissions due to the changing way businesses have operated during the lockdown caused by COVID-19 provides a tremendous opportunity to permanently reduce travel emissions if these new working practices are sustained post COVID-19. It should also be noted however that forecasts undertaken over the last couple of years (pre-COVID-19) by Transport for Wales (TfW) using their SE Wales Transport Model indicates that even sizeable percentage uplifts in public transport usage results in only minor percentage reductions in private car mileage due to the sheer number of car journeys that already take place. The effects of making all public transport in SE Wales free to use were modelled and it was found that by 2026 this would more than double bus use, triple rail use, but have only a 6% reduction in private car use. Thus, a reduction in private car mileage is not only dependent on

increases in public transport facilities and usage, but will also requires significant behavioural change.

Cardiff Capital Region's Energy Vision scenario requires a significant decrease in the number of petrol and diesel vehicles

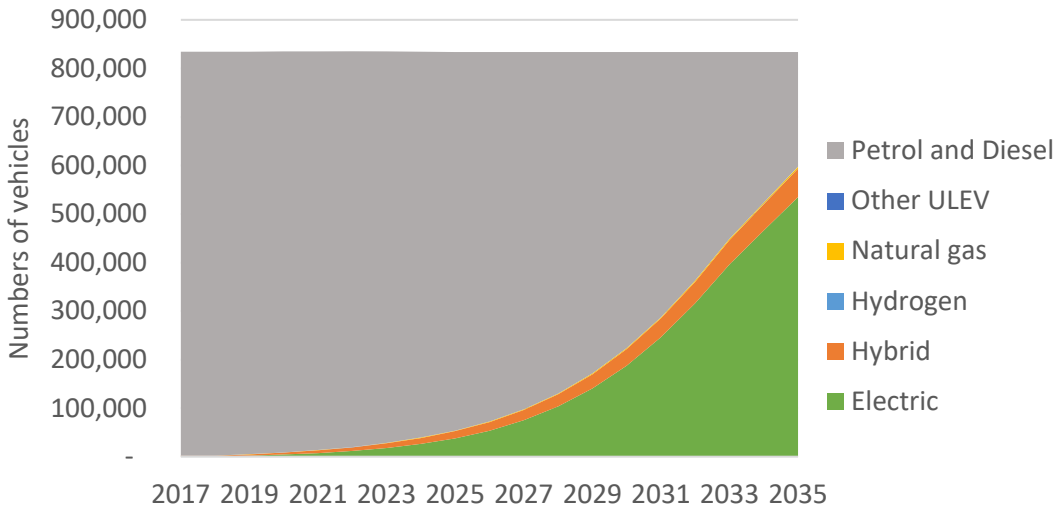


Figure 18: Cardiff Capital Region's Energy System Vision road vehicle numbers, by vehicle fuel. Source: WGES analysis

Cardiff Capital Region's Energy Vision scenario results in road transport emissions reducing by around 60%

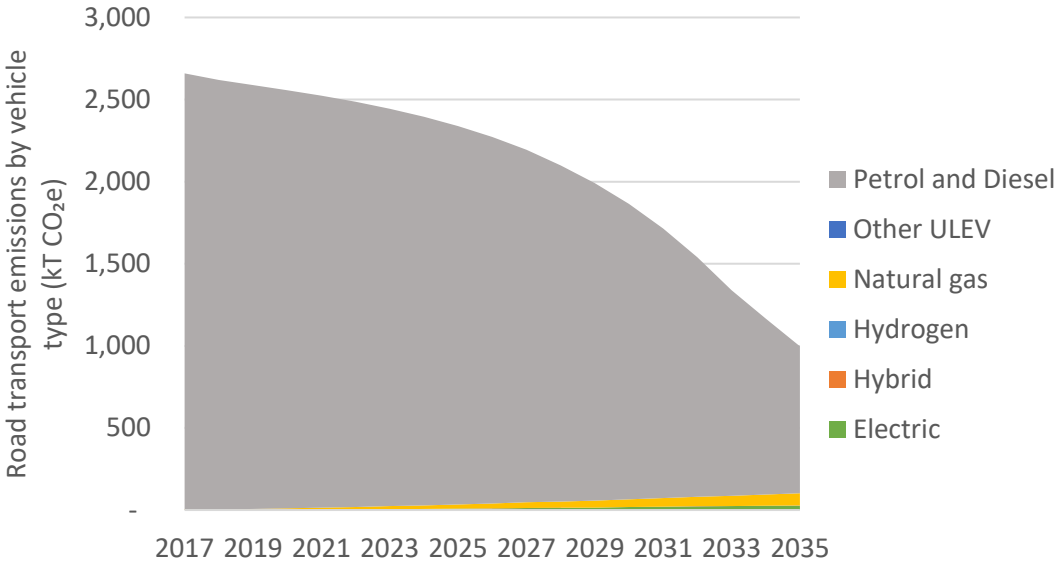


Figure 19: Energy System Vision road vehicle emissions, by vehicle fuel. Source: WGES analysis

Table 5: Summary: Transport

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Road transport	516,000 electric cars 3,300 gas and hydrogen HGVs 1,000 hydrogen vehicles 10,000 public and on-street EV chargers 20% reduction in private vehicle mileage	6.7 TWh reduction in petrol and diesel energy consumption 1.4 TWh increase in electricity consumption	1,606 kt CO_2 (60% reduction)

Achieving these outcomes requires 15,000 EV sales per year by the mid-2020s, peaking at 70,000 per year in the 2030s before reducing to 60,000 per year. Peak sales of fossil-fuelled cars in Cardiff Capital Region have historically reached 70,000 per annum[21]. Additional support, such as a scrappage scheme alongside a 2030 ban on new fossil-fuelled car sales[22], would be needed to retire some fossil-fuelled vehicles earlier than their average lifespan, in order to achieve a peak of 70,000 EV sales per year in the 2030s.

This level of EV sales will also require a supportive, area-wide EV charging network. Similarly, the switch to gas and hydrogen heavy goods 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 CCR is currently approximately 6.2 TWh[23]. It has fallen steadily since at least 2005, when electricity demand was nearly 7.6 TWh[23], as a result of efficiency improvements and deindustrialisation.

Commercial and industrial electricity consumption constitutes 55% of all electricity consumption, approximately 10 percentage points less than the Welsh and GB average. Almost all of the remaining electricity demand is used in domestic buildings and appliances. The Energy Vision includes ambitious uptake of renewable energy, including on-site generation, in order to contribute to the UK's decarbonised electricity supply.

[21] DFT (2019) Road traffic statistics (TRA) and Regen analysis

[22] The UK Government is due to consult on bringing forward the fossil-fueled vehicles ban to 2035 or earlier. The analysis assumes this is brought forward to around 2030.

[23] BEIS (2019) Regional and local authority electricity consumption statistics 2005 to 2018

Energy Vision scenario: annual electricity demand

The scenario projection shows an overall net increase in annual electricity demand in CCR of 10% by 2035, compared to 2017. Increased energy efficiency measures and appliance efficiency lead to a continued decrease in the base electricity demand; however, by 2025 this is overtaken by the increased demand resulting from the electrification of heating and transport. Peak demand increases may be higher depending on whether time of use tariffs and other smart methods are successful in shifting demand across each 24-hour period.

