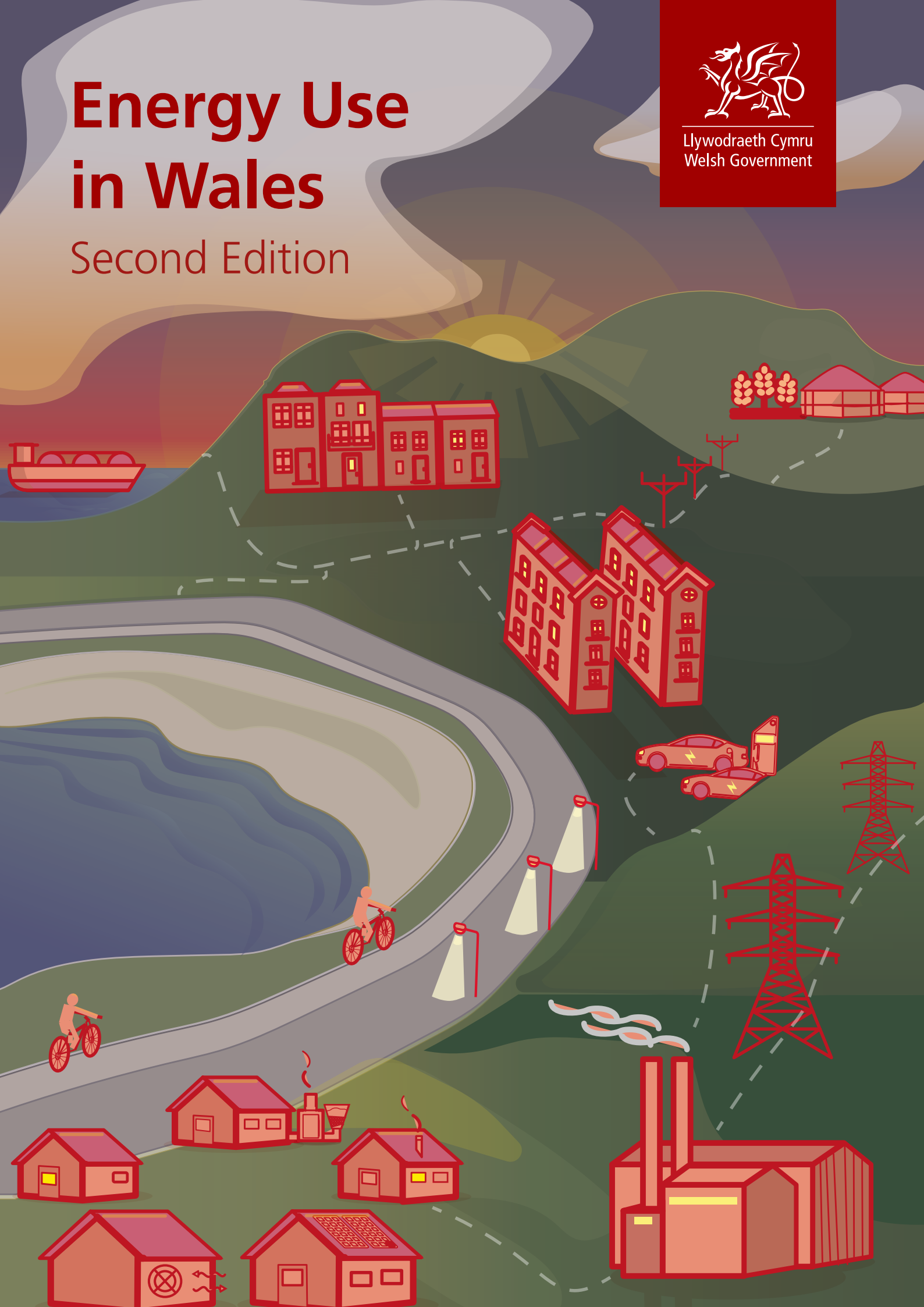


Energy Use in Wales

Second Edition



Llywodraeth Cymru
Welsh Government



Cover illustration: Regen

Written and produced by Regen for the Welsh Government



Regen is a not-for-profit centre of energy expertise and market insight whose mission is to transform the world's energy systems for a zero carbon future.

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Ministerial foreword

As set out in Net Zero Wales, the 2020s has to be a decade of climate action. Major decisions will need to be taken if we are to limit our contribution to global warming. We must rapidly accelerate our transition away from fossil fuel dependency and build a greener, fairer society.

Demand reduction, energy efficiency and a circular economy approach is a core thread throughout our emissions reduction plan, Net Zero Wales. This shared accountability for the energy transition should help us meet our ambitions reduce demand for energy together with the scaling up of the proportion of energy in Wales from renewable sources.

This report highlights the efficiencies we have already achieved, particularly in industry. However, there are still huge gains to be made across our society, and we all have a part to play in reducing our energy use and using renewable energy.

Electrification of transport, heating and industry will also be a key feature of the change in energy use over the period to 2050, and we anticipate hydrogen will play a key role as a means of storing and transporting energy. Our programmes across the Welsh Government are supporting this shift, alongside our actions to upscale renewable energy generation.

This report, and future editions of Energy Use in Wales, will track the progress of energy's role in our journey to a more efficient, circular and zero carbon society.



Julie James MS

Minister for Climate Change



Lee Waters MS

Deputy Minister for Climate Change

Introduction

The Energy Use in Wales Second Edition report provides a snapshot of how energy was used in Wales in 2020 and how this usage has varied over time. The purpose of the report is to offer the Welsh Government an accurate and clear picture of energy use to support policy making.

BEIS sub-national energy consumption statistics, enhanced with additional data analysis, have been used to explore energy consumption in Wales, with the resulting energy use data presented by end use, sector, fuel type and geographic area. This report draws from the latest available data in each case, which as a result spans the period between 2019-2021.

Between 2005 and 2019, total energy use in Wales reduced from a total of 109.9 TWh in 2005 to 92.8 TWh in 2019: a reduction of 16% over a 14-year period. While there have been reductions in energy use across all four regions of Wales, the greatest reduction has been in the Swansea Bay City Region, due to changes in industrial energy consumption.

This report:

- Has collated data from a wide range of publicly available sources, as well as data provided by key third-parties
- Has used the same energy usage definitions as can be found in the Welsh Government's Net Zero Wales Carbon Budget 2 (2021 to 2025) report (see methodology section for more details)
- Has studied energy consumption by fuel type, by sector and across the four regions of Wales - the Swansea Bay City Region, Cardiff Capital Region, Mid and North Wales
- Includes analysis and commentary on variations in energy use over time, at a national and sub-national level

Fuel use analysed:



Electricity



Petroleum products



Natural gas



Manufactured fuels



Coal



Bioenergy and wastes



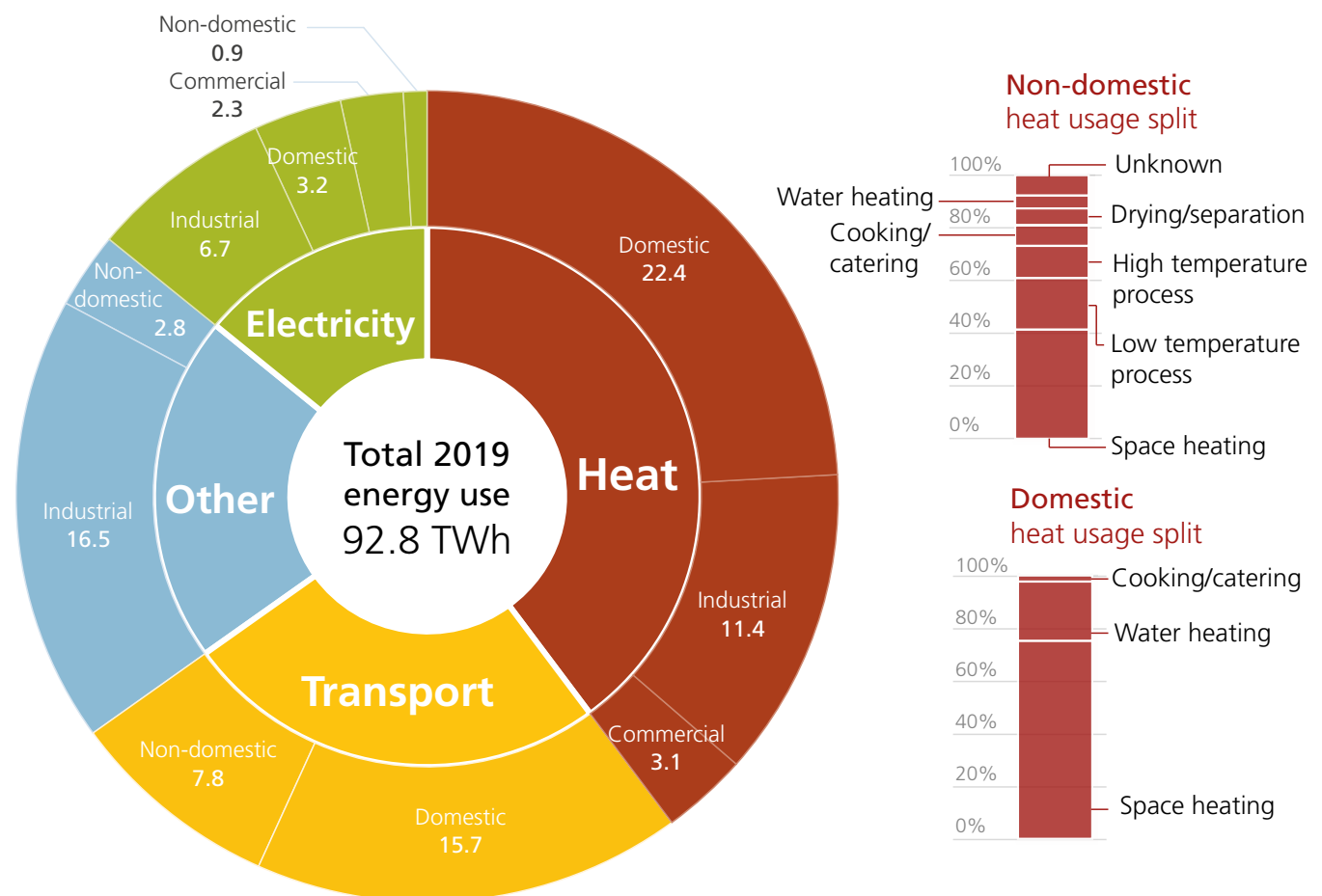
Types of energy use

In 2019, total energy use across Wales totalled 92.8 TWh. This represents a 16% reduction since 2005 – 2% more than England for the same time frame. However, most of this reduction took place in the late 2000s and early 2010s; between 2013 and 2019, there was a 5% decline in total energy use, compared to 15% in the preceding seven years.

40% of the energy used in Wales provides heat to homes, businesses and industry¹ – this includes electricity that is used for heating. With 23.4 TWh, transport makes up the second largest use category. The third broad use category is electrical non-heating use – which includes appliances, lighting and cooking powered by electricity – and represents around 9% of energy use in Wales. A fourth ‘other’ category represents non-domestic consumption of fuels such as petroleum for industrial or agricultural purposes.

Annual energy in Wales broken down by use, 2019 (TWh)

Data source: 1, 11



¹ Based on analysis of heating fuel categorisation by Regen

Case study - Swansea Bay City Region

Homes as Power Stations

The Homes as Power Stations (HAPS) project is a pioneering programme supported by all four local authorities in the Swansea Bay City Region, to facilitate the integration of energy efficient design and technologies in new build and to retrofit homes across the region². The aim of the initiative is to prove the viability and benefits of energy efficient homes, reducing carbon emissions, tackling fuel poverty, and helping residents to save money on their energy bills.

Image credit: Richard Youle



Having gained business case approval in June 2020, the programme will be implemented over the next 5 years with 7,000 existing homes and a further 3,300 new homes benefitting from support. Funding is coming from the Swansea Bay City Deal, an investment portfolio of £1.3 billion, the Welsh and UK governments, as well as the public and private sectors³. In addition, the programme aims to develop a skilled regional supply chain and a standardised HAPS approach, demonstrating the viability of the concept to the rest of Wales and helping to create a new industry in the Swansea Bay City Region.

The retrofit of six bungalows in Craigcefnparc in Swansea has already been completed, resulting in weekly bills as low as £1 in April 2020. These properties, which previously relied on LPG, oil and electricity to heat their homes, have been fitted with solar panels to generate electricity and ground source heat pumps for heating and hot water. Meanwhile the energy efficiency measures implemented include insulated wall rendering and triple-glazed windows. The cost of this has been approximately £55,000 per house.

² Swansea Bay City Deal, 2020; Regional approval for Homes as Power Stations project www.swanseabaycitydeal.wales/news/regional-approval-for-homes-as-power-stations-project/

³ Swansea Bay City Region Joint Committee, 2020 www.democracy.swansea.gov.uk/documents/s65927/10%20-%20Homes%20as%20Power%20Stations%20Business%20Case.pdf?LLL=0

Energy use by sector

In order to align with the sectoral pathways explored in the Welsh Government's Second Carbon Budget, the sectoral analysis for Energy Use in Wales Second Edition has been split into five sectors: transport, industrial, commercial, agriculture, and domestic consumption.

Of these sectors, industry has consistently accounted for the highest energy use in Wales, representing 37% of all consumption in 2019. In fact, it is estimated that energy use by industry exceeds all energy use in buildings (residential and commercial combined). However, energy use for industrial purposes has declined by 26% since 2005, when it represented more than 40% of energy consumption in Wales.

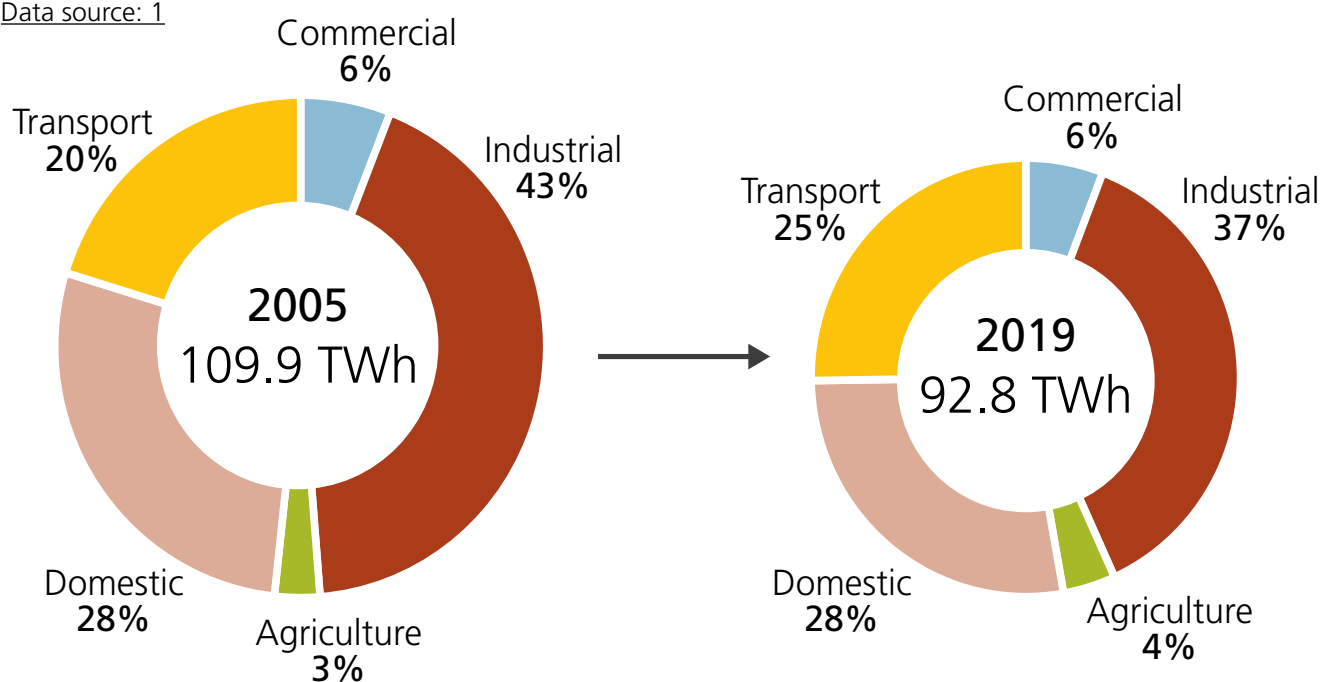
Energy consumption in Wales (TWh/yr)

Year	Transport	Domestic	Commercial	Industrial	Agriculture	Total
2005	22.3	30.8	6.5	47.0	3.3	109.9
2013	22.1	25.7	5.6	40.7	3.0	97.1
2019	23.4	25.6	5.4	34.7	3.7	92.8

Overall, three of the five sectors have seen reductions in energy use since 2005: industrial, commercial and domestic use. Meanwhile, both the agriculture and transport sectors used more energy in 2019 than 2005. While agriculture represents only a small proportion of energy use in Wales (less than 4%), transport represents a quarter of energy consumption in Wales, and has seen a 5% increase in consumption between 2005 and 2019.

