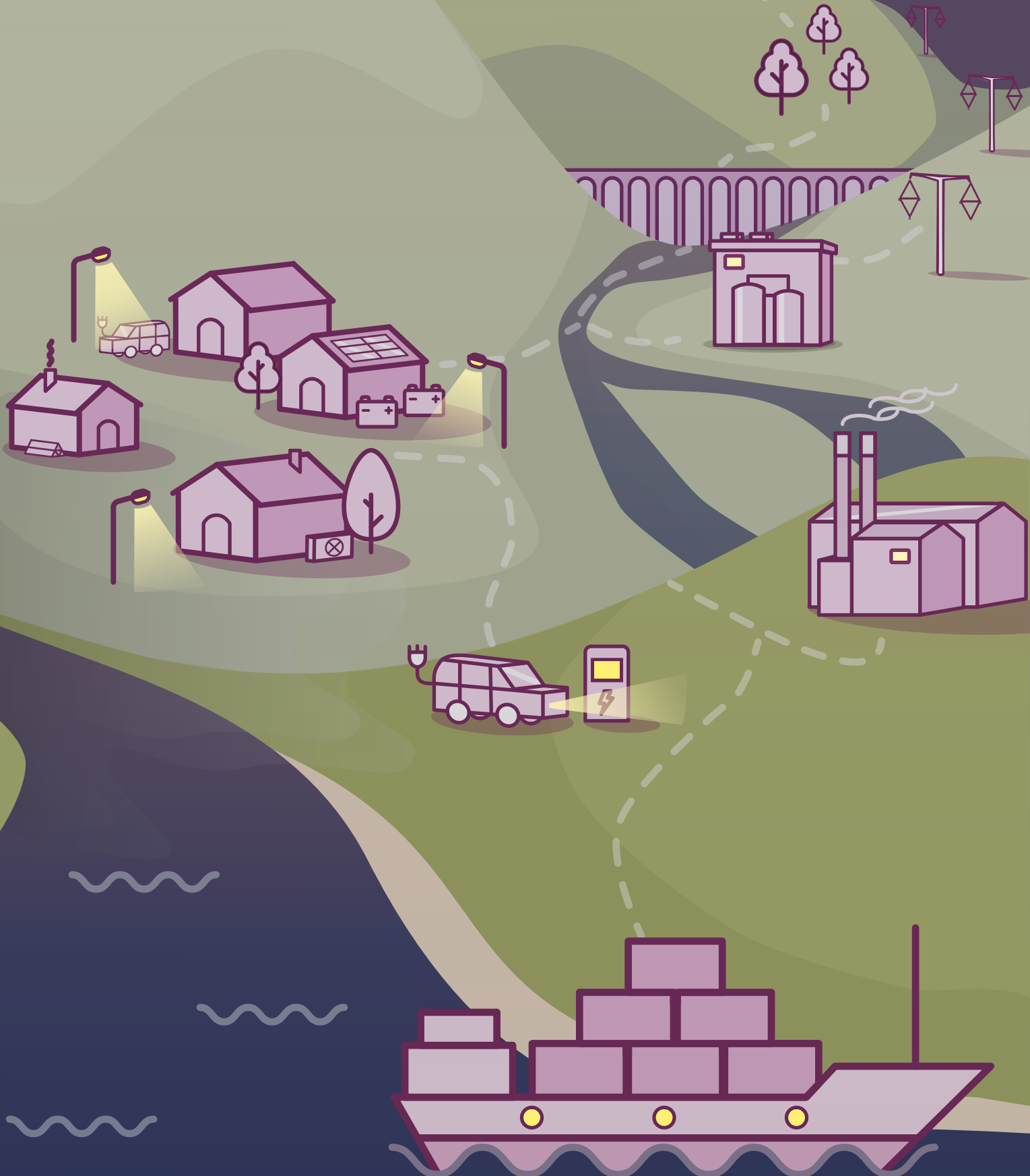




Llywodraeth Cymru
Welsh Government

Energy Use in Wales

Third Edition



Cover illustration: Regen

Written and produced by Regen for the Welsh Government



Regen is an independent centre of energy expertise with a mission to accelerate the transition to a zero carbon energy system.

For more information, visit www.regen.co.uk

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Ministerial foreword

The Welsh Government is strongly committed to stepping up the deployment of renewable energy in Wales, recognising its importance in achieving our climate goals. Our commitment to net zero requires a rapid transformation of our energy system. We need to accelerate the transition away from fossil fuels to a more localised, flexible, renewables-based energy system which delivers wider social and environmental benefits.