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

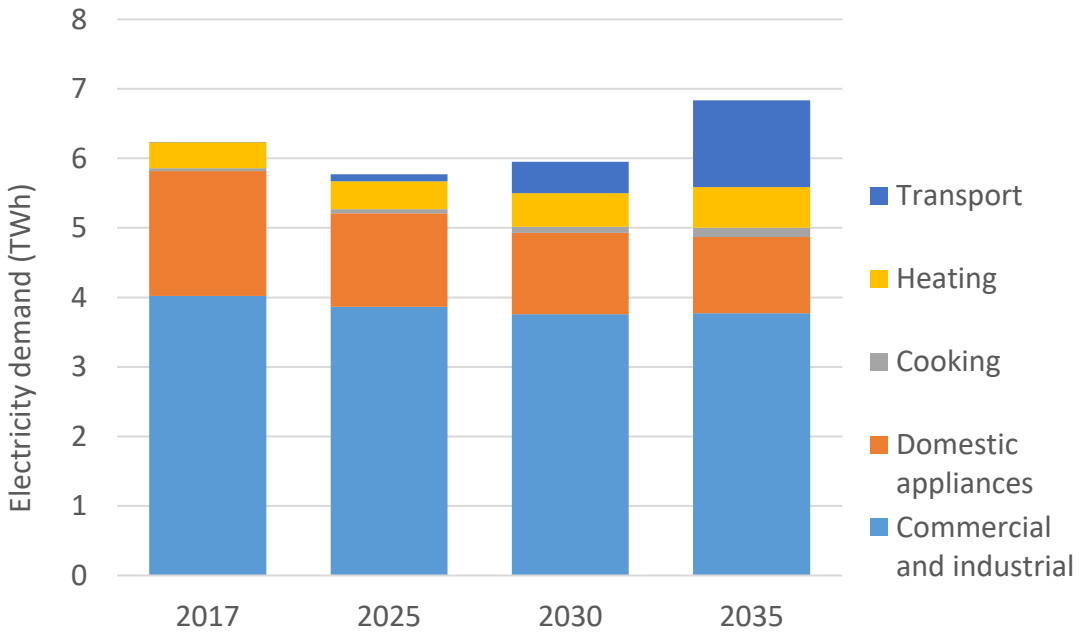


Figure 20: Cardiff Capital Region's Energy Vision scenario demand by sector. Source: WGES analysis

Our electricity generation

Baseline: electricity generation

Cardiff Capital Region hosts 311 MW of solar PV and 299 MW of onshore wind

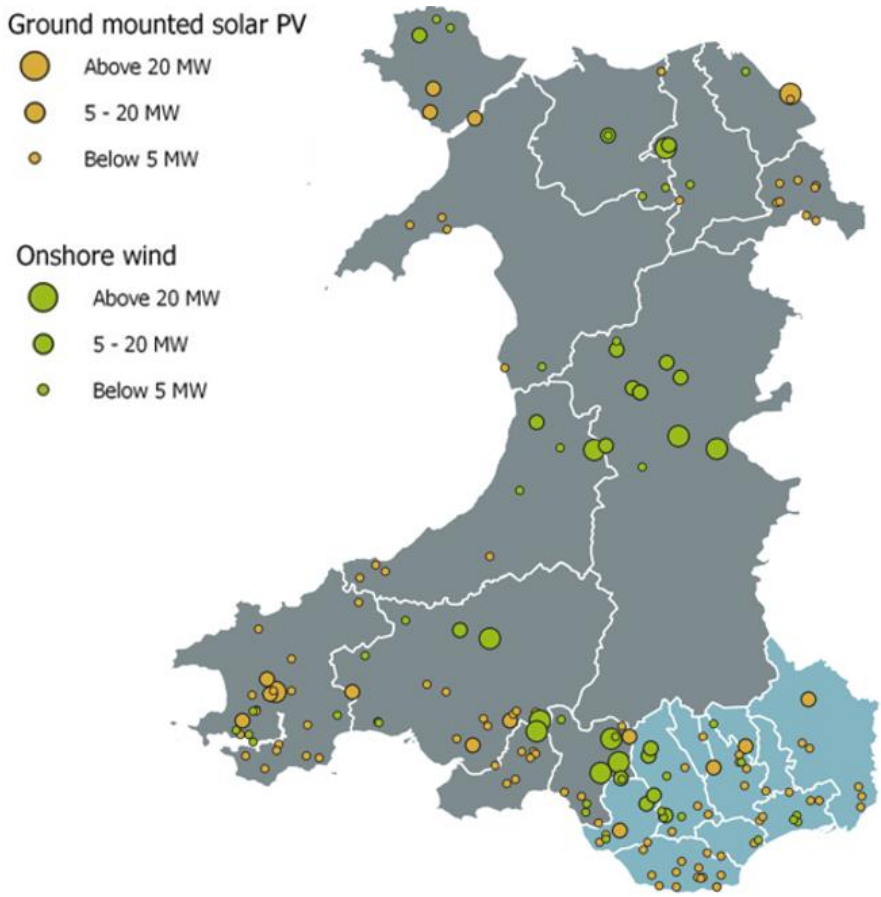


Figure 21: Solar PV and onshore wind projects (>1MW) currently generating in Wales. Source: BEIS Renewable Energy Planning Database, 2019

In 2019 there was a total of 709 MW of installed renewable electricity capacity in the region, with 221 MW of this locally owned[24].

Renewable electricity generation in CCR is mainly from onshore wind and solar PV. Solar PV has a relatively high installed capacity with 311 MW, but, due to a lower capacity factor, provides around 18% of renewable electricity generation in the region.

Cardiff Capital Region hosts approximately 40% of the Pen y Cymoedd wind farm, the largest wind farm in England and Wales. This project and nearly 90 others contribute to onshore wind currently generating 50% of the Cardiff Capital Region's renewable electricity generation.

[24] See Welsh Government (2019) Energy Generation in Wales, 2018 for definition of locally ownership.

The majority of the remaining renewable electricity generation in the region is made up of energy from waste, anaerobic digestion and biomass electricity/CHP projects.

Table 6: Current renewable energy generation in the region

Technology type	2018 Number of projects	2018 installed capacity (MW)	2018 Estimated annual generation (GWh)
Anaerobic digestion	10	9	48
Biomass electricity and CHP	13	42	245
Energy from Waste	1	30	125
Hydropower	25	1	2
Landfill gas	9	13	47
Onshore wind	91	299	770
Sewage gas	2	4	16
Solar PV	22,063	311	294
Total	22,214	709	1,549

50% of renewable generation in CCR is from onshore wind projects

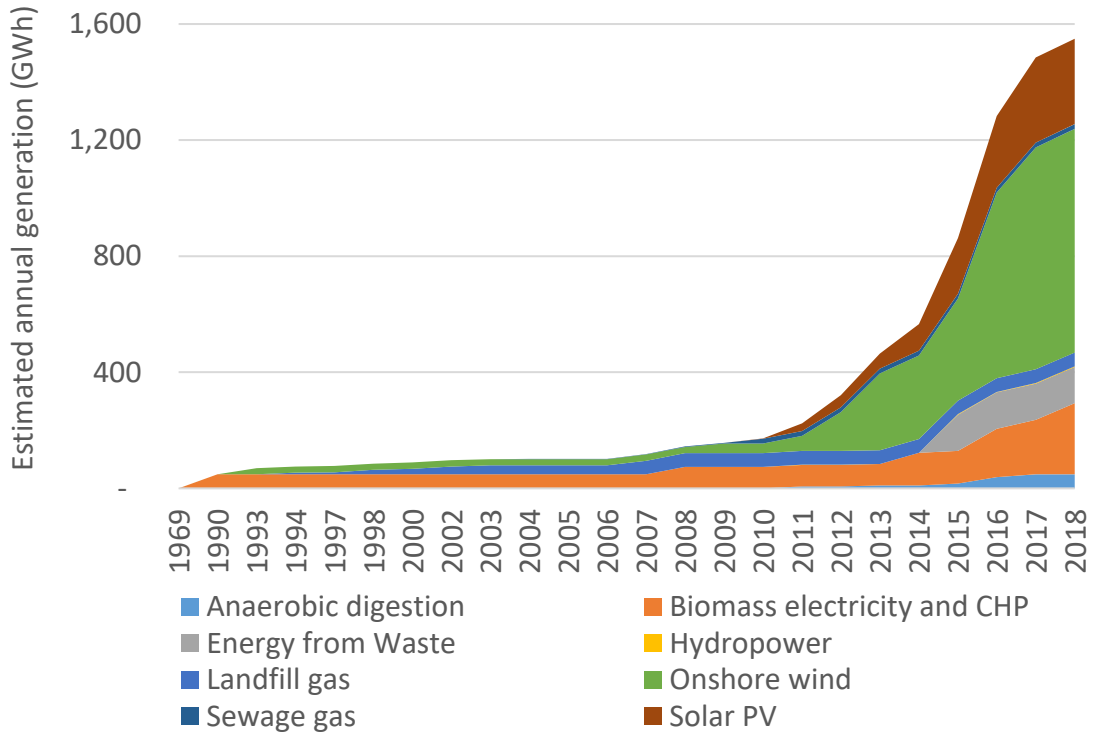


Figure 22: Cardiff Capital Region's renewable electricity generation trends 2008-2018. Source: WGES analysis, Energy Generation in Wales 2018

CCR hosts around a quarter of Wales' onshore wind capacity and a third of solar PV capacity.