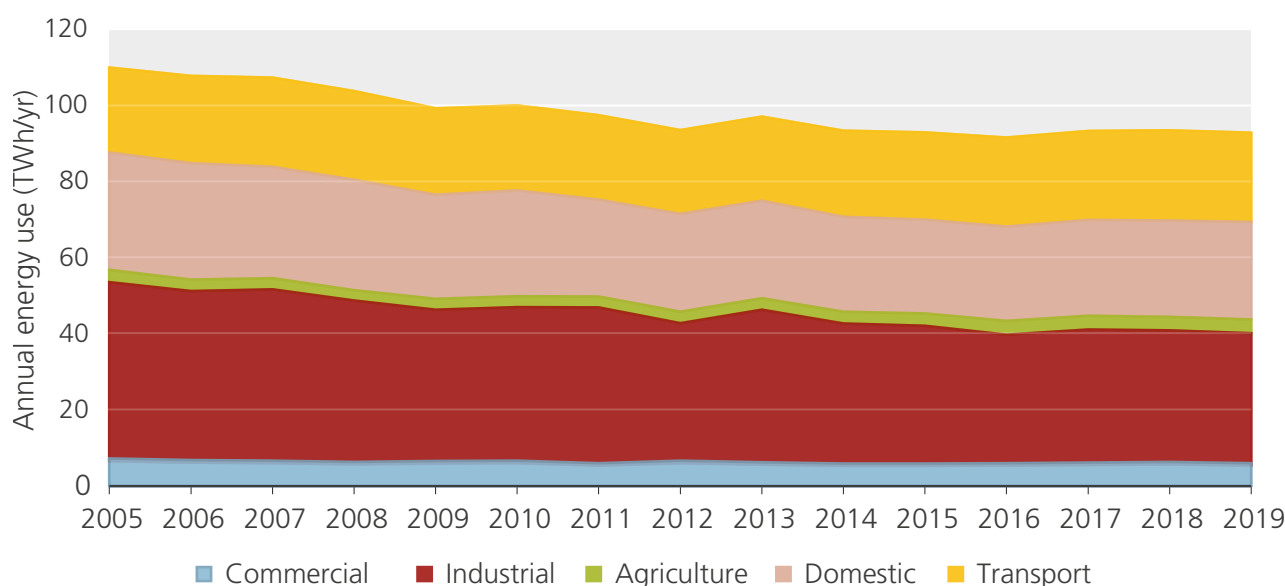
Energy consumption in Wales (TWh/yr)

Data source: 1



Energy use by sector, 2005-2019 (TWh)

Data source: 1

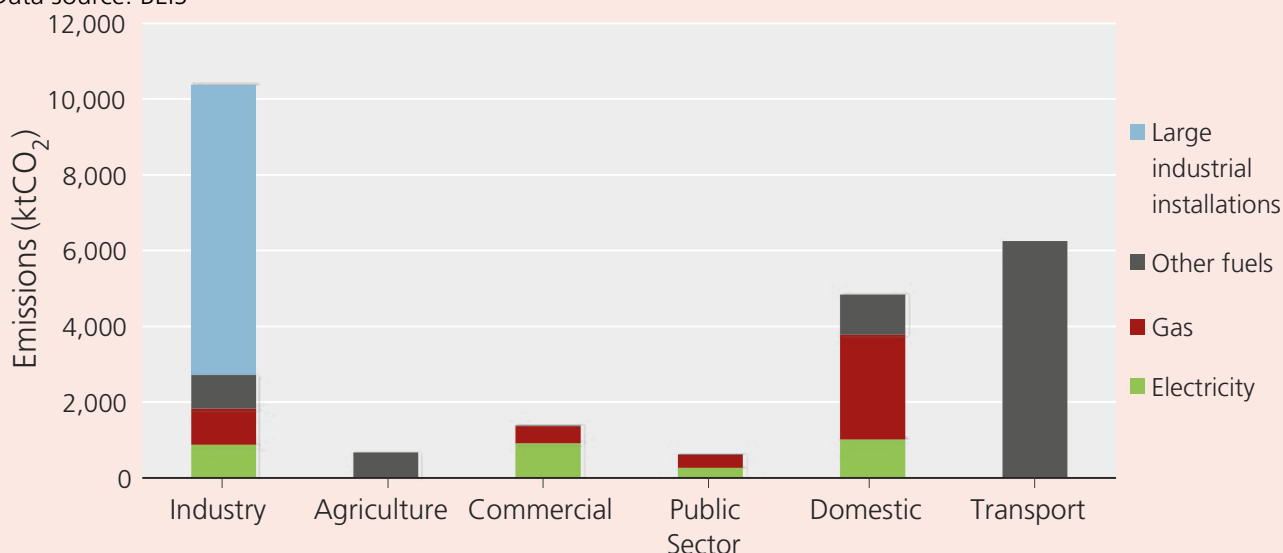


CO₂ emissions from energy consumption for Wales

BEIS data⁴ estimates that total emissions from energy use in 2019 were 24 MtCO₂ - 42% of this is estimated to be from industry, 26% from transport and 20% from domestic consumption. Emissions from energy use are estimated to make up around 62% of total emissions in Wales, when comparing this BEIS figure to the total emissions figure calculated in the Climate Change Committee's 6th Carbon Budget⁵ (39 MtCO₂e).

Emissions from energy use by sector for Wales, 2019

Data source: BEIS⁴



4 BEIS, 2021; UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2019 www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2019

5 The Climate Change Committee, 2020; Sixth Carbon Budget www.theccc.org.uk/publication/sixth-carbon-budget/

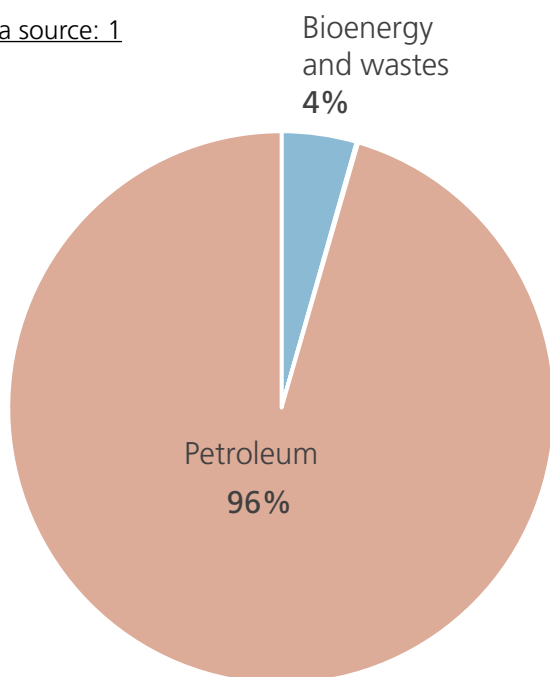
Transport

Energy use for road and rail transport in Wales has remained relatively consistent over the last decade, with 23.4 TWh consumed in 2019, compared to 22.3 TWh in 2005⁶. Consumption had been steadily decreasing since 2007, but, from 2013, levels began to increase again, peaking in 2018 at a new high of 23.7 TWh, in a trend that can be seen throughout the UK.

As reductions in other sectors continue, transport is accounting for an increasing share of the total energy use in Wales, rising from 20% in 2005 to 25% in 2019. This is smaller than for the UK as a whole, which has seen the proportion of total energy used by the transport sector increase from 26% in 2005 to 31% in 2019.

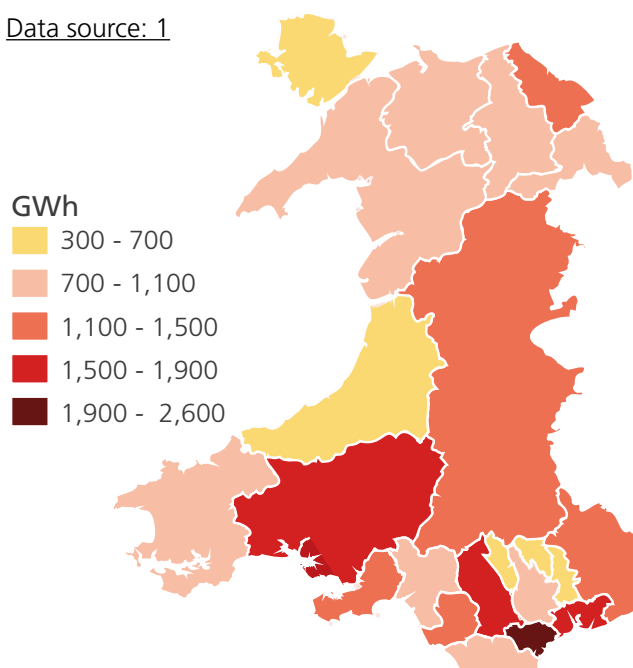
Transport consumption by fuel, 2019

Data source: 1



Annual transport energy use by local authority area, 2019

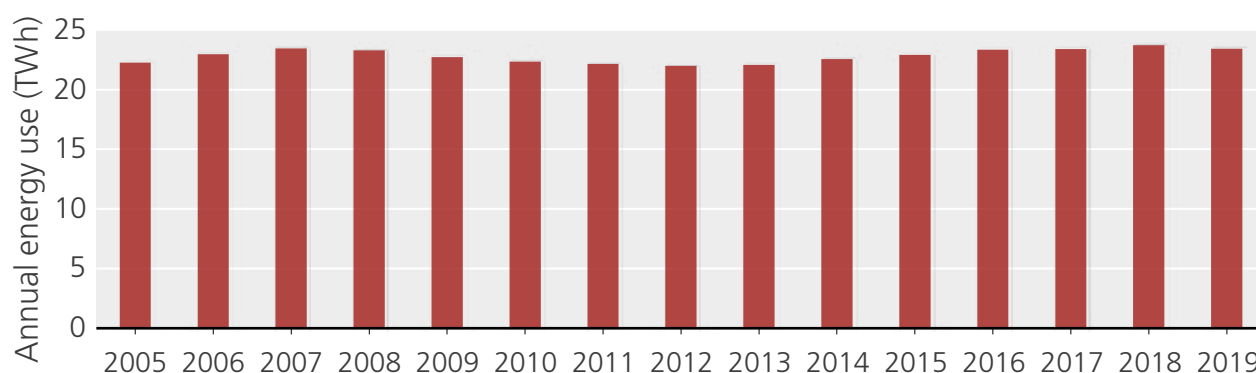
Data source: 1



The energy used for transport is highest around urban areas like Cardiff and Newport. However, the fastest growth in the use of energy for transport between 2005 and 2019 was in the rural areas of Ceredigion (17%), Pembrokeshire (14%) and Carmarthenshire (13%).

Transport consumption by year

Data source: 1



⁶ Aviation, shipping and electricity for trains and cars are not included in these datasets

The electrification of transport in Wales

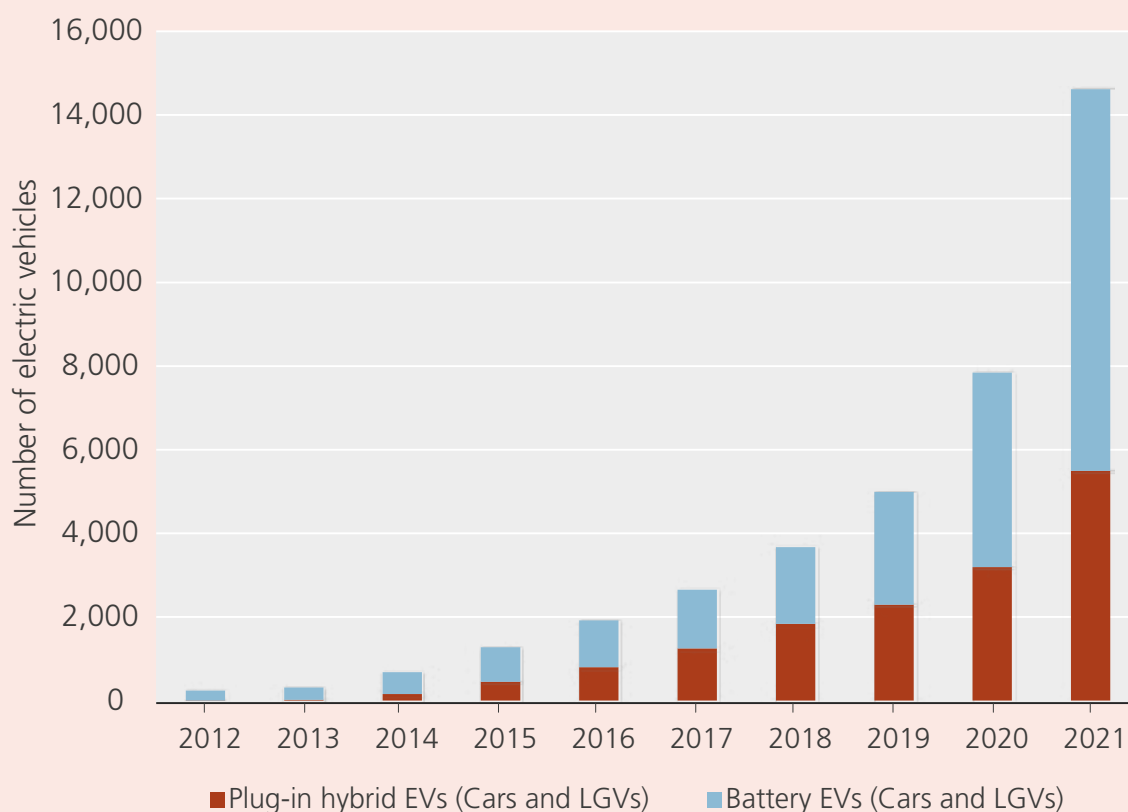
At the end of 2021, there were an estimated 14,600 Electric Vehicles (EVs) in Wales, including over 9,100 Battery Electric Vehicles (BEVs) and nearly 5,500 Plug-in Hybrid Electric Vehicles (PHEVs). The rate of sales of electric vehicles in Wales dramatically increased in 2021, particularly for BEVs, which are estimated to have nearly doubled in number over the last year.

The Climate Change Committee's Sixth Carbon Budget's 'balanced scenario' (December 2020) estimates that, to achieve net zero, Welsh surface transport emissions need to reduce by around 70% to 32 MtCO₂e by 2035, and to around 1 MtCO₂e by 2050⁷. Electric vehicles have a crucial role to play in delivering reductions in transport emissions and sales will need to continue to increase rapidly year on year.