Rebecca Evans MS

Cabinet Secretary for
Economy, Energy and
Planning

The importance of energy to the economy and wider society is clear. We want to support all sectors of the economy, our homes and citizens to benefit from the energy transition to create a more prosperous Wales and more vibrant communities.

Our whole-system approach helps us share accountability for the energy transition. We aim to reduce our demand and generate renewable energy to meet the equivalent of 100% of our annual electricity consumption from renewable sources by 2035 and continue to keep pace with consumption thereafter.

This third edition of the Energy Use in Wales report provides a complete and transparent picture of energy use across key sectors in Wales. This will help support our policymaking and our understanding of the challenges that we face in achieving the energy transition. As we said in our Energy Generation in Wales 2022 report, we now have new energy targets to report against, reflecting our commitment to a more sustainable future for Wales.

Since the release of our last report, Wales has reduced its overall energy consumption to 85.5 TWh (in 2021). With 62% of all energy consumed in Wales being used in the transport and industrial sectors, the electrification of transport, heating and industry will continue to be a key feature of the energy transition out to 2050.

The green economy is an important part of our overall economic plans and we are committed to seizing the opportunities of the green industrial revolution. We want our entrepreneurs, businesses, and workforce to thrive in all parts of Wales.

In February 2023, we launched the Net Zero Skills Action Plan, outlining the Welsh Government's commitment to a just transition to net zero. The plan emphasises the need to equip both current and future workforces with the skills required to meet economic demands. It will also play a key role in identifying skills gaps in collaboration with industry, trade unions, and further and higher education establishments.

This report, along with 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.

Introduction

This Third Edition of Energy Use in Wales presents a snapshot of the end use of energy and how this varies over time. This report aims to offer the Welsh Government an accurate and clear picture of energy use to support policymaking.

The Department for Energy Security and Net Zero (DESNZ) sub-national energy consumption statistics, supplemented with additional data analysis, have been used to examine energy consumption trends in Wales. The resulting data on energy use is categorised by end-use, sector, fuel type and geographic area. This report is based on the most recent and the most extensive data available, covering the period from 2005 to 2022.

This report

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

Energy consumption is analysed within this report by:

- **Energy use** – heat, transport, electricity and other
- **Sector** – agriculture, commercial, domestic, industrial, public sector and transport
- **Fuel** – bioenergy and wastes, coal, electricity, gas, manufactured fuels and petroleum
- **Geographic area** – local authority areas and Welsh regions



'Energy use' and 'Energy consumption' are both used in the report to refer to the end-point consumption of energy regardless of fuel (e.g. electricity, gas, petroleum) or end use (e.g. heating, appliances, industrial processes). Where the report is discussing a specific fuel, this is referred to directly e.g. 'electricity use/consumption in Wales'. Similarly, where the report is discussing energy use/consumption in a specific sector or specific end use, this is also referred to directly e.g. 'energy use/consumption for transport'.