Cardiff Capital Region hosts 22% of current Welsh renewable electricity capacity

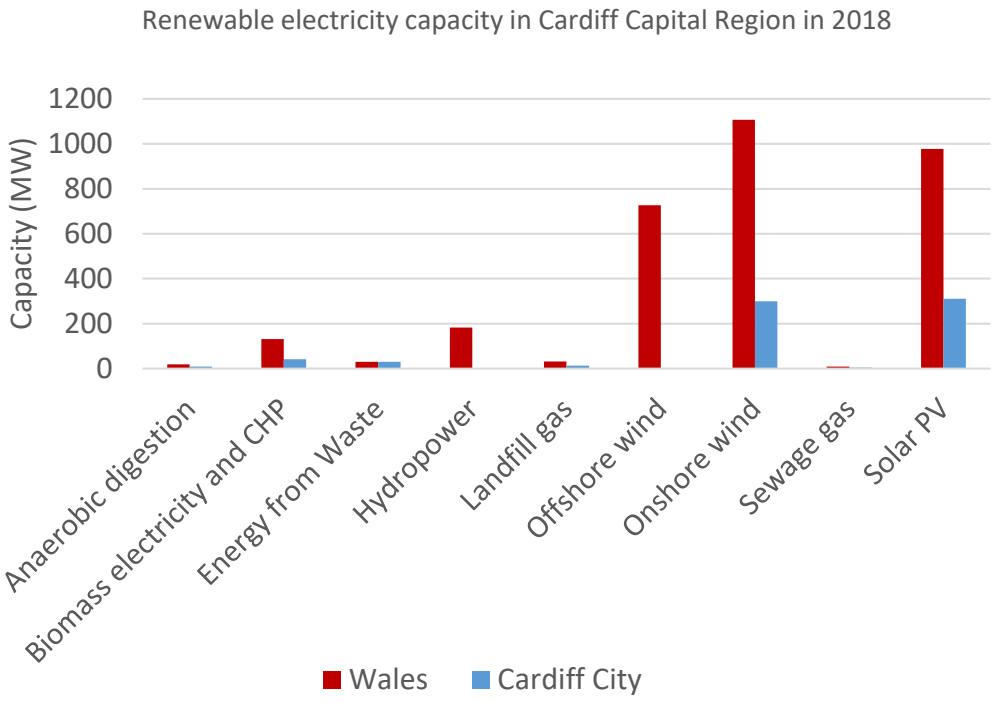


Figure 23: Renewable electricity capacity in Cardiff Capital Region, 2018. Source: WGES analysis, Energy Generation in Wales 2018

Cardiff Capital Region currently generates the equivalent of 25% of its electricity consumption from local renewable sources

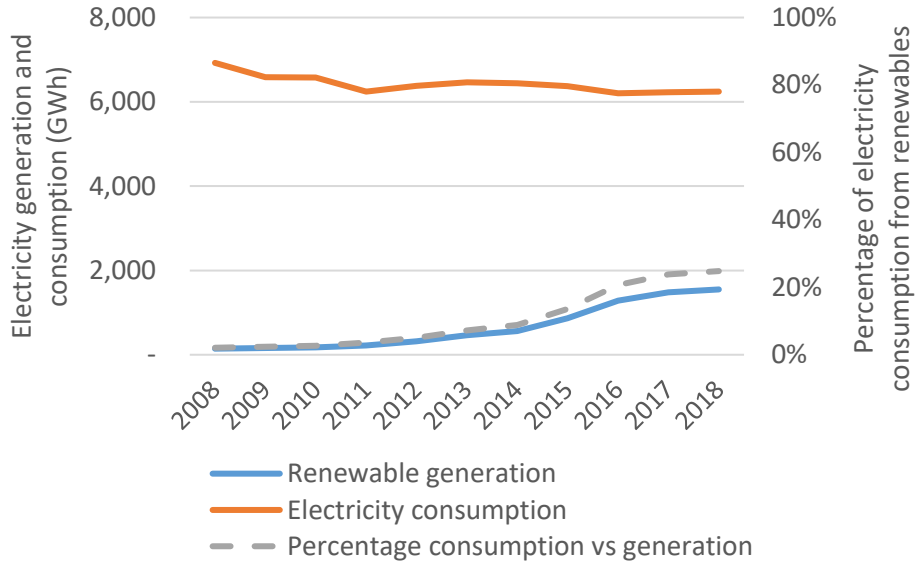


Figure 24: Percentage of electricity consumption from renewables in Cardiff Capital Region. Source: WGES analysis, Energy Generation in Wales 2018

Energy Vision scenario: electricity generation

Stakeholders engaged through the workshops for CCR were keen for the region to increase the amount of renewable electricity that is generated in the region. Compared to the other regions of Wales, it will be more challenging to exceed the equivalent regional annual consumption, with renewable electricity generation, due to the higher population base and lower availability of renewable resources.

As a result, the Energy Vision scenario includes the ambition that the region generates the equivalent of approximately 50% of its total energy consumption in 2035 from regional renewable sources. This figure is less ambitious than other parts of Wales but has been arrived at by balancing the region's ambition against the available resources, investment requirement and potential grid capacity[25]. 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. This would also support Welsh Government's target to have 1GW of renewable electricity and heat capacity in Wales to be locally owned by 2030, and for all new energy projects to have at least an element of local ownership from 2020[26]

Box 4: 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[1]. 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. Cardiff Capital Region has the natural resources and the ambition to play an increased role in delivering renewable energy deployment.

[25] This Energy Vision projection does not include a Cardiff or Newport Tidal Lagoon project.

[26] Policy Statement on local ownership of energy generation in Wales

To enable Cardiff Capital Region to meet the equivalent of 50% of its 2035 electricity consumption from local renewables requires a significant increase in generation and efficiency savings to offset new sources of electricity demand

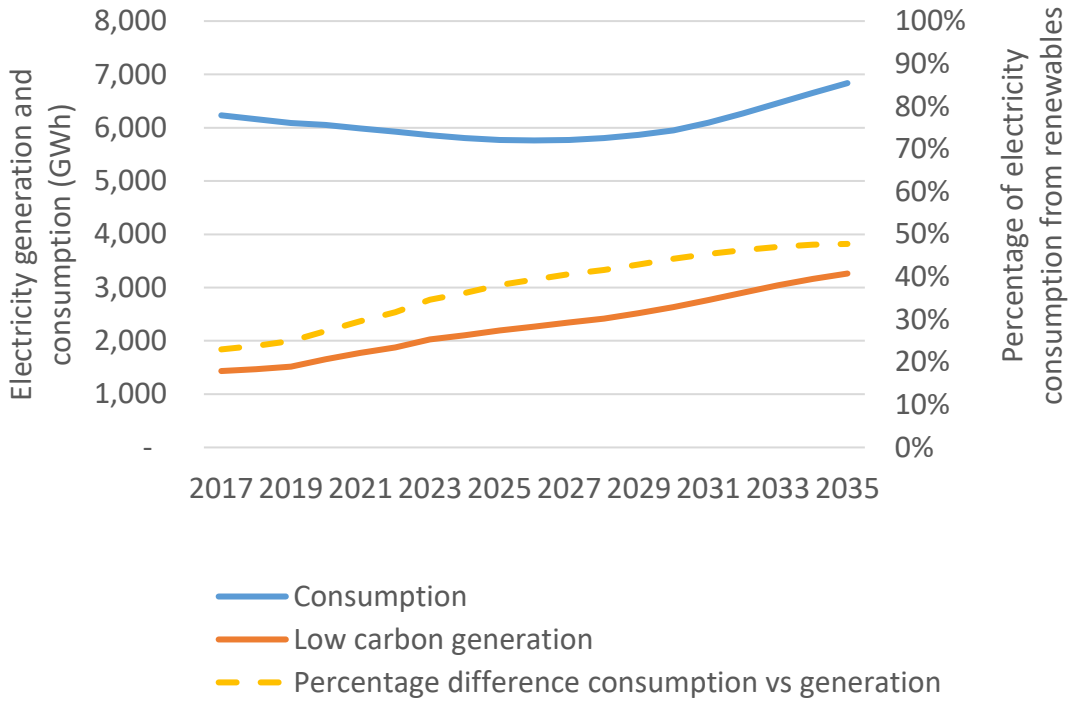


Figure 25: CCR's Energy Vision scenario electricity consumption vs low carbon generation. Source: WGES analysis

Figure 25 shows one pathway to achieving this level of electricity generation in the region.