It is estimated that the 14,600 EVs in Wales have increased electricity demand by approximately 27 GWh annually, while reducing petroleum demand by between 90 to 140 GWh depending on the number and types of vehicles that were displaced by EVs. The high efficiency of EVs compared to fossil fuel vehicles means that the associated decrease in petroleum use will greatly outweigh the increase in electricity demand, which must be met by renewable electricity to maximise emission reductions.

The number of new BEVs registered in Wales in 2021 is estimated to be nearly as many as all preceding years combined.

Data source: 15



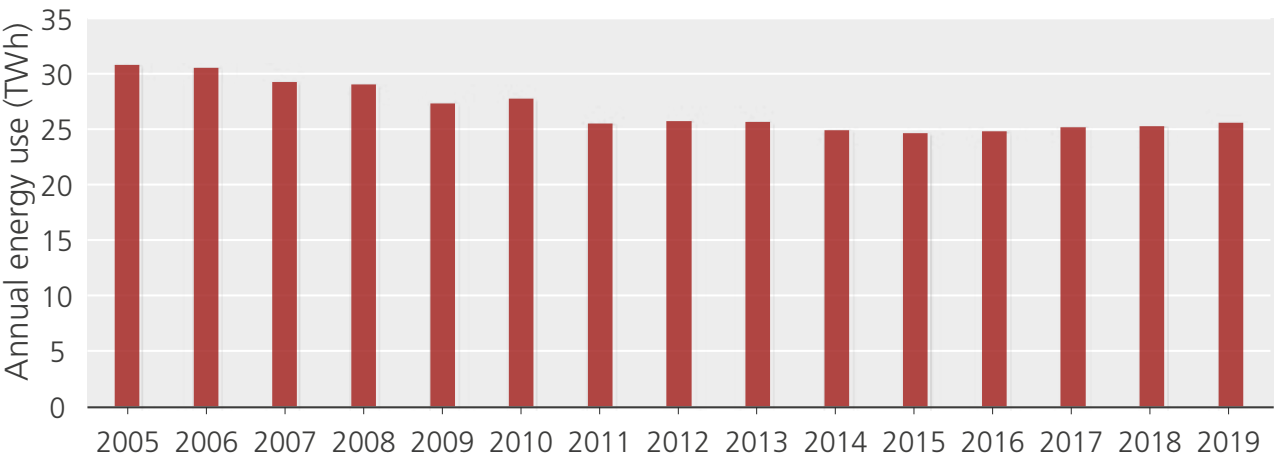
7 The Climate Change Committee, 2020; Sixth Carbon Budget www.theccc.org.uk/publication/sixth-carbon-budget

Domestic

Between 2005 and 2015 domestic consumption had been reducing across Wales, reaching a low of 24.7 TWh - a 20% change from 30.8 TWh in 2005. However, since 2015, consumption has slightly increased again, reaching 25.6 TWh in 2019. This is likely to have been influenced by the changing population of Wales, which increased by 6% 2005 and 2019.

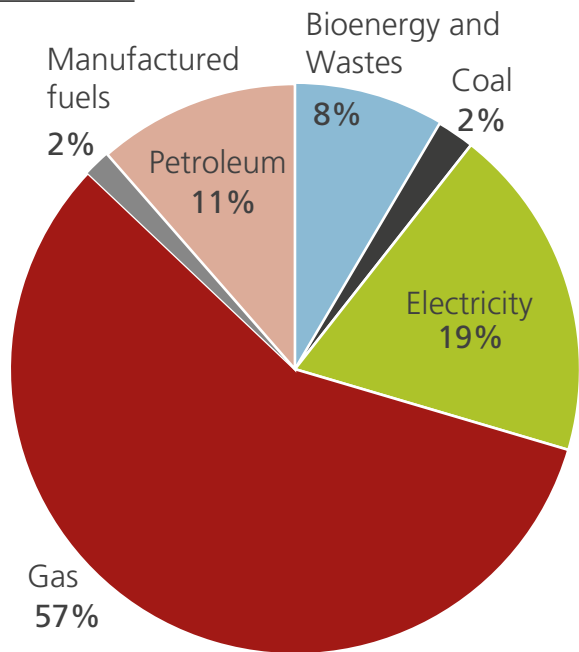
Domestic consumption by year

Data source: 1



Domestic consumption by fuel, 2019

Data source: 1



Offsetting this, investments in energy efficiency and heating efficiency will have had an impact in reducing overall energy demand. The average percentage of dwellings with EPC Band 'C' or above across local authorities in Wales has been slowly increasing since 2016, from 34% to almost 36%. In comparison, the England and Wales average has remained at 40.8%.

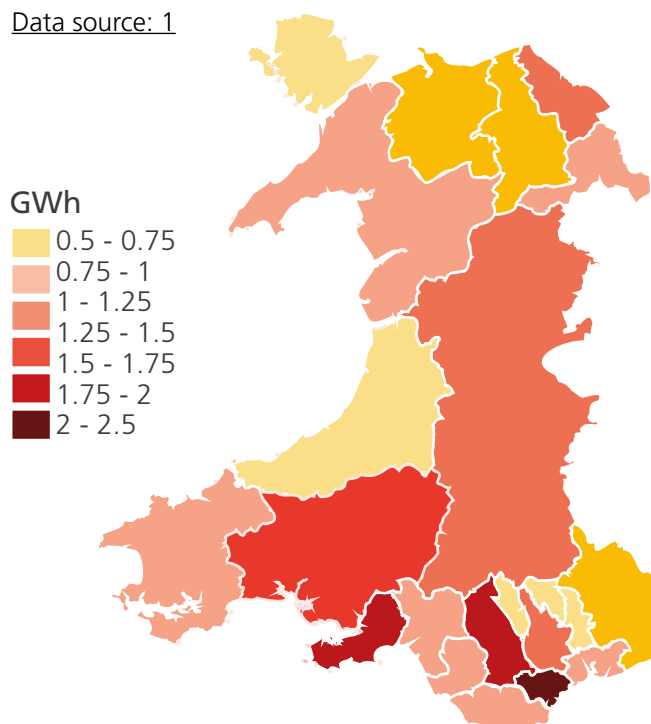
Gas has remained the dominant fuel consumed in domestic buildings, due to the prevalence of gas-powered heating systems, although its proportion of the fuel mix has reduced from 65% in 2005 to 57.5% in 2019.

The majority of this has been replaced by bioenergy, which has increased from 2% of domestic fuel consumption in 2005 to 8.5% in 2019.

The three most populous local authorities of Wales - Cardiff, Rhondda Cynon Taf and Swansea - represent 27% of the population of Wales, and accounted for almost 25% of all domestic consumption in 2019 (2.4 TWh, 1.97 TWh and 1.94 TWh respectively). While Cardiff has the second highest percentage of dwellings with EPC Band 'C' or above of all the local authorities in Wales (46.2% in 2020, second only to Newport with 49.6%), it is also the most populous local authority, with a population of over 369,000, explaining the high levels of domestic energy consumption.

Annual domestic energy use by local authority area, 2019

Data source: 1



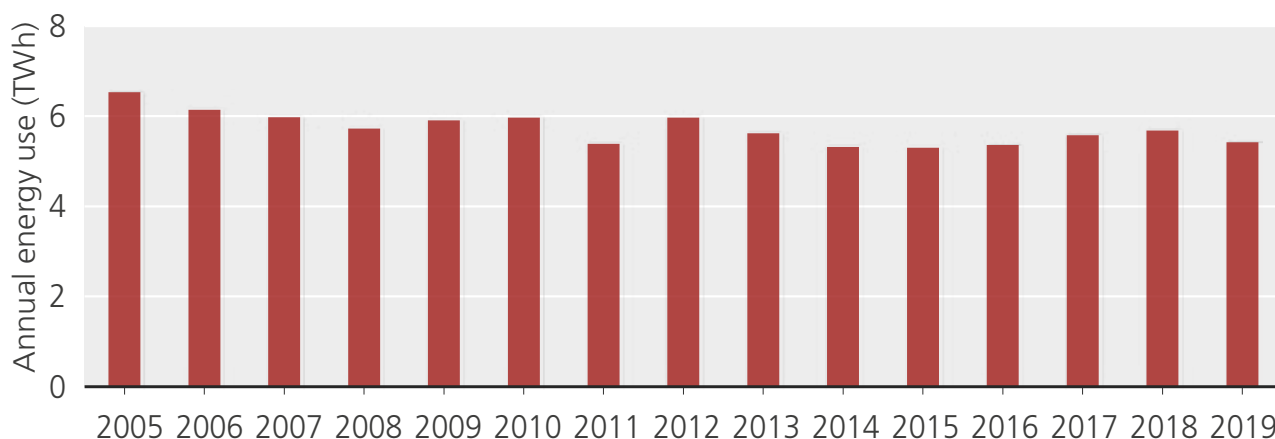
Commercial

Commercial energy use represents public and private sector activity outside of industry, such as education, public services or retail. Energy consumption in this sector has fluctuated between 2005 and 2019, reaching a low of 5.3 TWh in 2015 before beginning to increase again.

A total reduction of 17% has been achieved between 2005 and 2019: from 6.5 TWh to 5.4 TWh. While this is partly due to retrofit projects, behavioural change and other improvements to energy efficiency, the scale of change suggests other factors of influence, such as changes to the economy.

Commercial consumption by year

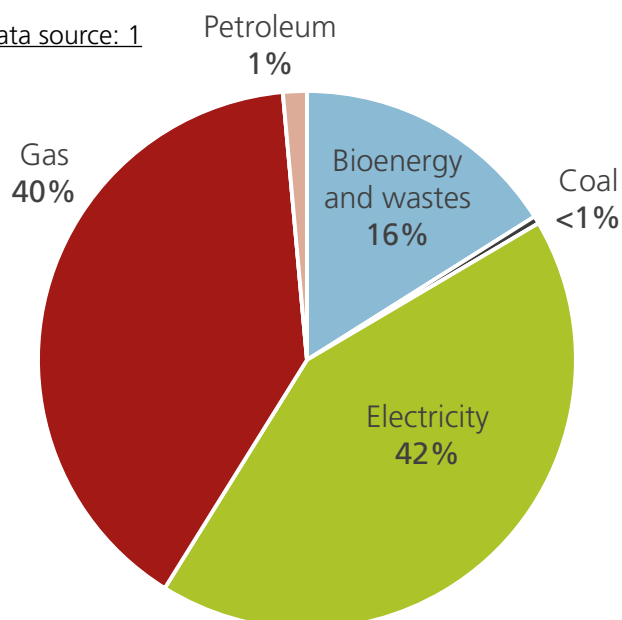
Data source: 1



The highest concentration of commercial consumption is associated with the most urban areas: Cardiff, Swansea and Newport. Commercial consumption has reduced despite employment increasing across Wales in this sector. Overall, commercial employment has increased by 12% since 2005, most significantly in the professional, scientific and technical activities sub-sector – as defined by BEIS – which has increased by 59% since 2005.

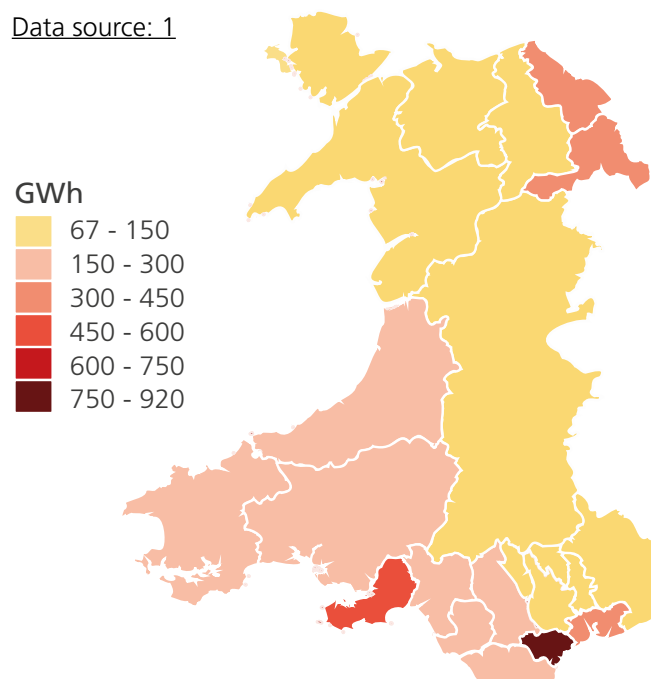
Commercial consumption by fuel, 2019

Data source: 1



Annual commercial energy use by local authority area, 2019

Data source: 1



The commercial sector has consistently accounted for 6% of total energy consumption in Wales, a similar figure to that seen UK-wide (5%).

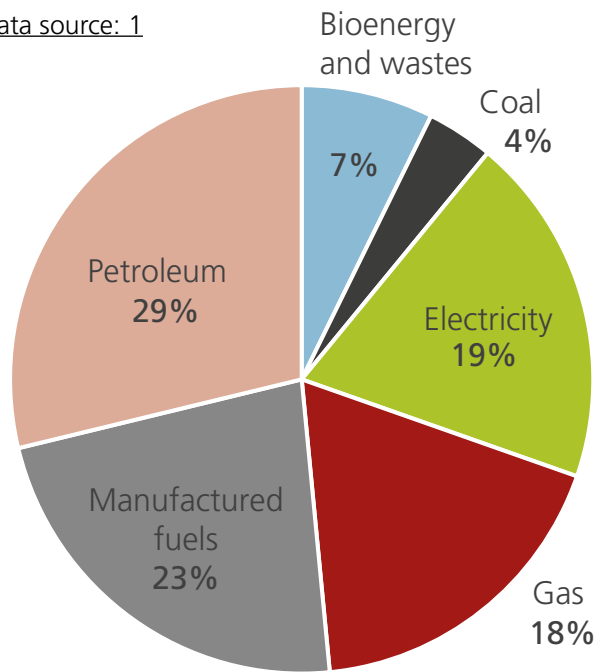
Electricity consumption accounted for 42% of all commercial energy use in 2019, making it the most dominant fuel. This proportion has remained steady since 2005, while gas use has declined by 10% to become the second most common fuel. Bioenergy and waste consumption has made up this shortfall, with use increasing 12% since 2005, most of which is supplied to meet heating demand, for example through biomass boilers.

Industrial

Industry is the sector in Wales that has seen the greatest decrease in energy use since 2005, falling by 26% from 47 TWh in 2005 to 34.7 TWh in 2019⁸. This fall in industrial energy use is partly caused by a reduction in industrial activity, but is also driven by improvements in efficiency of production. The proportion of total energy use represented by the industrial sector has decreased across the UK, from 35% in 2005 to 30% in 2019.

Industrial consumption by fuel, 2019

Data source: 1

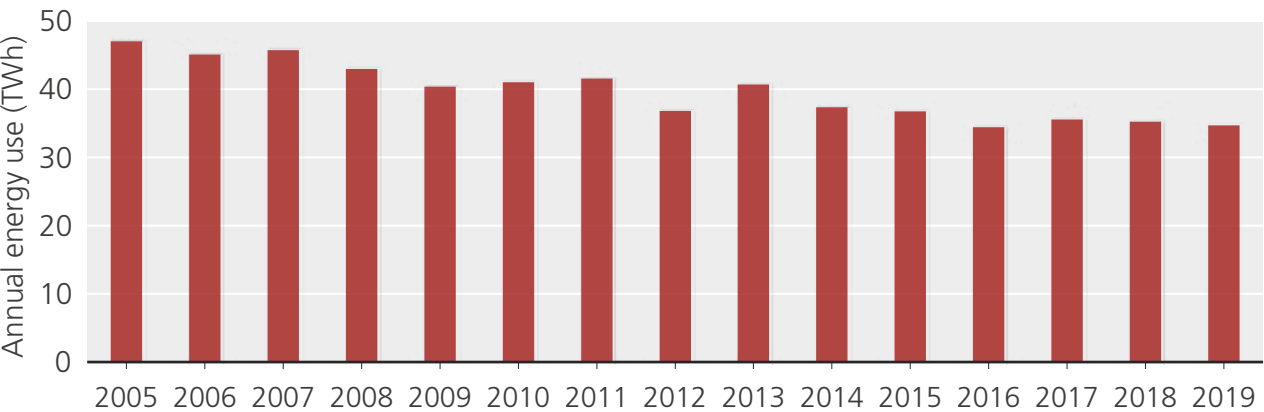


While cumulative employment across all industry sectors has fallen by some 5% in Wales since 2005, this decrease is mostly in manufacturing. A number of other industrial sectors have seen significant workforce increases, such as the energy sector (comprised of electricity generation, gas, steam and air conditioning), and the water supply sector (comprised of sewerage, waste management and remediation activities) – both as defined by BEIS – which have increased by 144% and 60% in Wales, respectively.