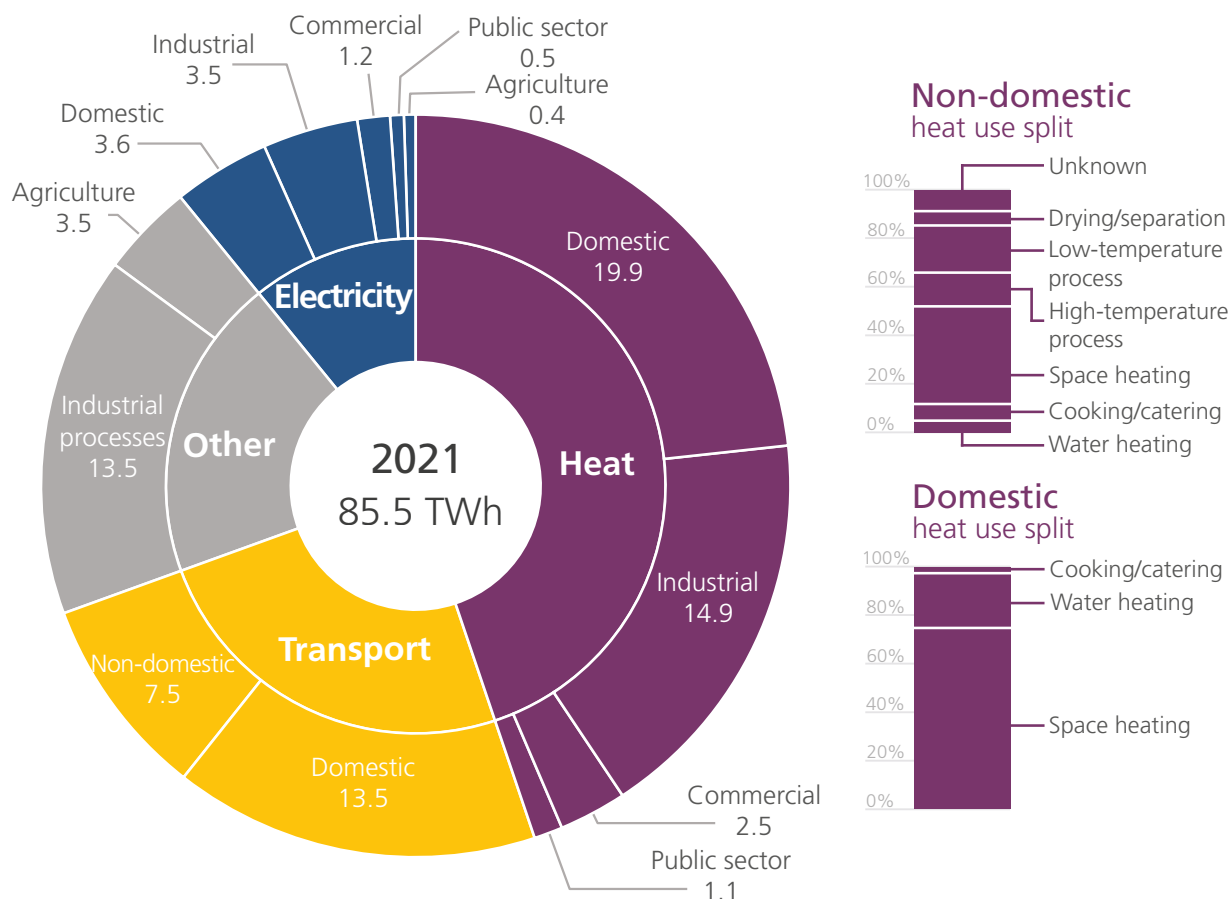
Types of energy use

In 2021, Wales consumed a total of 85.5 TWh of energy – a 22% decrease in energy consumption since 2005. In comparison, England’s energy use decreased by 20% during the same timeframe. There was an 8% drop in energy consumption between 2019 and 2020, attributable to the COVID-19 pandemic restrictions, which is significant compared to the average yearly decrease of 2% over the preceding 16 years. Energy consumption increased by 2% between 2020 and 2021.

It is estimated that 45% of energy is used for heating in homes, businesses and industry. This includes electricity used for heating purposes. The second-largest energy use is for transport, comprising 25% of Wales’s total energy consumption. Electricity for non-heating uses (appliances, lighting and cooking powered by electricity) represents around 11% of energy use. Finally ‘other’ energy consumption, mainly for industrial or agricultural processes, constitutes 20% of total energy use.

Annual energy consumption in Wales broken down by use, 2021 (TWh)

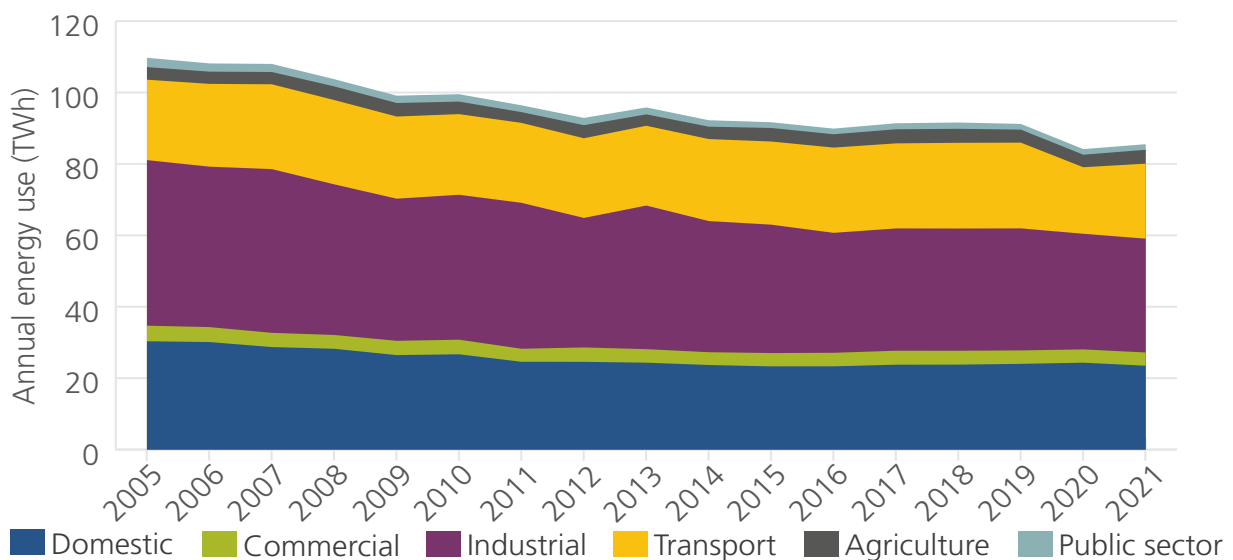
Data sources: (1, 2, 3, 4, 5, 6)