Onshore wind and solar PV are the main electricity generating technologies focussed on in Cardiff Capital Region's Energy Vision scenario

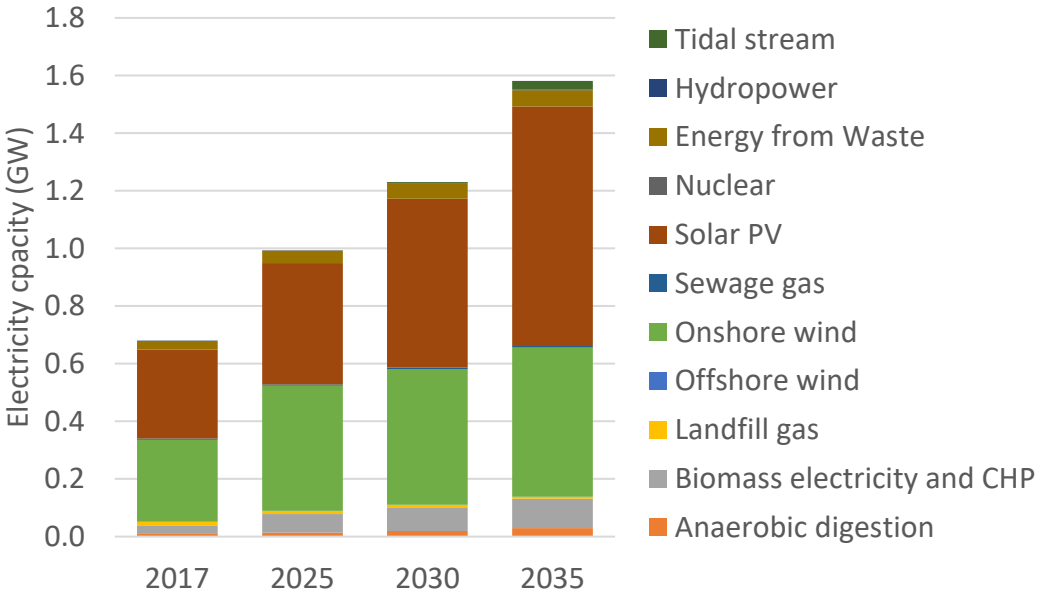


Figure 26: Renewable energy capacity increases under Cardiff Capital Region's Energy Vision scenario. Source: WGES analysis

Onshore wind

The Energy Vision scenario includes an increase in onshore wind capacity of 233 MW. This is a relatively small proportional increase, due to a lack of available sites, primarily due to the urban nature of the region. The capacity increase is made up of:

- a small number of projects currently in development
- new projects in the existing Strategic Search Area F (SSA)
- new projects in Priority Areas as designated in the National Development Framework (NDF) consultation
- new projects (made up of small numbers of large turbines) outside of areas designated by the NDF and SSAs
- and a number of small to medium-scale farm or community projects.

CCR's Energy Vision includes an increase in onshore wind capacity of over 70%

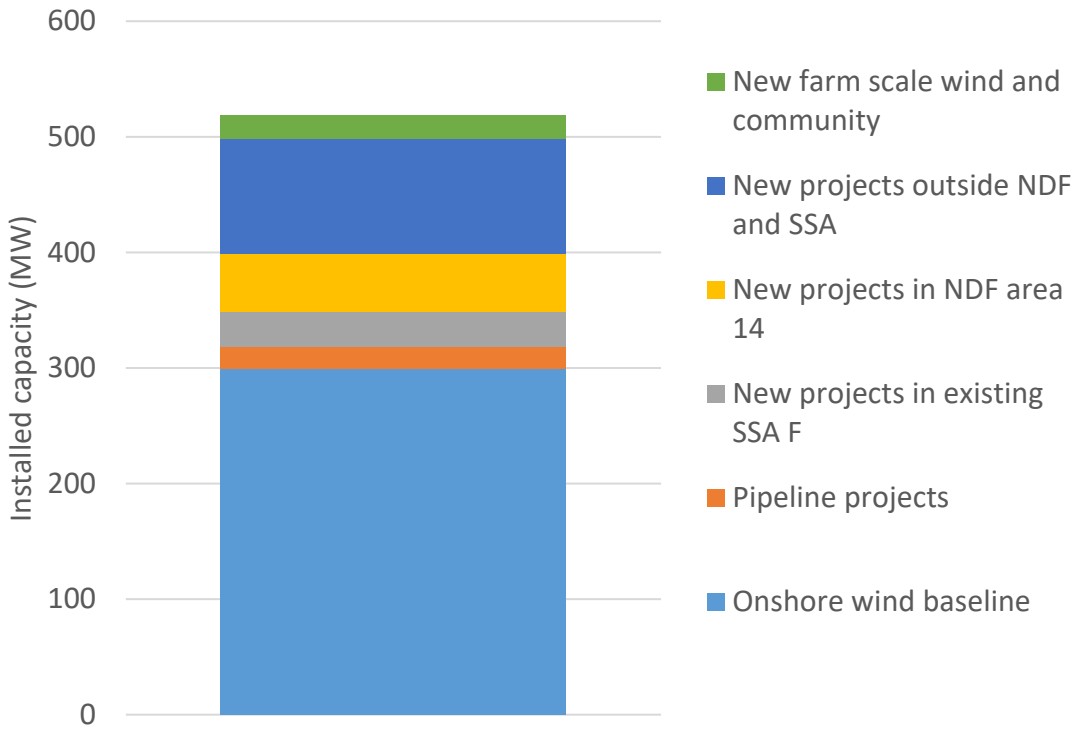


Figure 27: CCR's Energy Vision scenario for onshore wind. Source: WGES analysis

Solar PV

The Energy Vision scenario includes 0.5 GW of new solar PV, with 190 MW on rooftops and 325 MW from solar farms. Roof-mounted solar PV has an important role to play in the urban environment, particularly in engaging households and businesses in understanding the energy they consume as well as what they can generate.

Other renewables

The Energy Vision scenario also includes small increases in the deployment of anaerobic digestion (including biomethane-producing sites), and biomass electricity/CHP. Each of these technologies could have a small but significant impact on local renewable energy generation with associated economic benefits.

Marine

Stakeholder input and additional expert research suggested that, despite support and interest, a tidal lagoon project would be unlikely to be developed in the region by 2035 and its inclusion in the Energy Vision could mask the need to focus on other technologies.

Tidal power in the form of a barrage, lagoons or tidal stream continues to receive support in South Wales, with the potential Swansea Bay project (in the neighbouring region) and similar related projects investigated off Newport and Cardiff. Support for a tidal lagoon project is also highlighted within the CCR strategic business plan.

The Swansea tidal lagoon received significant commercial and public interest and was granted a development consent order in 2015[27]. But despite the interest in the area, to date there has been limited progress.

The Newport and Cardiff tidal lagoons are both potential projects in the pre-application stage of the National Infrastructure Planning register; however, no progress has been recorded on the register for either site since 2017[28]. Innovation is still required in this sector to reach a level of economic viability seen by other renewable energy technologies.