Petroleum use for industrial purposes across Wales has reduced by more than 40% since 2005, representing only 29% of the industrial fuel mix in 2019. Gas, having been the second most used fuel in 2005, represented less than a fifth (18%) of industrial energy use in 2019. Meanwhile, the amount of manufactured fuel used has increased, and now represents almost a quarter (23%) of all industrial energy use.

Industrial consumption by year

Data source: 1

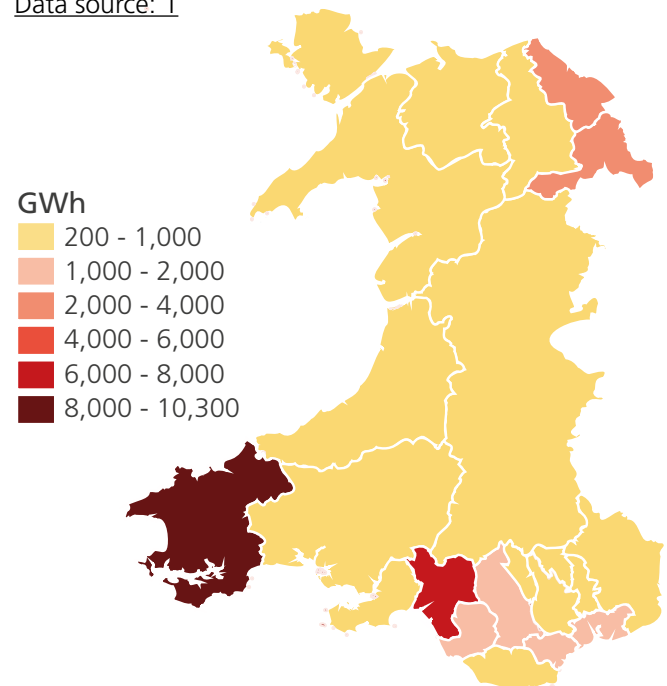


⁸ It must be noted, however, that some of the largest industrial users of gas in Wales are not included in the datasets analysed for this report due to commercial sensitivity. Gas use for power generation is also excluded, in line with most government statistics.

Pembrokeshire dominates industrial energy use, accounting for 29% of total Welsh industrial energy use in 2019. Pembrokeshire was responsible for 70% of all petroleum products used in Wales in 2019, and was second only to Neath Port Talbot for manufactured fuels such as coke.

Annual industrial energy use by local authority area, 2019

Data source: 1



Industry and the South Wales Industrial Cluster

Despite reductions in industrial activity, industry remains an important part of the Welsh economy and identity. Although Wales accounts for just 4.73% of the UK population, companies in Wales produced 18.8% of UK carbon emissions from major industries⁹. While reductions in production and improvements in energy efficiency have led to a decline in overall energy use, industry is widely recognised as a hard-to-decarbonise sector.

In 2021, it was announced that the South Wales Industrial Cluster (SWIC) deployment project had been granted £20 million funding from Innovate UK to continue exploring decarbonisation schemes and the infrastructure required for a hydrogen economy in South Wales. Organisations from the industrial, academic, law, public and private sectors from across the region are involved, working towards the creation of a net zero emissions industrial zone¹⁰.

Image credit: RWE - Pembroke Power Station



⁹ BBC news, 2021; Climate Change www.bbc.co.uk/news/uk-wales-58817328

¹⁰ Tata Steel, 2021; Next phase of project to decarbonise industry in South Wales receives funding www.tatasteeleurope.com/corporate/news/next-phase-of-project-to-decarbonise-industry-in-south-wales-receives-funding

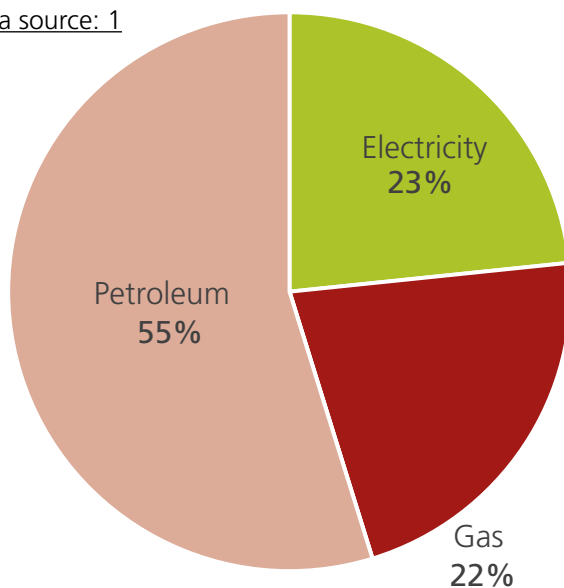
Agriculture

As a sector, agriculture has consistently accounted for around 3-4% of annual energy use in Wales since 2005. However, consumption has been increasing in this sector since 2011, a trend which can be seen throughout the UK.

The agricultural sector is viewed as a challenging sector to decarbonise, with over half of energy consumption represented by petroleum (55%) in 2019, rather than more sustainable fuels. The Climate Change Committee's Sixth Carbon Budget's 'balanced scenario' (December 2020) models agricultural CO₂ emissions in Wales as reducing by only a third by 2050.

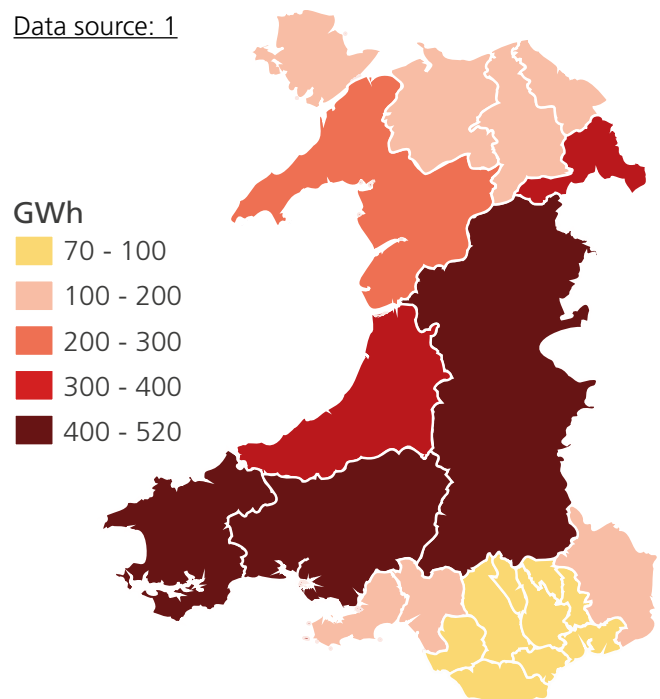
Agricultural consumption by fuel, 2019

Data source: 1



Annual agricultural energy use by local authority area, 2019

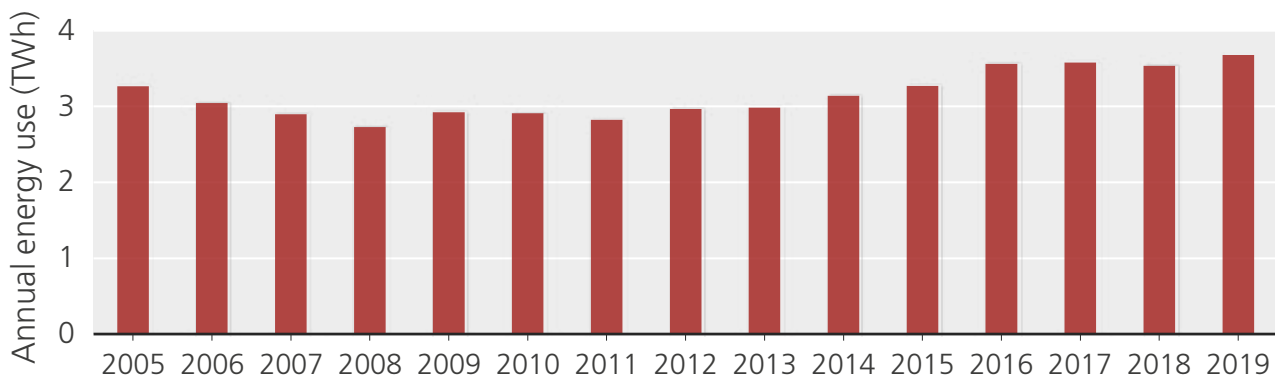
Data source: 1



Agricultural energy use is greatest in the rural local authority areas of Ceredigion, Powys, Carmarthenshire and Pembrokeshire which, due to their livestock farming activity, have relatively high demand for farming fuels.

Agricultural consumption by year

Data source: 1



Case study - North Wales

Coleg Cambria Llysfasi

A £15 million net zero farming centre is being developed near Ruthin in Denbighshire, in partnership with Ambition North Wales – a collaboration of the region's six councils, two universities, two colleges and private sector representatives¹¹. Part-funded by both the Welsh and UK governments, the Llysfasi Net Zero Farm is being developed as part of the Growth Deal, a programme of funding towards several sectors including low carbon energy and agriculture.

Taking place over a period of 15 years, this project aims to offer knowledge and training on how cutting-edge technologies and land management strategies can be used to reduce emissions and increase biodiversity. Within this, it hopes to boost renewable energy generation on farms and explore natural ways to store carbon. Its core objectives are to transfer knowledge to the local community, as well as to develop new opportunities for supply chain integration and sustainable regional business models in the area¹².

In practice, the initiative hopes that its work will create 40 renewable energy projects within five years, along with knowledge transfer to at least 500 businesses and other community members. The business case is now being developed with the hope that the project will be fully functioning from 2025.

This will be a vital step for the National Farmer's Union to achieve their ambition of net zero Welsh agriculture by 2040, and for Wales to meet its wider 2050 target, with agriculture and land management currently representing 14% of greenhouse gas emissions¹³.

Image credit: Coleg Cambria Llysfasi



11 Gov.UK, 2020; UK Government signs North Wales Growth Deal www.gov.uk/government/news/uk-government-signs-north-wales-growth-deal

12 Ambition North Wales; Llysfasi Net Zero Farm www.ambitionnorth.wales/agri-food-and-tourism/llysfasi-net-zero-farm/

13 Business News Wales, 2021; New £15m Net-Zero Centre to Help Farmers Meet Goals www.businessnewswales.com/new-net-zero-farm-approved/

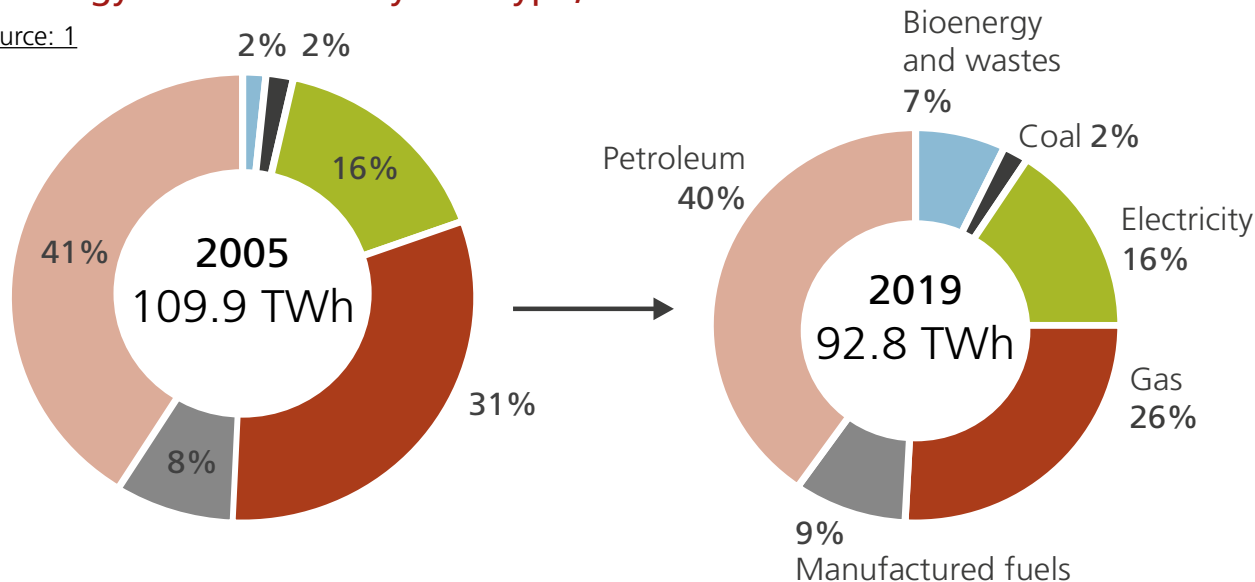
Energy use by fuel

The proportion of each fuel within the fuel mix has remained fairly steady since 2005.

The most notable change in energy use by fuel is the 5% increase in the use of bioenergy and wastes, from 5.6 TWh in 2019 to 1.7 TWh in 2005. Coal has consistently represented a small (2%) proportion of the fuel mix and, while consumption decreased from 2 TWh in 2005 to 1.8 TWh in 2019, its continued presence suggests that it is difficult to remove entirely from Welsh energy consumption. The proportion of gas in the fuel mix decreased by 5% from 2005 to 2019, although it remained the second most consumed fuel type in the fuel mix after petroleum.

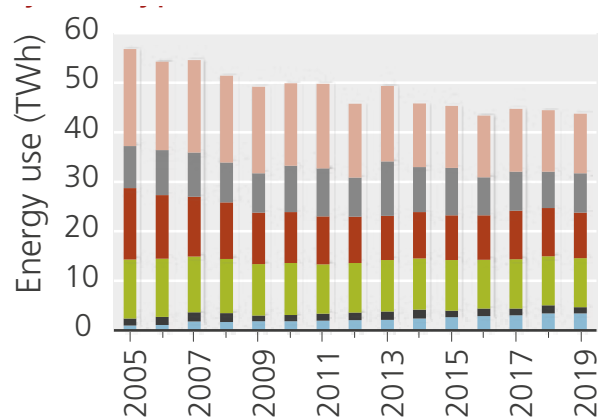
Total energy use in Wales by fuel type, 2005 and 2019

Data source: 1



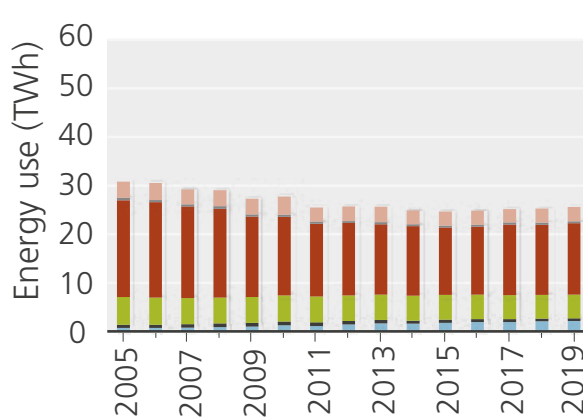
Non-domestic energy use by fuel type in Wales

Data source: 1



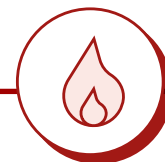
Domestic energy use by fuel type in Wales

Data source: 1



Both domestic and non-domestic energy use has fallen since 2005, with a reduction in domestic gas fuel use and non-domestic petroleum products being the main drivers of change.