For tidal stream, the resource in the CCR area is limited and there are no projects in development in the public domain. Better tidal stream resource has been identified in Pembrokeshire and around Anglesey. The highest velocity tidal stream resource in the CCR region is near to Aberthaw in the Vale of Glamorgan. However, there are issues with the velocity at these sites being both marginal and/or unidirectional, meaning there is a better flood or ebb flows but not both. In addition, the best resource is in the main shipping lane, with limited options to divert shipping due to shallow waters either side[29].

Network infrastructure

At present there are significant network constraints on the transmission network in the licence area that supplies CCR. As a result, there is an embargo on controllable generators that run at peak times connecting to the Western Power Distribution (WPD) network in the South Wales licence area. This doesn't affect onshore wind,

[27] Planning Inspectorate (2020) National Infrastructure Planning
[28] National Infrastructure Planning register
[29] Welsh Assembly Government (2011) Marine renewable Energy Strategic Framework

solar or generators under 1 MW, but does affect the deployment of battery storage, gas generation, energy from waste and bio-energy that generates electricity.

It is possible that a system of Active Network Management on the distribution system could manage the constraint with a non-investment solution or equally the constraint may worsen and the embargo would continue. WPD are exploring whether exemptions to this embargo can be made for storage projects.

WPD's network capacity map shows significant further constraints for generation and demand customers across the region[30]. One method of working around network constraints would be through local flexibility and alternative connection agreements. The current embargo on connecting battery storage over 1 MW presents a barrier to some aspects of flexibility.

Storage and flexibility

Cardiff Capital Region hosts one of Wales' first large scale batteries, The Parc Stormy 4 MW/4.8 MWh storage project that came online in February 2018 and provides Firm Frequency Response (FFR) to the National Grid. Smaller-scale commercial behind the meter projects are known to be hosted in the region, in addition to tens of domestic battery projects[31].

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 Cardiff Capital Region by enabling more renewables to connect to the network in constrained areas and supporting the business case for investing in renewables. These will be explored further through the delivery plan.

Table 7: Summary: electricity generation

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Renewable generation	Sufficient flexibility, including storage, and network infrastructure upgrades to enable low carbon generation and demand technologies to connect 532 MW of onshore wind (233 MW of new capacity) 830 MW solar PV (520 MW of new capacity)	Generating the equivalent of over 50% of electricity consumption in 2035	Contribution towards reduction in UK grid carbon factor

[30] WPD (2020) Network capacity map

[31] Welsh Government (2019) *Energy Generation in Wales*

Summary

Under a Business as Usual scenario, CCR is expected to achieve only 26% 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.

Potential Business as Usual and Energy Vision decarbonisation trajectories in CCR

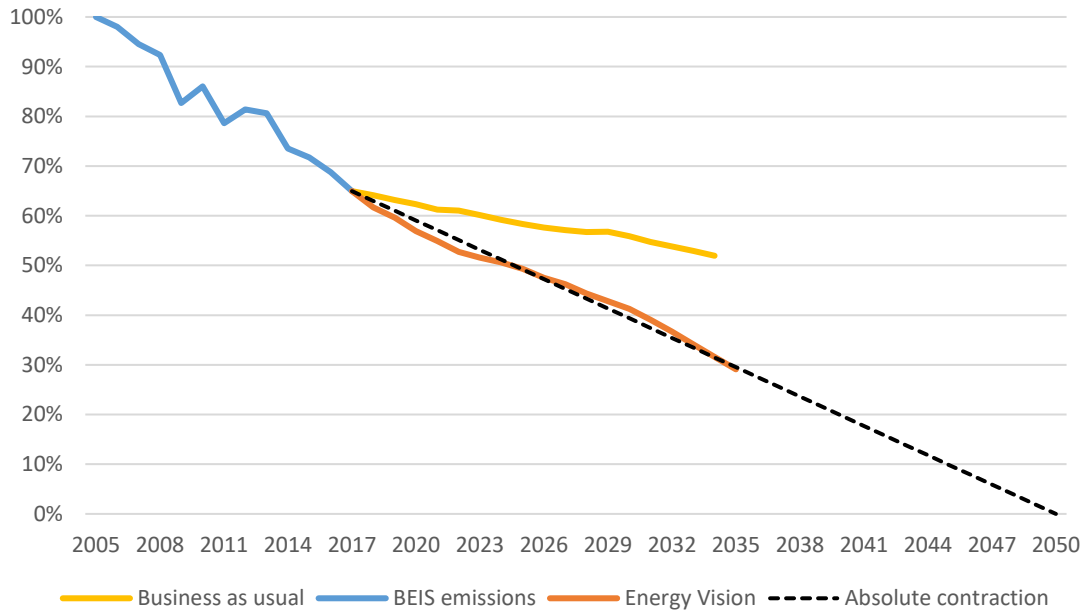


Figure 28: Decarbonisation trajectories in Cardiff Capital Region. Source: WGES analysis

The Energy Vision scenario focuses on known, deployable technology and behavioural change to 2035. Based on National Grid's 2019 Future Energy Scenarios[32] and the Committee on Climate Change[33], the scenario prioritises "clear, urgent, no regrets" actions. Table 1 summarises the results of the modelling, setting out key example outcomes to be achieved by 2035. Potential initial actions to set the region on course to achieve these outcomes are explored in the CCR delivery plan.

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 delivery plan includes consideration for some of the longer-term issues raised, such as supporting research and development on hydrogen generation and use through the region's universities and heavy industries.

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

Table 8: Summary of Energy Vision scenario modelling results

Sector	Example outcomes Energy Vision scenario	Energy prize	Carbon saving potential
Domestic heat and energy efficiency	• 42,000 houses fitted with internal or external wall insulation • Over 185,000 other insulation measures in homes • Over 140,000 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	• 18% reduction in gross thermal energy demand • 30% net decrease in domestic heating energy consumption, taking into account demand reduction and improved heat technology efficiencies, including the impact of heat pump performance.	666 kt CO_2 (51% reduction)
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	• 35% reduction in coal and petroleum energy consumption • 19% reduction in gas consumption • 4% of demand supplied by hydrogen through industrial clusters • 6% reduction in electricity demand	1,284 kt CO_2 (51% reduction)
Road transport	• 260,000 electric cars • 2,600 gas HGVs • 1,000 hydrogen vehicles • 2,000 public EV chargers • 20% 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)
Flexibility and renewable generation	• Sufficient flexibility, including storage, and network infrastructure upgrades to enable low carbon generation and demand technologies to connect	• Generating the equivalent of over 50% of electricity consumption in 2035	Contribution towards reduction in UK grid carbon factor

	• 532 MW of onshore wind (233 MW of new capacity) • 830 MW solar PV (520 MW of new capacity)		

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
- 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 Cardiff Capital Region 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 29 below visualises these concepts.

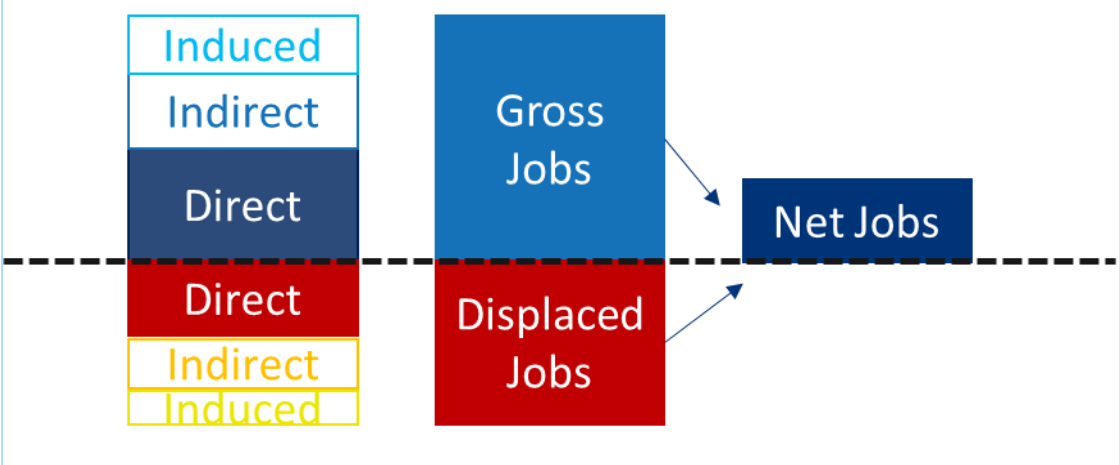


Figure 29. Shows the relationship between gross, displaced, and net jobs. Indirect direct and induced jobs are also shown. Indirect and induced jobs have not been filled with colour because these jobs are not taken into account in this analysis. [34]

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 the Cardiff Capital Region; other jobs may be held by those who travel into the region to perform their roles.

[34] 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 the Cardiff Capital Region 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.

Table 9 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 10 summarises the additional investment, jobs, and GVA associated with the Energy System Vision (ESV) scenario.

Table 9 BAU and ESV economic impact2020- 2035[35]

Scenario	Gross Jobs including losses*	Average annual jobs including losses*	Discounted GVA	Discounted Investment
Business as usual (BAU)	32,737	2,182	4,110,777,412	£366,128,354
Energy system vision (ESV)	40,166	2,678	4,964,582,623	£1,114,348,193
**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.*				

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

Table 10. Difference between the ESV and BAU scenarios 2020-2035[36]

Scenario	Net Jobs	Discounted GVA	Discounted Investment
Difference between ESV and BAU	7,429	853,805,211	£748,219,839
Difference between ESV and BAU (percentage)	23%	21%	204%

Investment

In terms of investment, the energy system vision scenario requires additional investment associated with the amount of new electricity generation included in the scenario, as well as the specific technologies involved. Onshore wind, solar PV, energy from waste, and biomass electricity and CHP each are related with approcimately 1/5th of the additional investment required to achieve the energy system vision. Figure 30 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.

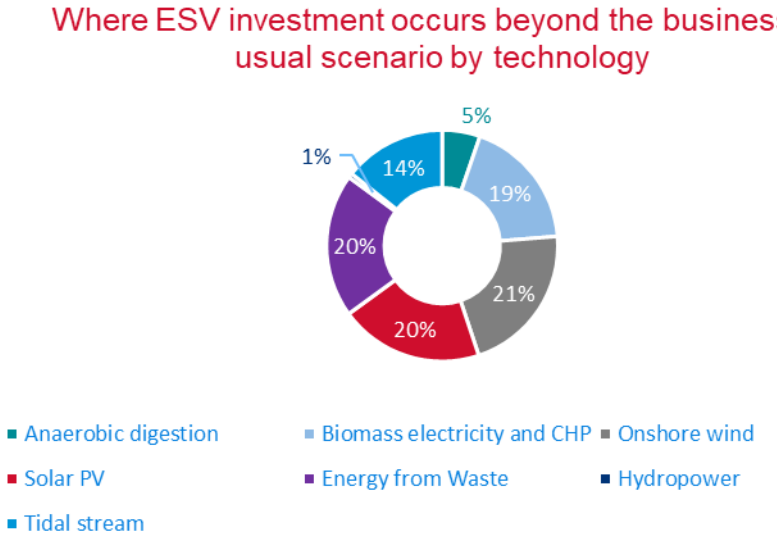


Figure 30 Where ESV Investment occurs beyond the BAU scenario by technology

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 solar PV) as well as the fact that some jobs will be lost as the capacity and output from fossil-fuel based generation technologies falls. The breakdown of jobs required in the energy system vision scenario is visualised on an annual basis in Figure 31 below.

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

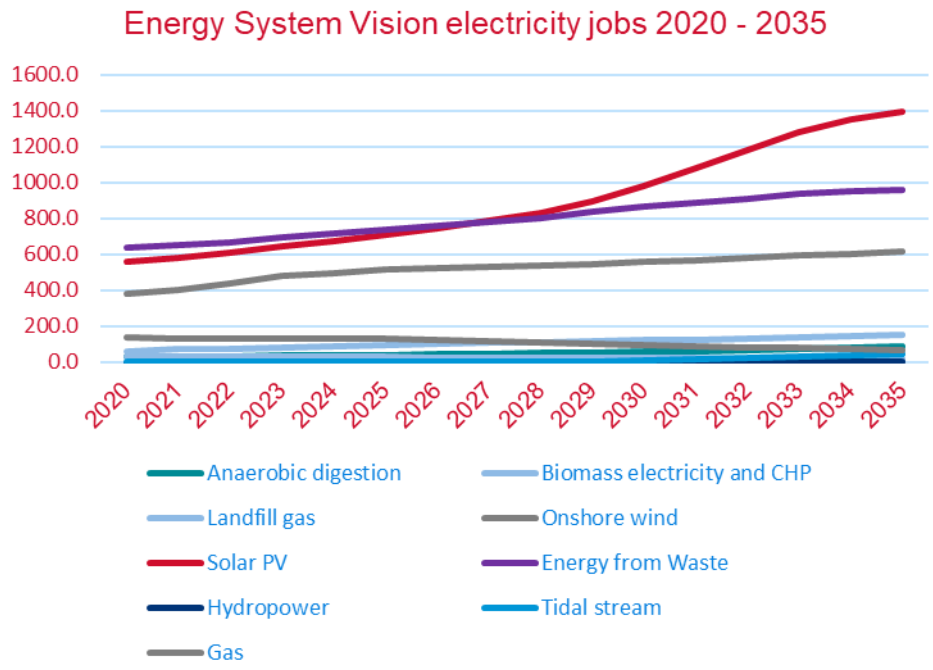


Figure 31. ESV Gross Jobs including job losses

It is estimated that in the energy system vision scenario electricity generation is responsible for 40,166 direct gross jobs from 2020 to 2035. This represents an average of 2,678 jobs per year. The number of annual jobs related to this scenario changes over the 2020 - 2035 as the deployment of technologies change. For example, in 2020 the energy system is estimated to support 1,821 jobs of which 133 are related to gas powered generation. Of renewable jobs in 2020, energy from waste is related to the largest number of jobs at approximately 634. By 2035, we estimate that the energy system vision scenario will support 3,323 jobs of which only 66 relate to gas generation. By 2035, solar PV requires the largest number of renewable jobs with 1,393 jobs or ~42% of the total jobs in that year.

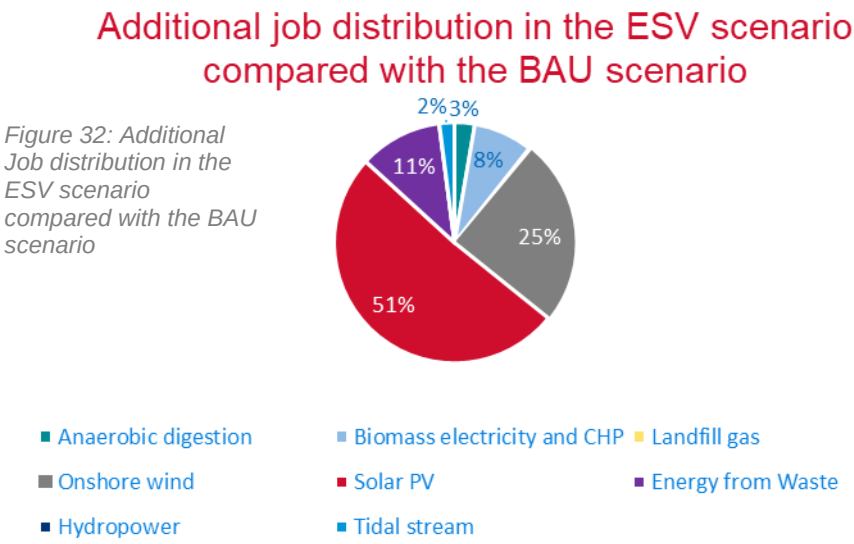


Figure 32: Additional Job distribution in the ESV scenario compared with the BAU scenario

Figure 32 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. Solar PV represents that largest difference in jobs between the two scenarios, followed by onshore wind and energy from waste.