Gas



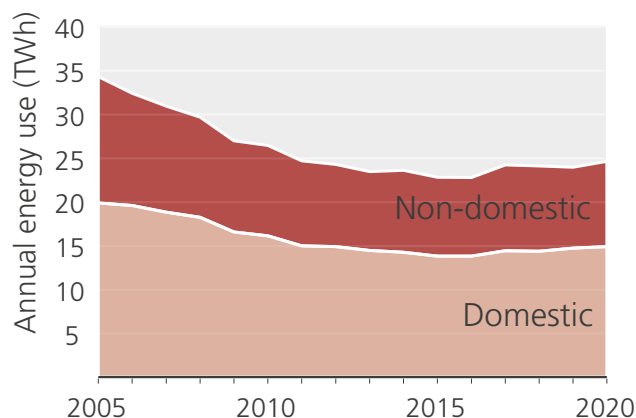
Total gas use in Wales in 2020¹⁴ was 24.6 TWh, with 14.9 TWh being used for domestic purposes, and 9.7 TWh for non-domestic use. Proportionally, the ratio of domestic to non-domestic gas use in Wales has remained consistent, with 60% being used for domestic space heating, cooking and hot water¹⁵.

Gas has seen the single largest absolute reduction in fuel use in Wales since 2005. Between 2005 and 2020, there was a 9.7 TWh drop in demand for gas, from 34.3 TWh in 2005 – a reduction of 28%, which is greater than that achieved in both England (23%) and Scotland (21%) over the same period. As discussed in the sectoral split chapter, this is as a result of changes in domestic energy and heating efficiency, as well as a fall in industrial demand for gas. However, total annual consumption did increase by 0.7 TWh between 2019 and 2020, with increases present in both domestic and non-domestic use, possibly as a result of restrictions brought on by the coronavirus (COVID-19) pandemic.

The gas distribution network has a significant impact on how domestic energy use varies across Wales. There is a strong correlation between areas that have low numbers of homes connected to the gas network and higher than average energy use. Ceredigion has the lowest percentage of homes connected to the gas network (only 26% in 2020), and the highest energy use per capita, primarily due to below average levels of home energy efficiency.

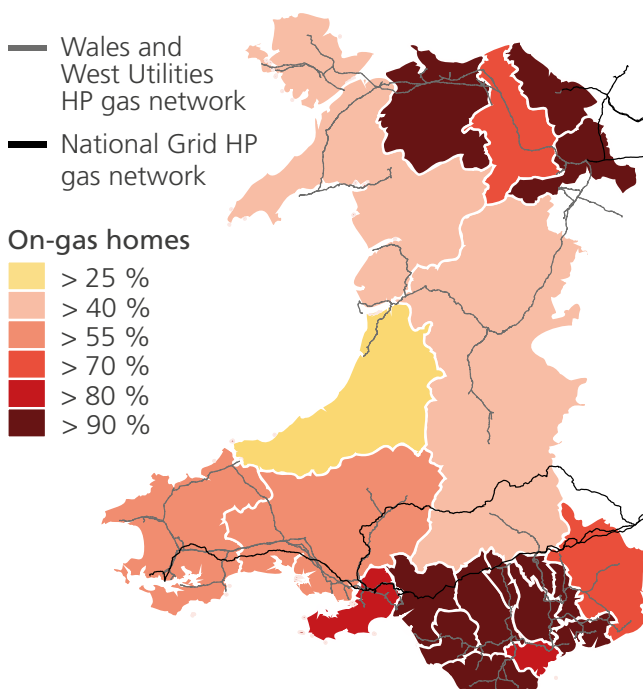
Gas consumption in Wales, 2005-2020

Data source: 3



Percentage of on-gas homes by local authority area in Wales, 2020

Data source: 3



14 Gas used for electricity generation and large industrial users is excluded from this data, in line with how BEIS report their figures. See methodology section for more details.

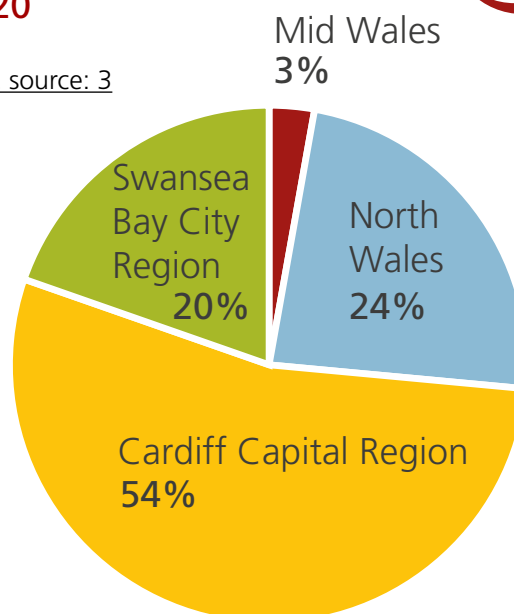
15 Data taken from Energy Consumption in the UK figures, 2020 www.gov.uk/government/statistics/energy-consumption-in-the-uk-2020

In 2020, the majority (54%) of gas consumption was in the Cardiff Capital Region which, considering it represents 49% of the national population, is to be expected. Mid Wales only accounted for 3% of annual gas consumption, as a result of its low connectivity to the gas grid.

More than 60% of total gas consumption is used for space heating and, as a result, there is a strong seasonal variation in annual demand, with weather being the main driver. In 2020, 50% of annual gas consumption occurred within a third of the year, in the months of December (3,321 GWh), January (3,263 GWh), February (3,113 GWh) and March (2,968 GWh)¹⁶.

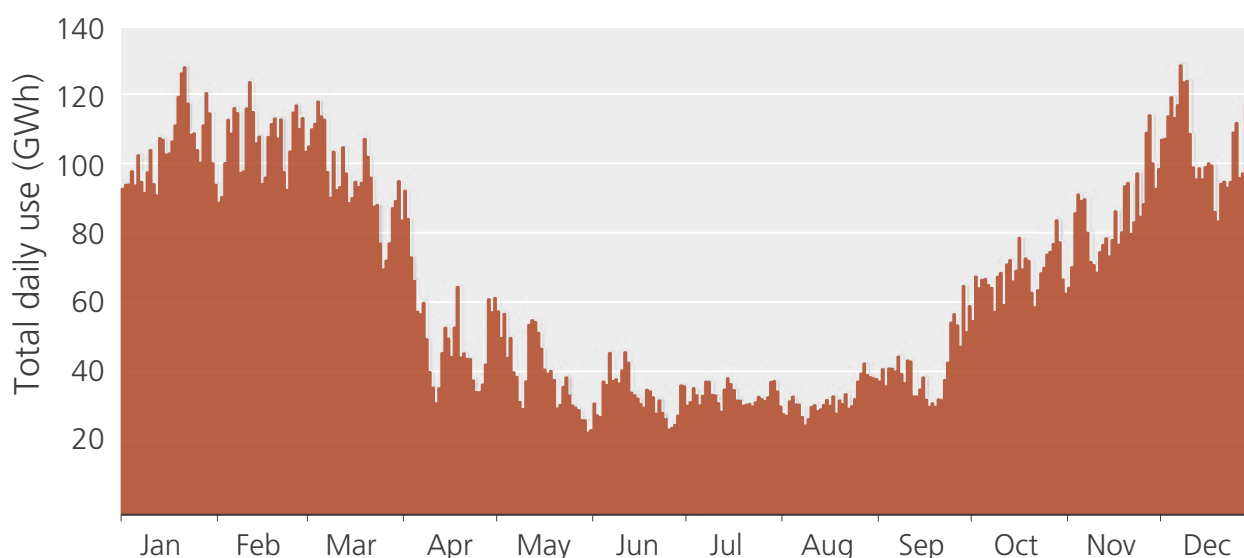
Proportion of annual gas consumption by region, 2020

Data source: 3



Daily gas consumption in Wales, 2020

Data source: 12



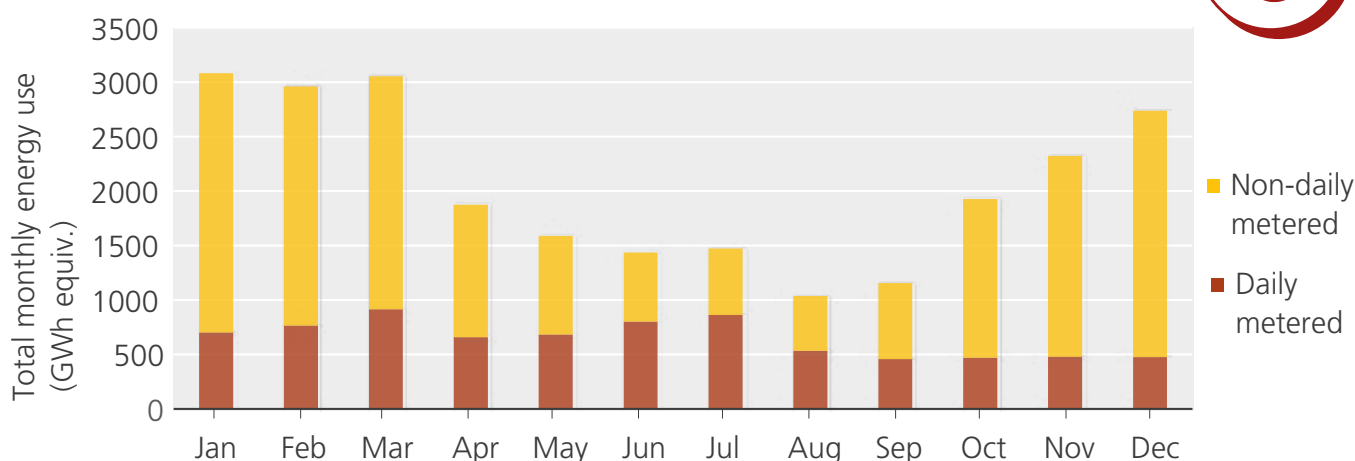
Gas demand forecasting

It is well recognised that weather has the largest influence on domestic gas consumption. Daily temperature, wind speed, effective temperature and the variation from seasonal normal temperatures are all considered when forecasting future demand. The effective temperature is calculated as half of yesterday's temperature added to half of today's temperature; this is included to reflect consumer behaviour and perception of the weather, where a domestic consumer is more likely to turn on their heating if the weather has been cold for a number of days. This combination of temperature and other weather variables is called the Composite Weather Variable (CWV).

¹⁶ This data represents historic demand from both DM (daily metered) consumers and NDM (non-daily metered) consumers, as provided by Wales and West Utilities. A small number of large industrial sites have been removed to protect anonymity.

Monthly gas consumption in Wales, 2020

Data source: 13



When breaking down total demand by daily and non-daily metered supply¹⁷, there is a contrast in seasonal gas use between the two. Daily-metered consumption of gas, which represents larger industrial premises, is more consistent month to month, with around 7% of annual consumption represented in each month. However, it is interesting to note a sustained reduction in daily-metered consumption towards the end of 2020. While it is difficult to extrapolate from the data the cause of this change, it might have been a result of business closures caused by COVID-19.

In contrast to this, non-daily metered demand, which largely represents domestic and commercial premises, sees much greater variation month-to-month. In January 2020, for example, consumption represented almost a fifth (17%) of annual non-daily metered consumption in that year. This is greater than the combined consumption across the three summer months of June (4%), July (4%) and August (3%).

Gas meter classes

Gas meter classes are defined by the annual gas consumption of a supply point.

Daily Metered (DM) sites are generally sites with a very large annual consumption, such as heavy industry, which are fitted with meters that can provide daily readings. It is mandatory for sites with an annual consumption greater than 58.6 GWh to be daily metered.

Non-Daily Metered (NDM) sites are those with smaller annual demand, such as domestic properties, commercial premises or blocks of flats, which are not required to provide meter readings on a daily basis. NDM demand can be further split into classes, again defined by annual consumption: domestic dwelling (0-73 MWh), a large block of flats or commercial premises (73-732 MWh), a large commercial or small industrial site (greater than 732 MWh).

¹⁷ Data taken from the National Grid's Data Item Explorer of historic demand by Local Distribution Zone (LDZ)

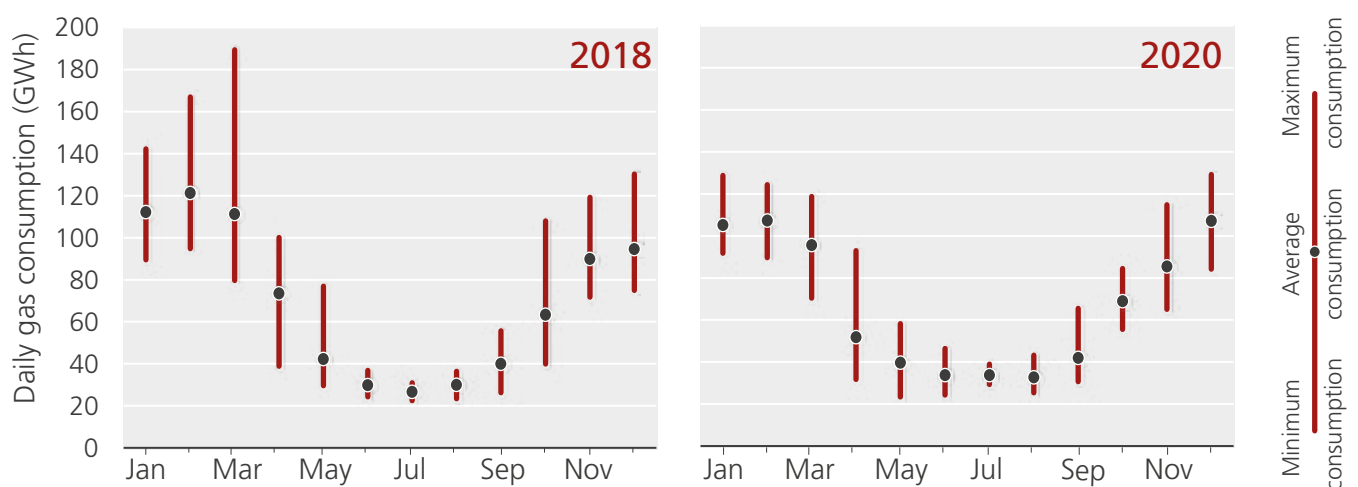
The main driver of seasonal variation in gas consumption is temperature. When comparing monthly variation in daily gas use, the range during March 2018 was almost 2.5 times greater than in 2020 for the same month: a difference of 110 GWh between the maximum and minimum daily values in 2018 versus 48 GWh in 2020.



This can be attributed to the extreme cold weather experienced in the UK as a result of 'the Beast from the East', which caused daily gas consumption to spike, reaching a maximum of almost 190 GWh. However, variation in gas demand is much smaller during the summer months of June, July and August. This is because heating tends to be switched off, meaning any variation in temperature will not impact gas demand for heating.