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 11.

Table 12 shows that the energy system vision requires approximately 1.6 times the investment and jobs compared with the business as usual scenario. Additionally, it supports approximately 1.6 times the GVA associated with the business as usual scenario.

Table 11. Domestic Energy Efficiency additional economic impact of the ESV scenario compared with the BAU scenario from 2020 -2035[37]

Scenario	Net jobs	Discounted GVA	Discounted Investment
Business as usual (BAU)	21,900	£1.3b	£4.6b
Energy system vision (ESV)	31,300	£1.9b	£6.5b
Difference between ESV and BAU	9,300	£600m	£2b
Difference between ESV and BAU (percentage)	43%	43%	43%

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

* 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 33.

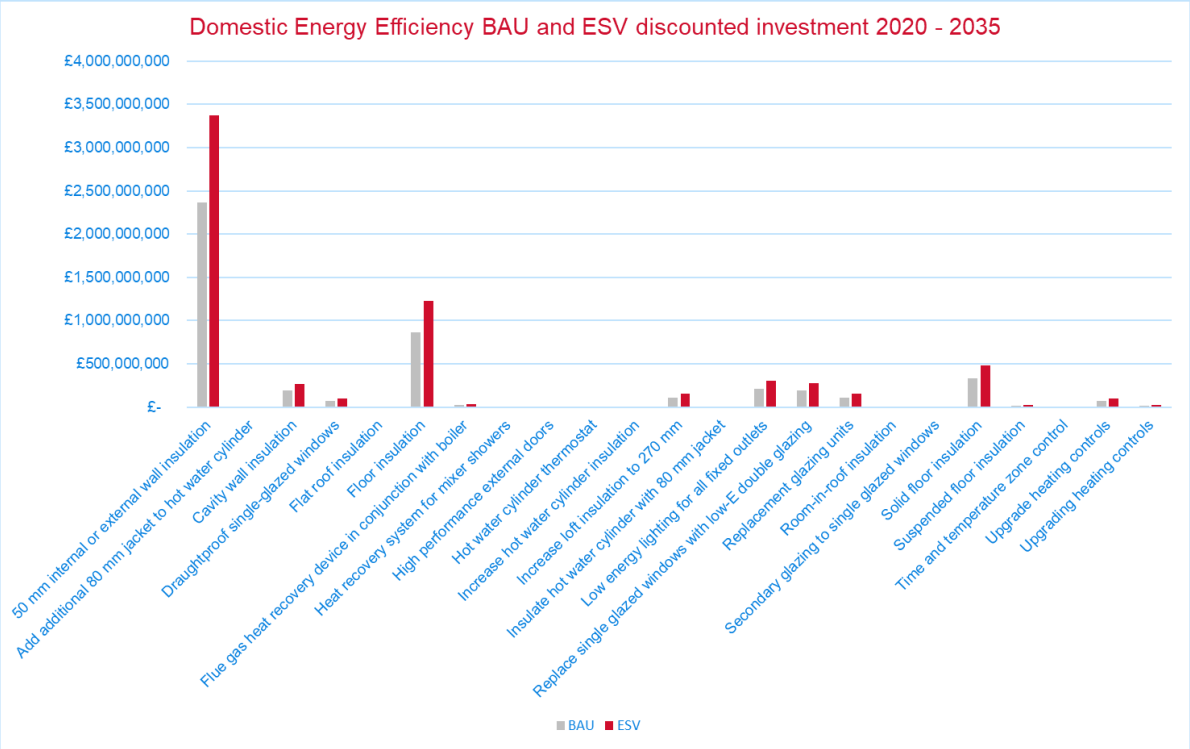


Figure 33. BAU and energy efficiency Investment requirements 2020- 2035

Jobs

9,300 additional net jobs are related to the energy system vision scenario in comparison with the business as usual scenario between 2020 and 2035. These are net direct jobs and take account of the fact that energy efficiency requires additional jobs to deliver and install the relevant technologies, but could also reduce jobs associated with the reduced need for energy production and supply. Like electricity generation, some energy efficiency jobs may be held by those residing in the region and other jobs may be held by people who travel into the region to perform these jobs.

The majority (52%) of the additional jobs in the ESV scenario relate to installation of 50 mm internal or external wall insulation and 20% of jobs relating to floor insulation. Figure 34 below show the estimated jobs required to implement the energy efficiency measures that relate to the EPC shift in the BAU and ESV scenarios.

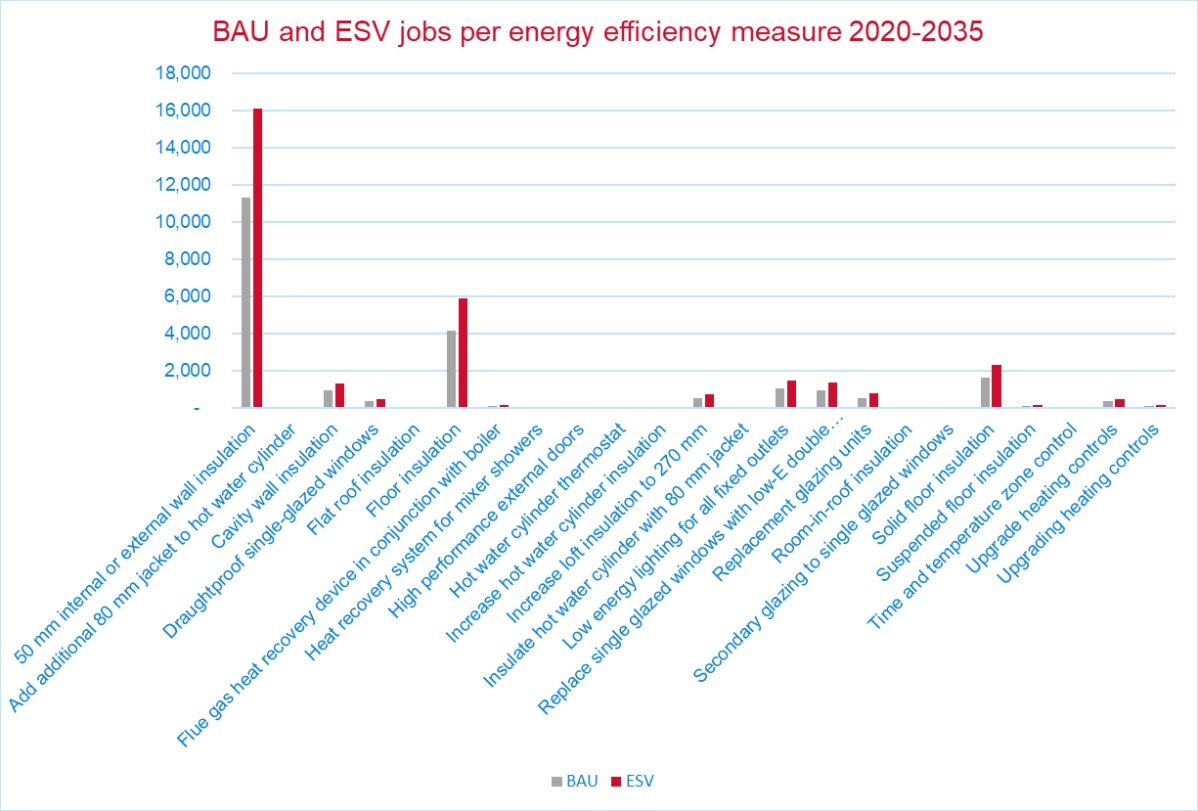


Figure 34. Net BAU and ESV jobs per energy efficiency measure 2020 – 2035.

Domestic heat

For domestic heat, we estimate that the energy system vision scenario has a larger economic impact than the business as usual scenario when it comes to investment and GVA. For example, the GVA related to the energy system vision scenario is 320 percent greater than the BAU. Similarly, 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 12 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 35.