Variation in daily gas consumption by month in Wales

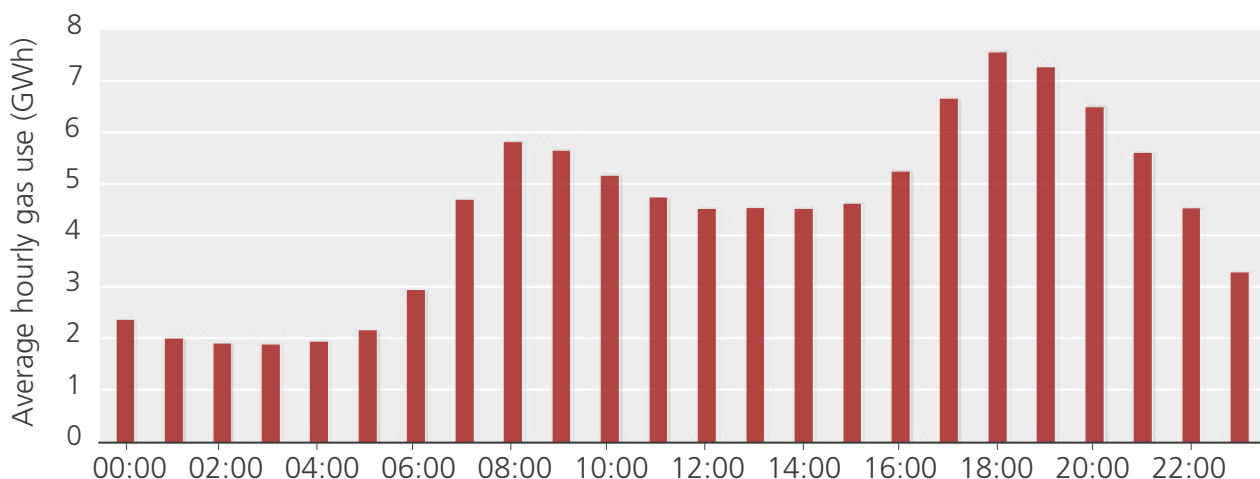
Data source: 12



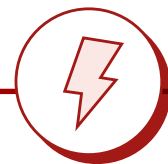
Within-day variations in gas use can also be seen. While consumption is lower during the early hours of the morning (midnight to 7 am), two distinct peaks can be seen throughout the day. These broadly correlate to a morning peak at 8 am to 9 am, when people are starting their day, and an evening peak at 5 pm to 9 pm, when people are returning home. This variation can be seen at all times of year, even during July when the absolute consumption is far lower.

Within-day gas consumption in Wales, January 2020

Data source: 12



Electricity



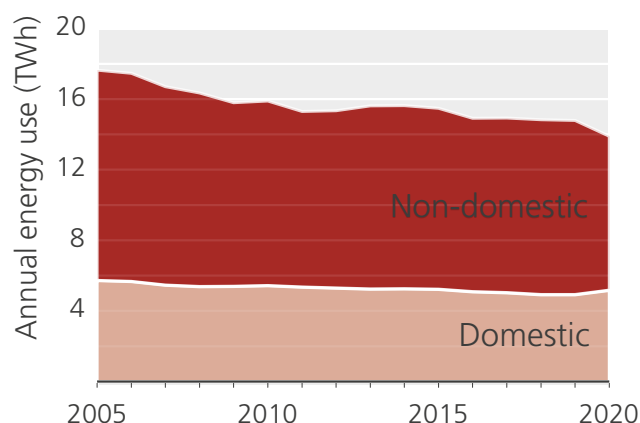
Until 2015, total electricity use in Wales had been steadily decreasing year on year, falling by 12% from 17.6 TWh in 2005 to 15.4 TWh in 2015, in line with similar reductions in both England (10%) and Scotland (16%) across the same time frame. This had been driven mainly by reductions in non-domestic use in the late 2000s, which fell by 14% between 2005 (11.9 TWh) and 2015 (10.2 TWh) in Wales. While this plateaued between 2016 and 2019 at around 14.8 TWh, with non-domestic consumption remaining at around 9.9 TWh each year, 2020 saw another sharp reduction in non-domestic consumption of more than 1 TWh, possibly due to restrictions brought on as a result of COVID-19.

Domestic electricity use, in contrast, had been slowly but steadily falling until 2020. Total domestic electricity use in 2019 was 4.9 TWh, a 14% reduction in annual consumption since 2005 (5.6 TWh). However, with COVID-19 restrictions requiring people to spend more time at home, domestic consumption increased by 5% in 2020, an uptick which also occurred in both Scotland (4%) and England (6%). Despite this, with domestic consumption only representing a third of electricity consumption, such changes have only a small impact on total consumption of electricity in Wales.

In 2020, the majority (42%) of electricity consumption was in the Cardiff Capital Region, while electricity use in Mid Wales represented only 6% of total annual consumption. These proportions have remained consistent since 2005, with only a 1% change across both the Cardiff Capital Region (from 43% in 2005 to 42% in 2020) and the Swansea Bay City Region (from 27% in 2005 to 28% in 2020).

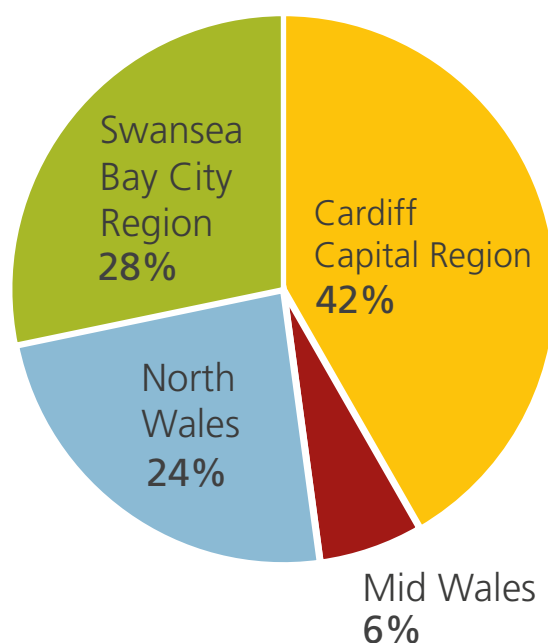
Electricity consumption in Wales, 2005-2020

Data source: 2



Proportion of annual electricity consumption by region, 2020

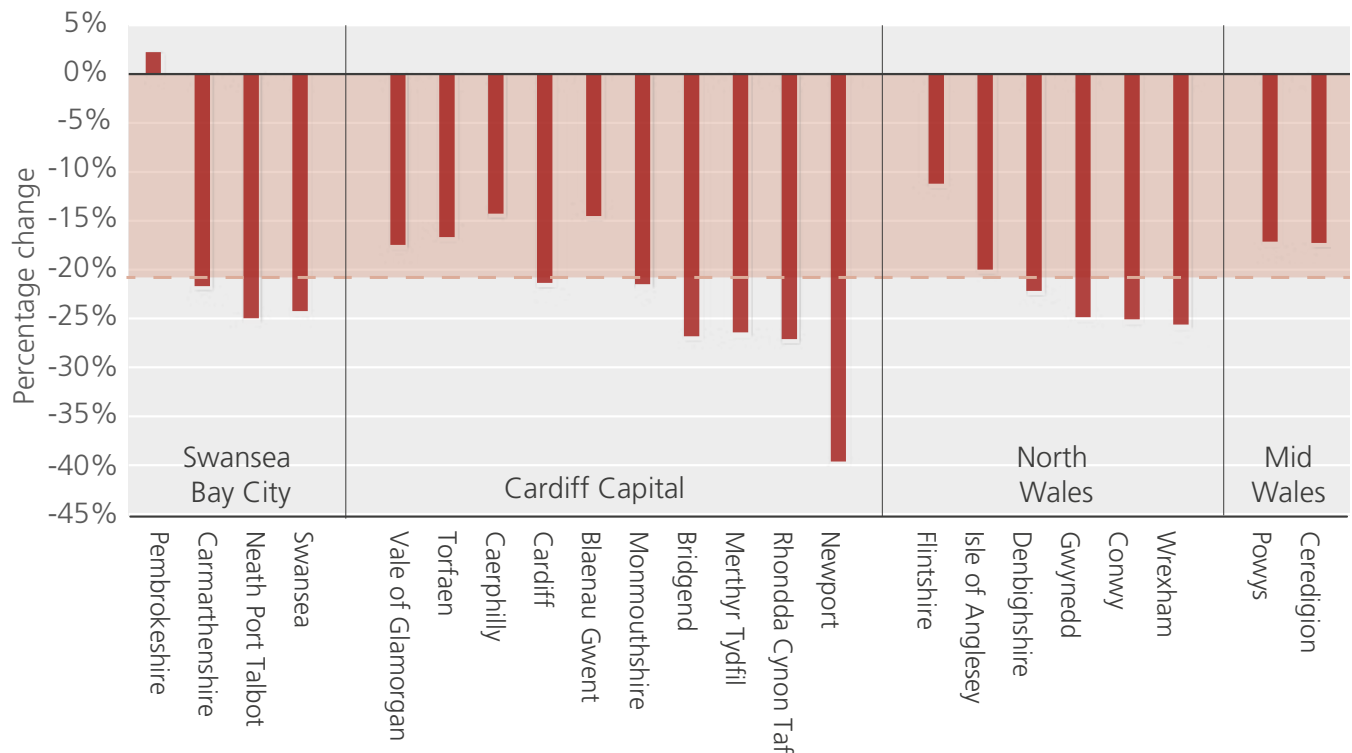
Data source: 2



Percentage change in electricity use per local authority area in Wales between 2005 and 2020

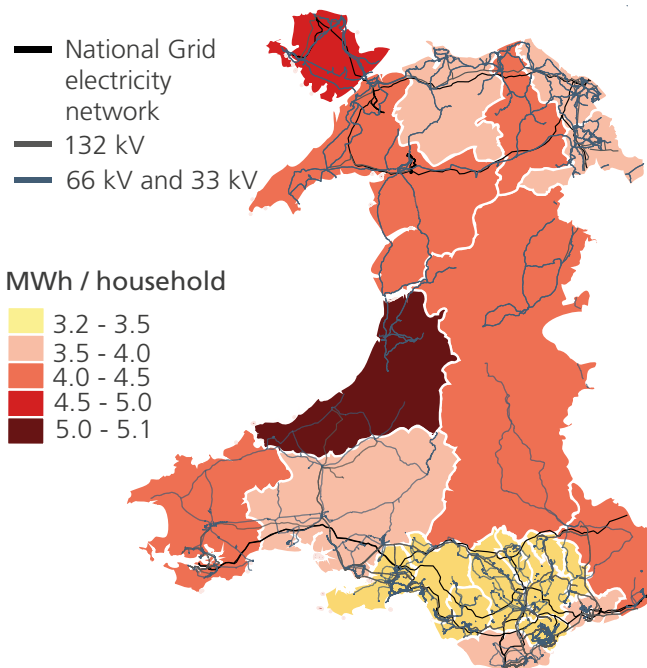


Data source: 2



Mean domestic electricity consumption per household (MWh), 2020

Data source: 2



All local authority areas but one have seen a reduction in total electricity consumption since 2005, by an average of 21%. Between 2005 and 2019, the average reduction was 16% – the marked reduction for 2020 may be as a result of restrictions brought on by COVID-19, causing changes in electricity use across almost all local authorities. Pembrokeshire is the only local authority area to have seen an increase in electricity usage, as the industry-heavy local authority shifts away from more traditionally polluting fuels such as petroleum.

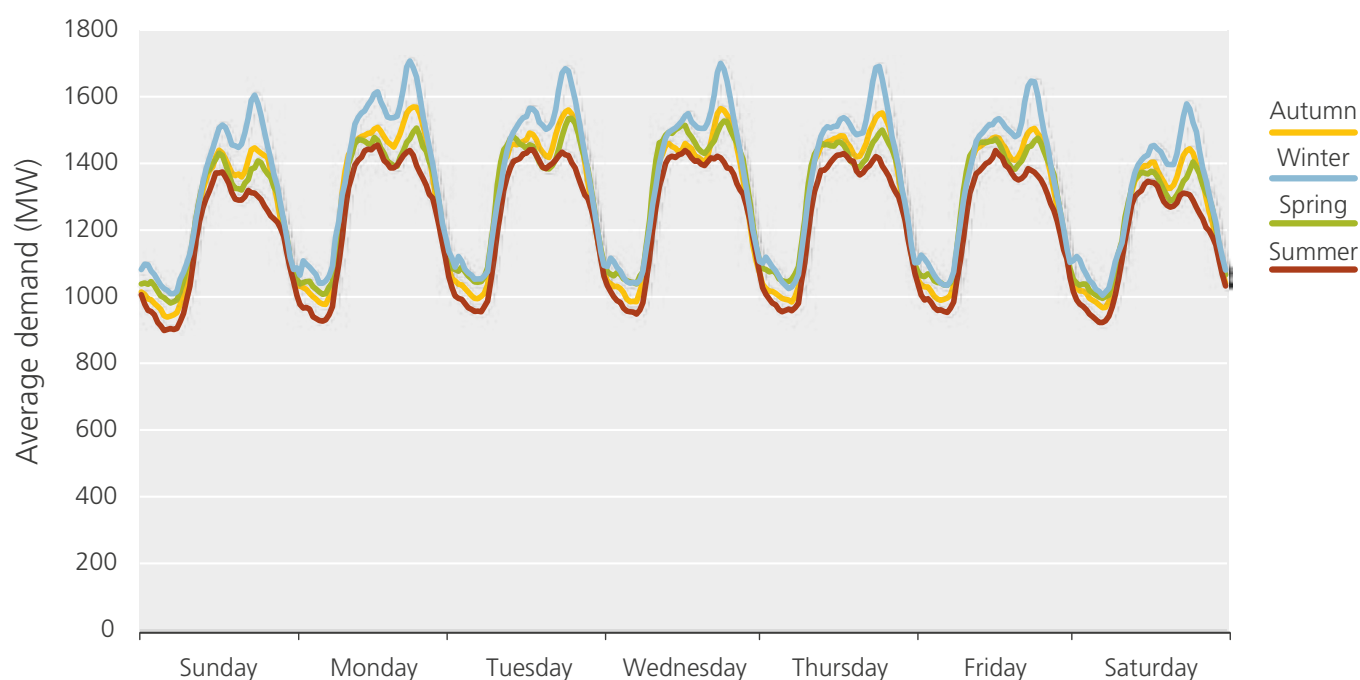
The local authority with the greatest mean domestic consumption is Ceredigion. Ceredigion is the local authority area with the fewest gas connections, meaning it is more reliant upon electricity to support heating demand.

When focusing on data for the Western Power Distribution electricity network, covering the South Wales licence area, variation in the daily profiles of average electricity consumption can be seen across the seasons¹⁸. Two peaks are present throughout the day in autumn (September to November), winter (December to February) and spring (March to May) which, much like gas consumption, broadly correlate to a morning peak at 8 am to 9 am and an evening peak at 5 pm to 9 pm. During the summer months (June to August), this evening peak is less pronounced, particularly during the weekend days of Saturday and Sunday.



Average half-hourly electricity demand by day and season within the South Wales licence area, 2021

Data source: 14



This suggests that electricity use is subject to a degree of seasonal variation. For example, peak half-hourly consumption during the winter season is almost 300 MW higher than that seen during the summer season (1,657 MW versus 1,384 MW), which may be attributable to increased lighting and appliance demand in winter, with people spending more time indoors.

However, a much smaller proportion of electricity demand is used for space heating, meaning that annually, there is less seasonal variation present than seen in gas consumption. On average across Great Britain, 9% of households rely on electricity for heating; in the South Wales licence area that figure is even smaller, at 5%¹⁹.

¹⁸ This data represents historic demand as taken from Western Power Distribution's Live Data Feed Application

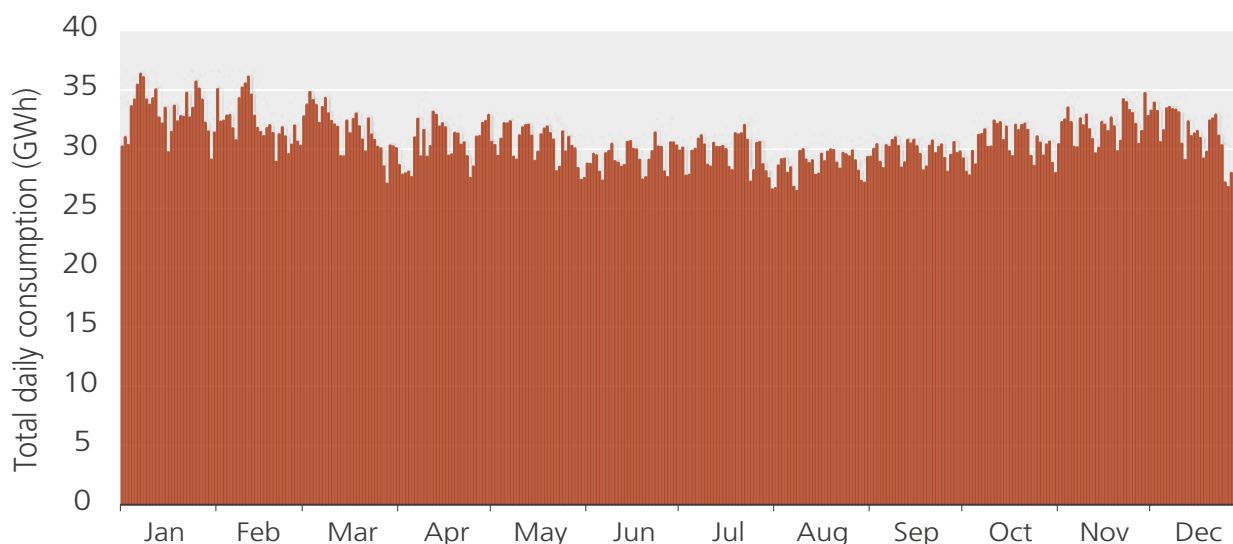
¹⁹ Based on regional strategy analysis undertaken by Regen

When comparing monthly variation in electricity demand at five-minute intervals, some limited seasonal variation can be seen. The average range in maximum and minimum demand for the months of November, December, January and February was 965 MW. For the summer months of May to August, this variation is 235 MW less, with an average range of 730 MW.



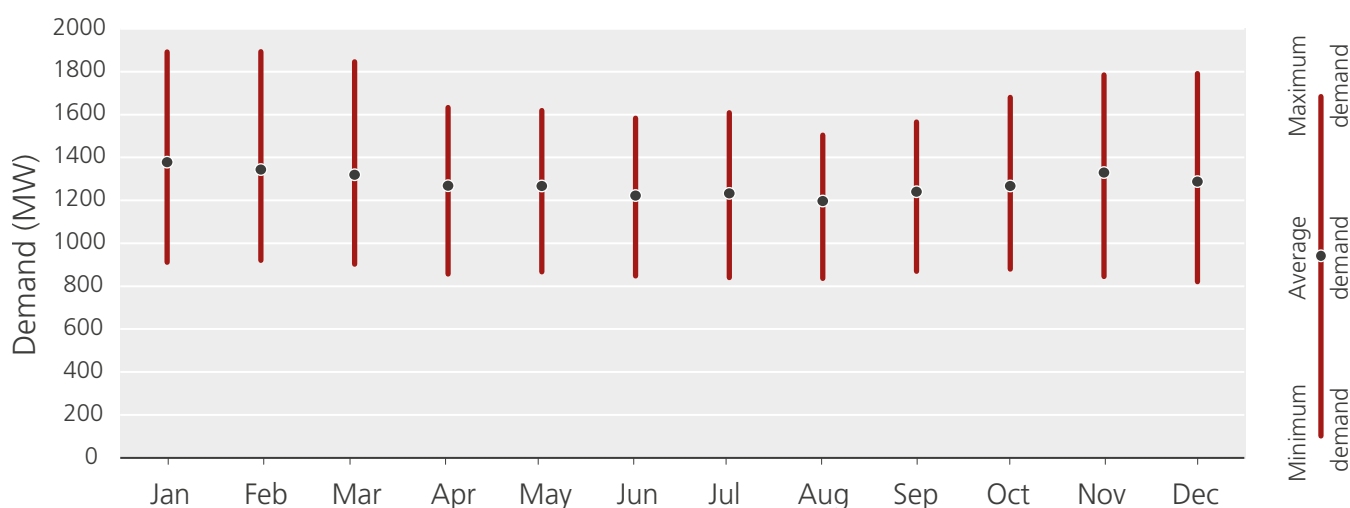
Total daily electricity consumption in the South Wales license area, 2021

Data source: 14



Variation in five-minutely electricity demand by month in the South Wales license area, 2021

Data source: 14



Case study - Cardiff Capital Region

Cardiff district heat network

In August 2020, funding was confirmed for a district heat network in Cardiff²⁰. This will improve the carbon efficiency of heating for several major buildings and new developments in the city by connecting them to a central source of heat via insulated underground pipes. The heat will be sourced from the Trident Park energy recovery facility in Cardiff Bay, an existing facility which currently diverts approximately 350,000 tonnes of non-recyclable waste from landfill.



Image credit:
Sustainable
Energy

The Cardiff heat network has so far received £8.6 million from the Welsh Government, as well as £6 million from the UK government. This has enabled phase one of the project to begin construction, with the first buildings expected to connect in 2023. These include the Senedd building, Wales Millennium Centre, and County Hall²¹.

Discussions are already underway with potential new customers along the phase one route, with ambitions for a second phase of the heat network currently being set out. The total investment of the project is expected to be £26.5 million. One of the key benefits of the heat network is that steam from Trident Park used to transfer heat to the heat network has an extremely low carbon content, being sourced after its energy has already been used to generate electricity elsewhere in the plant. It is estimated that those connected will save 5% on their annual energy bill and will reduce their heating emissions by up to 80% compared to conventional gas heating, and as much as 60% compared with other low carbon heating sources such as air source heat pumps.

The heat network is owned and managed by Cardiff Heat Network Ltd which is owned by Cardiff Council. This project will help Cardiff to reach its 2030 net zero target with a potential annual carbon saving of 5,600 tonnes.

20 Viridor, 2020; Funding approved for first phase of Cardiff's District-Heating Network www.viridor.co.uk/who-we-are/latest-news/2020-news/funding-cardiffs-district-heating-network/

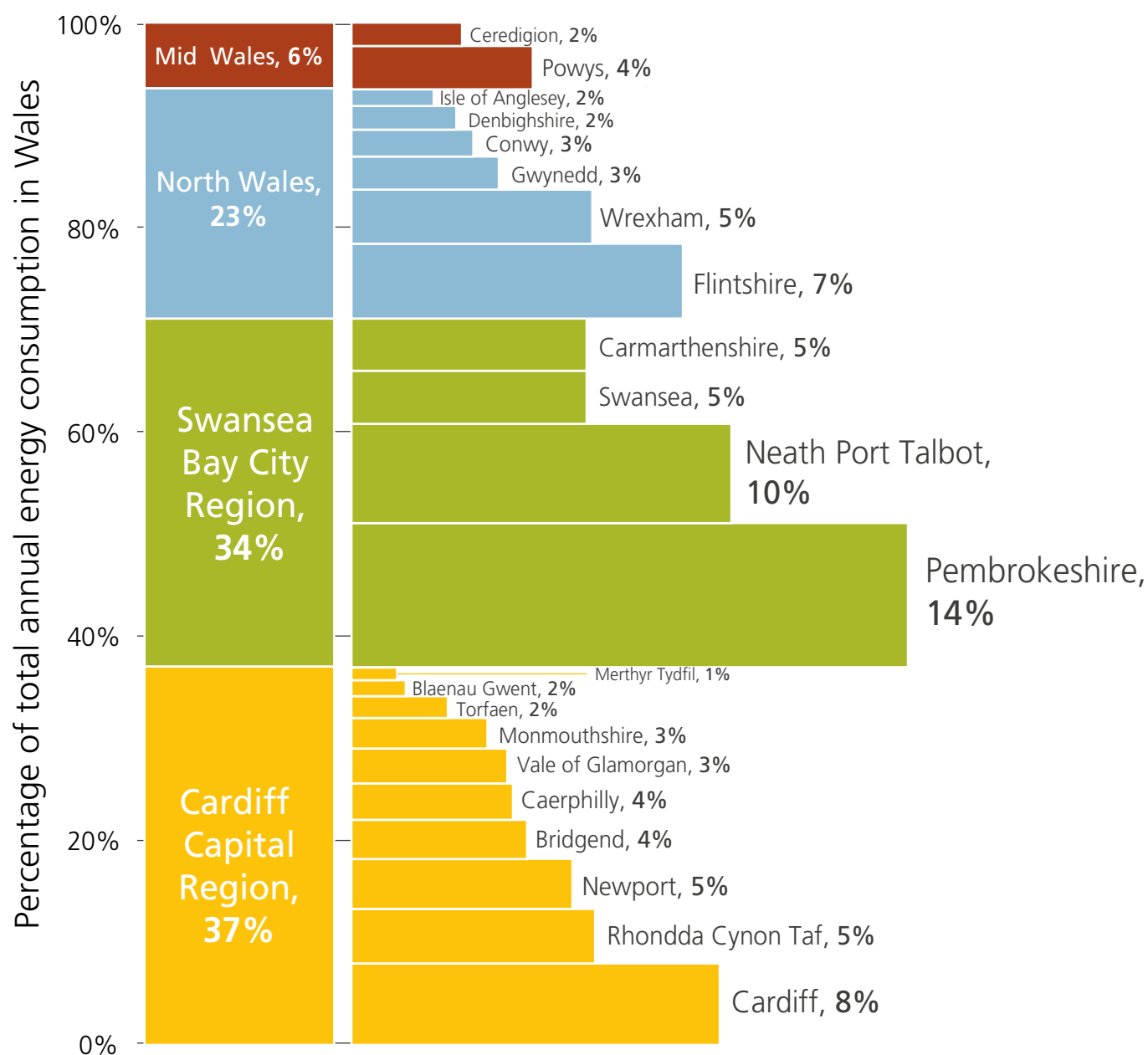
21 Wales Online, 2021; Why huge gas boilers are set to be built underneath a major Cardiff road www.walesonline.co.uk/news/wales-news/huge-gas-boilers-set-built-20342610

Energy use by region and local authority area

The Swansea Bay City Region represented almost a third of energy use in Wales in 2019, due to the large industrial areas of Neath Port Talbot and Pembrokeshire. In contrast, Mid Wales accounted for only 6% of total energy use in 2019, representing the more rural local authority areas of Powys and Ceredigion.

Annual energy use in Wales by region and local authority area, 2019

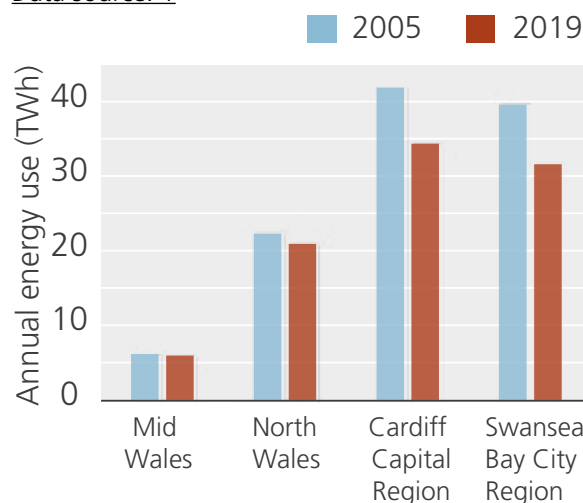
Data source: 1



Since 2005, total energy consumption has reduced in all regions. However, the greatest reductions can be seen in the Swansea Bay City Region and Cardiff Capital Region, both of which have seen an annual absolute reduction of more than 7 TWh. This represents a 20% reduction in energy use in the Swansea Bay City Region, and 18% in the Cardiff Capital Region.

Total annual energy consumption by region, 2005 to 2019

Data source: 1



Fuel poverty in Wales

The Welsh Government defines a household to be in fuel poverty if more than 10% of their full household income is paid towards maintaining a satisfactory heating regime²². Under this definition, and according to the Welsh Government's research series exploring fuel poverty in Wales, 155,000 Welsh households were living in fuel poverty as of 2018. The latest reports in this series can be found here:

- [Fuel poverty estimates for Wales 2018](#)
- [Local area fuel poverty estimates: April 2017 to March 2018](#)

A 2022 housing study by the Office for National Statistics²³ found that 25% of Welsh housing stock pre-dates 1900 – the largest proportion in the UK – and 63% was graded EPC Band 'D' or below. In addition to this, Citizens Advice²⁴ states that the COVID-19 lockdowns of 2020 pushed 66,000 Welsh households behind on paying their energy bills, as incomes shrunk and households increased their energy use, as a result of spending more time indoors. 2021 also saw a rise in wholesale electricity prices in the UK, due to a 500% increase in the cost of gas in Europe, further compounding the increase in costs. In response to these high wholesale prices, Ofgem announced that the price cap will increase by 54% on the 1st of April 2022. This is expected to have an extreme impact on all households, but particularly those already in fuel poverty.

22 House of commons library, 2022; Fuel Poverty www.researchbriefings.files.parliament.uk/documents/CBP-8730/CBP-8730.pdf

23 Office for National Statistics; Age of the property is the biggest single factor in energy efficiency of homes www.ons.gov.uk/peoplepopulationandcommunity/housing/articles/ageofthepropertyisthebiggestsinglefactorinenergyefficiencyofhomes/2021-11-01

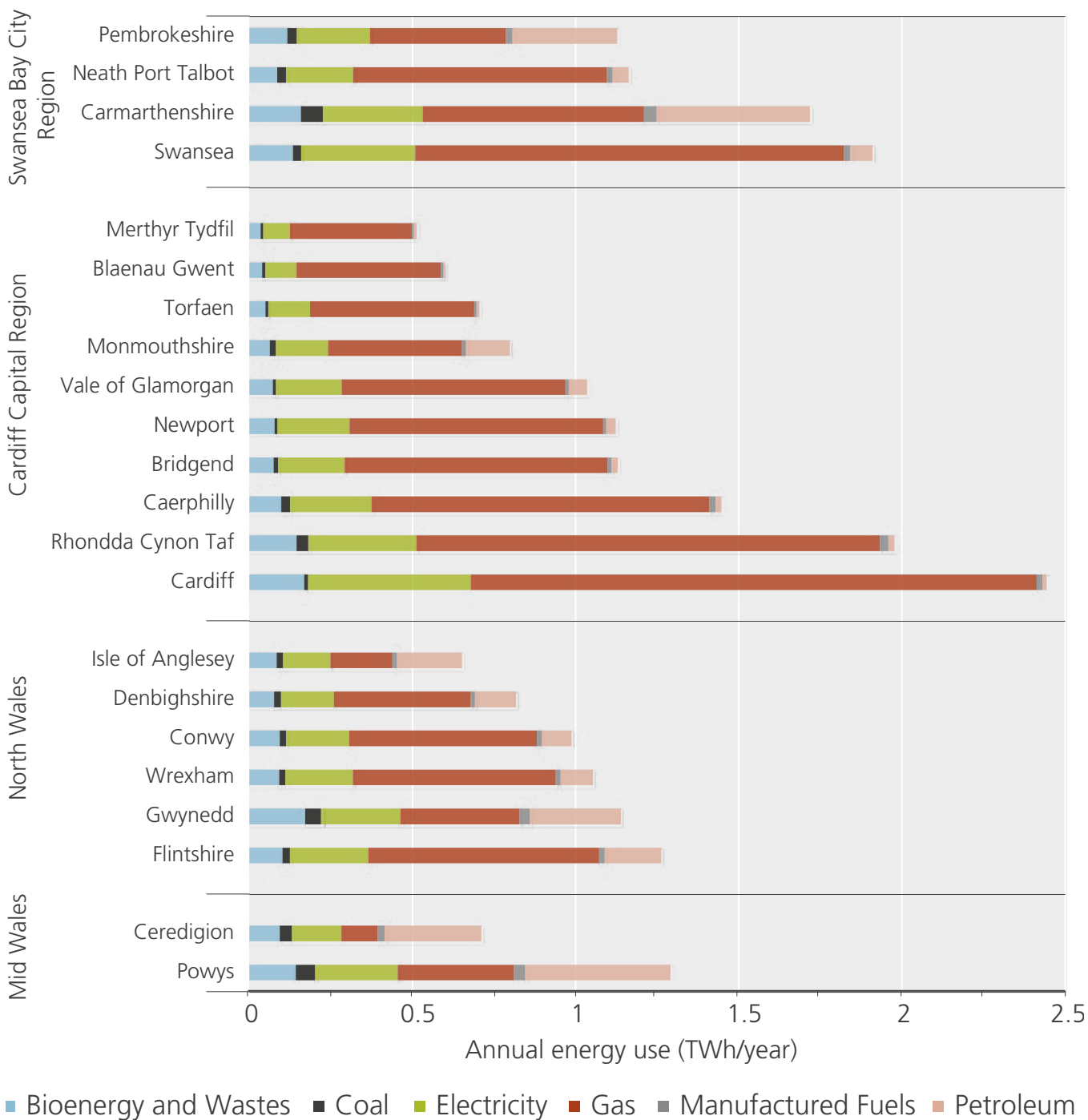
24 Citizens Advice, 2020; Crisis in the cold [www.citizensadvice.org.uk/Global/CitizensAdvice/Wales/Energy%20briefing%20v1%20\(1\).pdf](http://www.citizensadvice.org.uk/Global/CitizensAdvice/Wales/Energy%20briefing%20v1%20(1).pdf)

Energy use by local authority area

Domestic fuel use in Wales (excluding transport) is dominated by gas for almost all the local authority areas, with Isle of Anglesey and Ceredigion as the most notable exceptions.