Table 12. BAU and ESV economic impact as well the difference between ESV and BAU economic impact 2020-2035[38]

Scenario	Gross jobs associated with low carbon heating*	Discounted GVA associated with all heating technologies	Discounted Investment associated with all heating technologies

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

Business as usual (BAU)	966	112,904,278	£253,448,346
Energy system vision (ESV)	3,971	474,208,575	£954,916,917
Difference between ESV and BAU	3,005	361,304,297	£701,468,570
Difference between ESV and BAU (percentage)	311%	320%	277%
*For domestic heat it is more difficult to link jobs to the local economy. This is because energy efficiency jobs are related to the manufacturing of energy efficiency technologies and products as well as their installation. A portion of these jobs is likely to be located within the Cardiff Capital Region however other jobs will be held by persons resident outside of the region.			

Investment

Figure 35 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 2025 in relation to air source heat pumps.

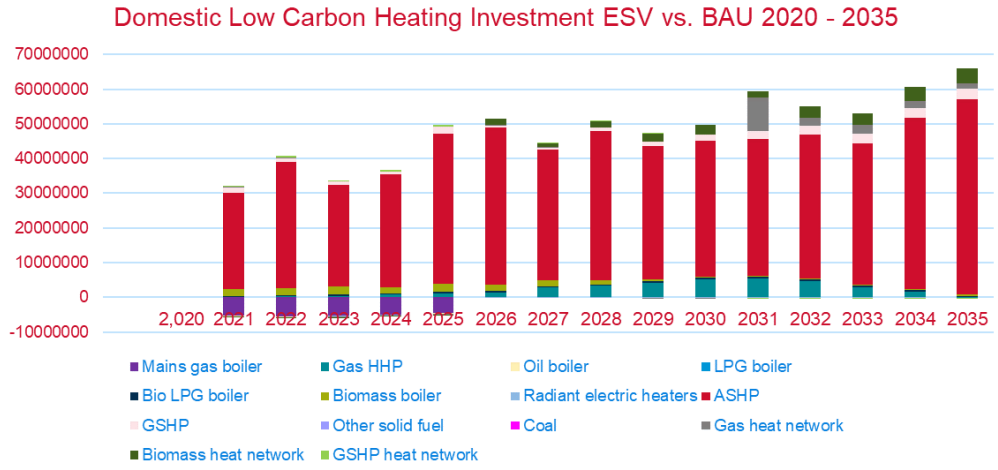


Figure 35. ESV vs. BAU discounted heat investment 2020 – 2035. Discounted at a rate of 3.5%.

Jobs

The job figures estimated for domestic heat differ from those calculated for electricity generation. Fewer studies have been undertaken to quantify the jobs related to the installation of heating technologies than electricity generation technologies. Specifically, indicators of FTEs/ £m turnover in non-heat network low carbon heating technologies were available. For heat networks the indicators used were permanent jobs per annual GWh heat generated.

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

Figure 36 below shows the difference in low carbon heating jobs between the ESV scenario and the BAU scenario. Like investment, the majority of jobs related to air source heat pumps. It's worth emphasizing that these figures relate to low carbon heating only and don't include jobs related to traditional heating technologies such as gas or oil boilers (either within the BAU or ESV scenarios). Additionally, as stated at the beginning of this section on domestic heating, it is difficult to comment on the location of these jobs; some jobs will be held by Cardiff Capital Region residents while others will be held by those outside of the region.

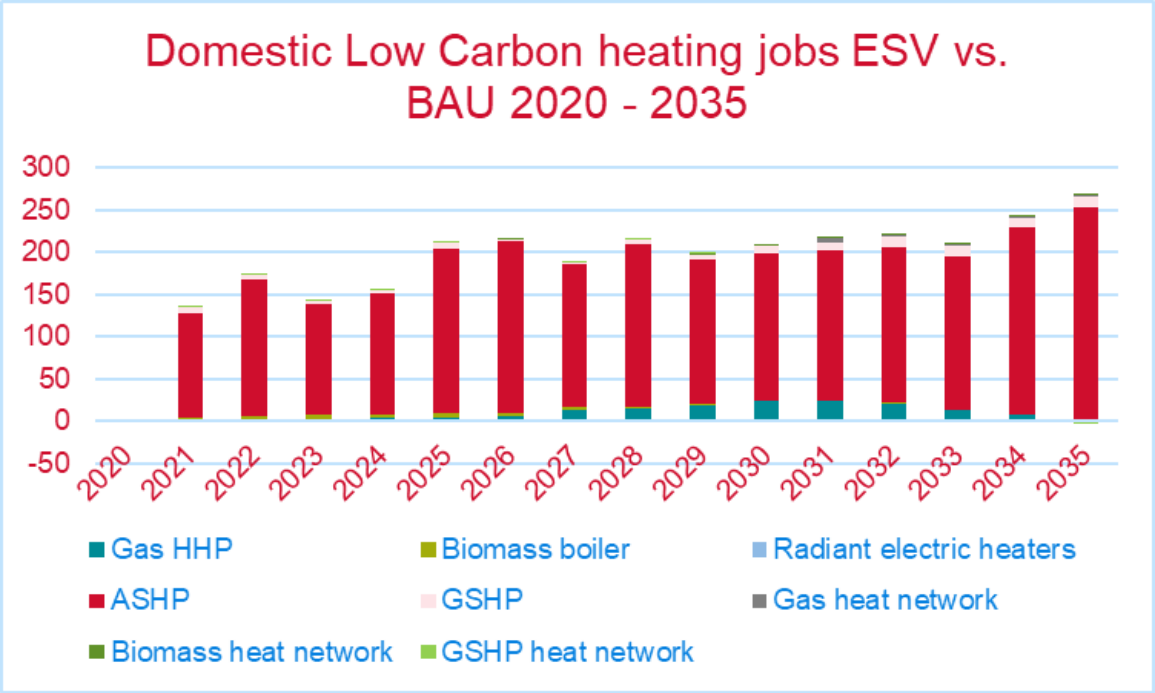


Figure 36. Domestic Low Carbon heating jobs ESV vs. BAU 2020-2035

Summary

Across all technologies, the substantially 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. Likewise, achieving the ESV scenario delivers more jobs and additional GVA. In total the ESV scenario requires £3.4 billion of additional investment which is a 65% increase against business as usual. In terms of jobs, the ESV scenario is estimated to require an additional 16,700 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 nearly £1.7 billion more GVA (discounted at 3.5% over the period 2020-2035). In addition, it is estimated that there will be over 3,000 more gross jobs associated with the provision of low-carbon heating technologies in the ESV scenario than the BAU scenario, associated with £361 million of GVA.

Next Steps

Next Steps

The Cardiff Capital Region Energy Strategy has undertaken several important first steps towards addressing the climate emergency in CCR. We have developed a collaborative vision for the future energy system in CCR 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 we will now take to transition from a strategy to real world action in the delivery of our CCR energy system vision:

1) **Defining the strategy governance.** We will establish a robust and formal governance structure for the CCR Strategy. This will include defining a structure of cross-sectoral governance, powers, roles and responsibilities for overseeing the implementation of the strategy, and the monitoring and evaluation of its progress. This is essential to coordinate and unlock action, and to ensure momentum going forwards.

2) **Communicating and socialising the strategy.** We will undertake a series of engagement activities to communicate, socialise and build support for the final strategy amongst key political, corporate and community stakeholders throughout the region. This activity will help to align a diverse stakeholder group to the CCR energy vision and raise awareness of insights arising from the analysis and engagement undertaken as part of the strategy development.

3) **Establishing a delivery plan.** We will create a delivery plan for addressing the challenges identified in the energy modelling work, and for defining the processes and actions that could be taken forward to realise the energy system vision. We anticipate that the delivery plan will be a living document that is regularly reviewed and updated, and may be influenced by future local area energy planning or other relevant developments and research.

The energy modelling presented has shown that significant action is required for the Cardiff Capital Region 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.

The economic assessment also illustrates that the energy system transition may bring benefits to the Cardiff Capital Region in the form of jobs, however additional investigation is required to maximise these benefits. Likewise, the energy vision clearly sets out the intention that the future energy system should support the wellbeing of communities wherever possible. These next steps will help to scale up the existing decarbonisation and energy transition efforts in the region and turn the vision into action.