Domestic energy use by region and local authority area in Wales, 2019

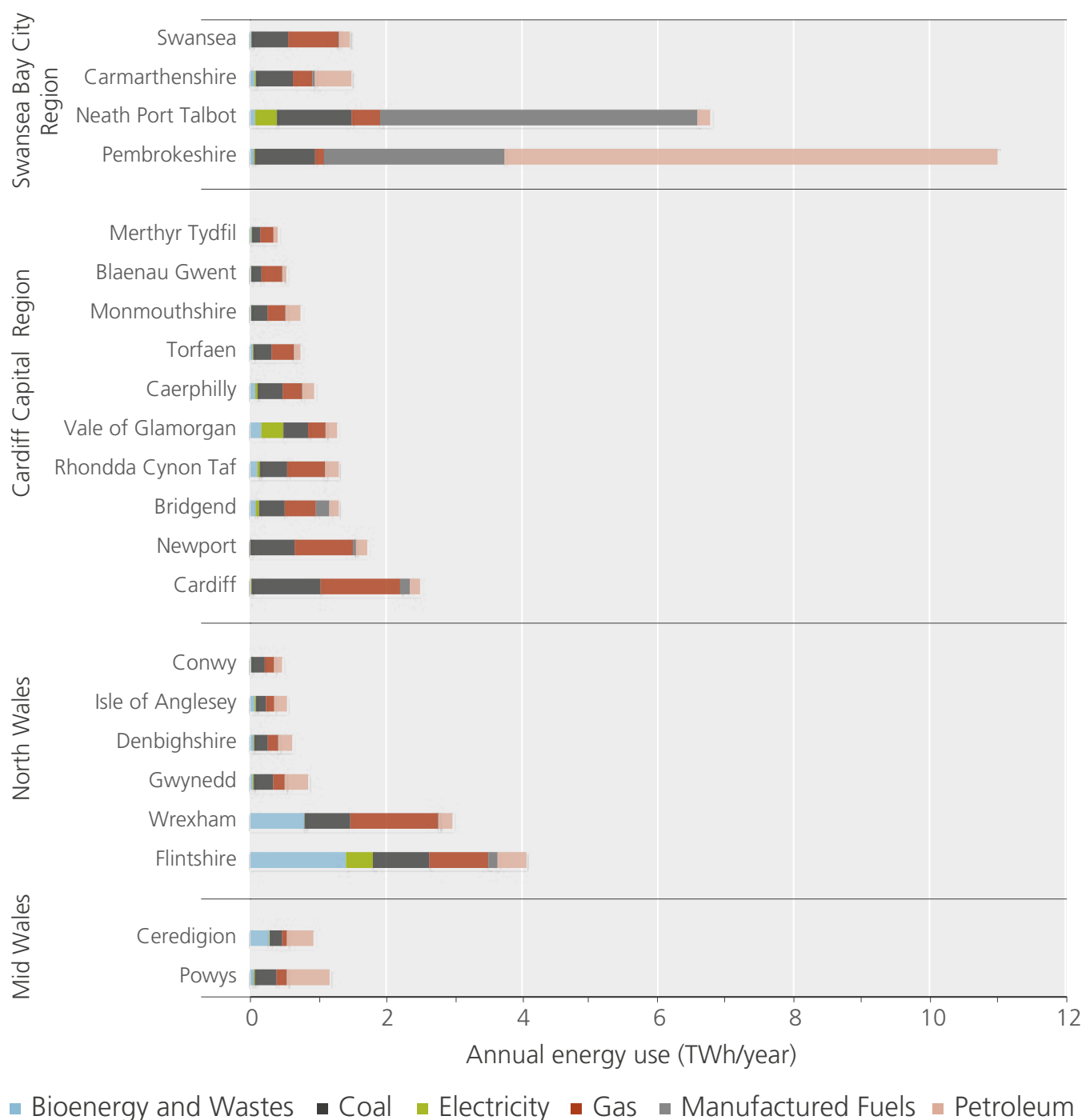
Data source: 1



Non-domestic fuel use in Wales ranges from 0.4 TWh in Merthyr Tydfil to just under 11 TWh in Pembrokeshire in 2019, with the latter being 66% petroleum products. Pembrokeshire's substantial use of petroleum products is likely due to the industrial activity of the oil and liquified natural gas terminals, port and refinery. However, Pembrokeshire has seen a 30% reduction in its total energy use since 2005, with 91% of that (5 TWh) coming from reductions in petroleum usage.

Non-domestic energy use by region and local authority area in Wales, 2019

Data source: 1



Hydrogen in Wales

The production and wider use of low carbon hydrogen is a developing technology sector which has gained momentum in recent years. This is due to its capacity for driving the decarbonisation of traditionally 'difficult to decarbonise' sectors, such as heavy industry and heavy transportation. Hydrogen also has the potential to displace natural gas in heating systems or be used as a storage medium for renewable electricity.

Hydrogen is an energy carrier that can be used to store, move, and provide energy for consumption in a number of sectors, but as it requires energy to produce it, the hydrogen process can be viewed under both supply and demand of energy. It can be produced in several ways, including:

- 'Grey' hydrogen – produced via steam reformation of natural gas
- 'Blue' hydrogen – produced in the same way as 'grey' hydrogen, but the carbon dioxide emitted from the process is captured rather than released
- 'Green' hydrogen – produced via the electrolysis of water, which produces no direct CO₂, but may not be fully zero carbon depending on the source of electricity

There is uncertainty as to where in the economy and to what extent hydrogen will contribute to the development of a net zero society, due to it being a developing technology. Regen's analysis of the hydrogen value chain²⁵ shows that markets such as transport and industry represent higher value uses of hydrogen than as a fuel for heating or to generate electricity.

The Welsh Government is committed to wholly exploring the role hydrogen should play in Wales in the longer term, across the transport, industry, and heating sectors and more widely in energy production and consumption sectors. In the 2021 publication Net Zero Wales Carbon Budget 2, the Welsh Government stated intentions to develop at least one renewable hydrogen production site greater than 10 MW in size by 2023-24, as well as supporting local projects and place-based approaches, and engaging with other hydrogen initiatives such as opportunities for hydrogen boilers and hybrid heat pumps. Furthermore, in 2020 the Welsh Government consultation 'Developing the hydrogen energy sector in Wales' sought responses to a proposed Wales Hydrogen Pathway, building on the baselining report Hydrogen development in Wales²⁶. The Hydrogen Pathway contains ten key objectives which aim to add momentum to the Welsh hydrogen sector and lay the foundations for scaling-up and commercial deployment from the end of the 2020s.

The results of this consultation are due in Spring 2022.

25 Regen, 2021; Building the hydrogen value chain www.regen.co.uk/building-the-hydrogen-value-chain/

26 Welsh Government, 2020; Hydrogen development in Wales www.gov.wales/sites/default/files/consultations/2021-01/baselining-report-hydrogen-development-in-wales.pdf

Case study - Mid Wales

Riversimple

Riversimple is a manufacturer of hydrogen-powered fuel cell electric vehicles, based in Llandrindod Wells, in Mid Wales²⁷. Founded in 2001, the company has developed a two-seater hydrogen fuel cell car – the Rasa – and is currently producing prototype vehicles for customer trials, with support from the Office for Zero Emission Vehicles as part of the HTP (Hydrogen for Transport) programme.

The Rasa has the potential to reduce greenhouse gas emissions and improve air quality across towns and cities in Wales, depending upon the method of hydrogen production. Riversimple's business plan is based on offering cars on an all-inclusive service basis, where customers pay a monthly fee and a low cost per mile charge²⁸. Riversimple aims to start commercial production of Rasa in 2025, and a light goods vehicle in 2026. Each plant would create around 220 jobs, making 5,000 vehicles per year, as well as indirect supply chain jobs.

In addition to its hydrogen car production, in 2021 Riversimple announced the launch of Circular Revolution – a Circular Economy Innovation Centre for Wales²⁹. Designed and delivered in partnership with Swansea University and the University of Exeter, the Circular Revolution will be the first business-led hub in the UK focussed on circular thinking. The Circular Revolution will be run from a dedicated centre in Riversimple's HQ in Llandrindod Wells and will deliver an outreach programme for business in West Wales and the Valleys who are keen to engage with more sustainable products, services and business models.



Image credit: Riversimple

27 The Engineer, 2021; Siemens to help Riversimple toward volume production www.theengineer.co.uk/content/news/siemens-to-help-riversimple-toward-volume-production

28 Welsh Government, 2020; Hydrogen development in Wales www.gov.wales/sites/default/files/consultations/2021-01/baselining-report-hydrogen-development-in-wales.pdf

29 Riversimple, 2021; Riversimple presents the Circular Revolution www.riversimple.com/wp-content/uploads/2021/02/Circular-Revolution-Press-Release-Final.English.pdf

Methodology

Regen was commissioned by the Welsh Government to collect and analyse data regarding energy use in Wales, aligned to the sectors as defined in the Net Zero Wales Carbon Budget 2 (2021 to 2025).

The Net Zero Wales Carbon Budget 2 (2021 to 2025) report split greenhouse gas emissions arising in Wales into eight sectors:

- Land use, land use change and forestry (LULUCF)
- Electricity and heat generation
- Industry and business
- Residential buildings
- Agriculture
- Waste management
- Transport

This broadly correlates with the sector definitions used in the data analysed (BEIS).

In line with the methodologies adopted by many government institutions, there are some sources of energy use that are not included in the analysis underpinning this report. The effect of these exclusions is to under-report actual energy use in Wales, which is difficult to quantify:

- 1. Gas used for power generation:** UK government datasets on fuel consumption do not include the gas consumed by power stations to produce electricity, as the electricity itself is treated as a fuel.
- 2. Gas used by very large industrial plant:** Some of the largest energy users in Wales have their gas demand excluded from the data in this report as this would be disclosive, but the emissions from these sites are likely to be accounted for via the UK Emissions Trading Scheme (UK ETS).
- 3. Transport and Aviation:** In line with BEIS methodology, aviation, shipping and electricity for trains and cars are not included in these datasets, as such energy consumption cannot be allocated at a local or regional level.

Assumptions

Assumption	Source
Land use, land use change and forestry sector	As the LULUCF sector of the Net Zero Wales Carbon Budget 2 covers carbon emissions and sinks associated with land use, there is negligible energy consumption associated with this sector. It was therefore excluded from this study.
Power (generation) sector	BEIS data on gas use excludes gas used in the production of power, as those power stations are producing electricity as another 'primary' fuel. All power generation as a sector has also been excluded for this reason.
Estimated energy in each Net Zero Wales Carbon Budget 2 sector	Energy intensity of UK job categories were evaluated and applied to Welsh jobs at a Local Authority level, to estimate the proportional split of energy across the BEIS 'Industry and Commercial' sector. The proportional split of energy by sector was then applied to BEIS Local Authority energy use data, to get total energy demand in Domestic, Commercial, Industry, Agriculture and Transport.
UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2019	The Department for Business, Energy and Industrial Strategy (BEIS)'s UK local authority and regional carbon dioxide emissions national statistics publication combines data from the UK's Greenhouse Gas Inventory with data from a number of other sources, including local energy consumption statistics, to produce a nationally consistent set of carbon dioxide emissions estimates from energy use by sector. Notably, this excludes other sources of emissions such as methane emissions and F-gases. This dataset includes emissions estimates from large industrial installations that, for purposes of confidentiality, have been excluded from other datasets analysed in this report.
Estimated Welsh domestic energy end uses (heat and non-heat electricity)	Heating fuel use splits have been scaled using BEIS data and are based on the assumption that all of domestic gas use is for space heating, hot water or cooking. The proportions of domestic electric heating have been estimated from previous Regen analysis.

Assumption	Source
Estimated Welsh non-domestic energy end uses	Figures from the ECUK end use tables were used, alongside the proportion of commercial and industrial energy demand in Wales, to estimate the proportional split of non-domestic gas and electricity fuel use between heat and power. The heat provided by other remaining fuels was assumed to be based on fuel type.
Estimated Welsh transport energy use	BEIS transport energy use was distributed between domestic and non-domestic by applying the proportion of 'Personal' and 'Freight' use in Wales.
Transport	Road transport data does not include electricity or LPG.
Final energy use	Final use energy consumption and energy consumption sector splits have been generated using overall UK energy consumption data as a proxy for both the energy intensity of jobs and final energy uses within domestic and non-domestic heat. BEIS energy consumption has been totalled by local authority, and so does not include unallocated volumes for consistency (unallocated volumes are estimated to represent <0.2% of the total volume).
WWU data	Excludes very large daily metered sites for anonymity.
National Grid data explorer	Data scaled to BEIS gas totals for consistency.

Notes on definitions

Units

Orders of magnitude	Explanation
W	1 watt = 1 watt
kW	1,000 watts = 1 kilowatt
MW	1,000,000 watts = 1 megawatt
GW	1,000,000,000 watts = 1 gigawatt
TW	1,000,000,000,000 watts = 1 terawatt

Power and energy

Power (capacity) X Time = Energy (e.g. demand and generation)



50 watts

X



20 hours

=

1,000 Wh or 1 kWh
(of demand)



1,000,000 watts (1 MW)

X



1 hour

=

1,000,000 Wh or 1 MWh
(of generation)

Data sources

1. BEIS Sub-national total final energy consumption statistics 2019 (latest)
2. BEIS Sub-national electricity consumption statistics 2020 (latest)
3. BEIS Sub-national gas consumption statistics 2020 (latest)
4. BEIS Sub-national estimates of properties not connected to the gas network 2020 (latest)
5. BEIS Sub-national road transport fuel consumption tables 2019 (latest)
6. StatsWales Workplace employment by industry and area 2019 (UK and Wales)
7. ONS Energy use by industry, source and fuel, 1990 to 2019
8. ONS Sectoral energy use in the United Kingdom, 1990 to 2019
9. Nomis Labour Market Statistics - workforce jobs by industry (SIC 2007)
10. Regen internal analysis and resources from previous projects relating to heating technology splits.
11. Energy Consumption in the United Kingdom (ECUK), End use tables, 2019
12. Actual historic gas load demand as provided by Wales and West Utilities (WWU), 2020
13. National Grid LDZ actual historic demand, Data Item Explorer, 2017-2020
14. Actual historic electricity demand as provided by Western Power Distribution, 2021
15. Department for Transport, Vehicle Licensing Statistics Table VEH0131, January 2022