Energy use by sector

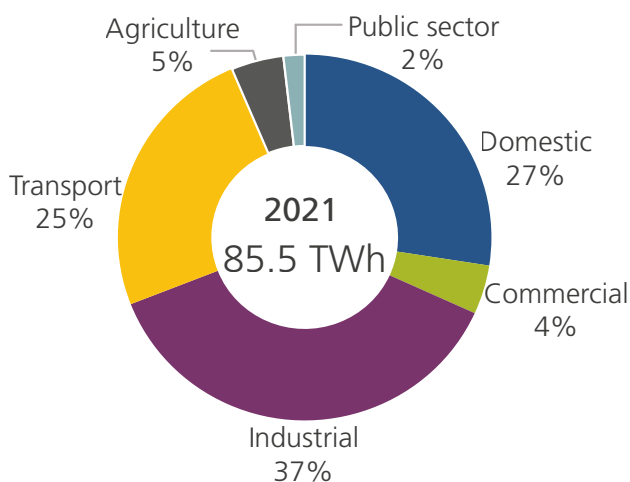
Since 2005, the proportions of energy use by sector have remained broadly consistent. Industry now constitutes 37% of total energy consumption, down slightly from over 40% in 2005. This is followed by the domestic and the transport sectors, consuming 27% and 25% of total energy demand in 2021 respectively.

Energy use by sector 2005-2021 (TWh) Data source: (1,3,7)



Energy consumption in Wales (TWh/yr)

Data source: (1,3,7)



Total energy consumption reduced sharply by 7 TWh in 2020. This is attributed to a reduction in transport energy use from 24 TWh in 2019 to 19 TWh in 2020, largely attributed to COVID-19 pandemic restrictions.

Between 2005 and 2021, only the agricultural sector saw an increase in energy consumption. However, this increase has been small – agricultural energy consumption has increased by 0.35 TWh to 3.9 TWh, now representing 5% of total energy use in Wales.

In previous editions of Energy Use in Wales, public sector energy use was included within the commercial sector. To align with the sector pathways outlined in the Welsh Government’s Second Carbon Budget, public sector and commercial energy use is now estimated separately.

Energy use by fuel

Approximately 90% of energy consumed in Wales is estimated to be from fossil fuels. Petroleum is the most abundantly consumed fuel, accounting for 39% of total energy use and is primarily used in the transport sector as vehicle fuel, as well as in the industrial, domestic and agricultural sectors.

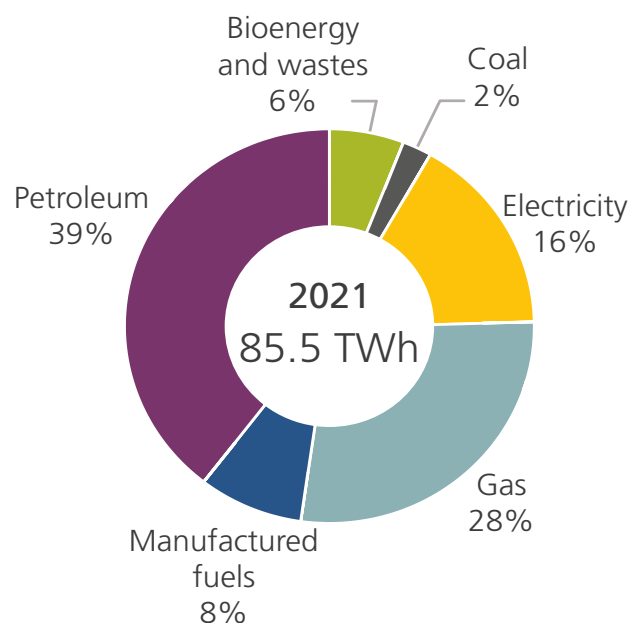
Gas follows as the second most-used fuel, making up 28% of total energy consumption. Its predominant end use is for heating and industrial processes, however, it is also consumed by Wales' gas power stations (excluded from this report, see Energy Generation in Wales).

Electricity ranks third, making up 16% of total energy use, predominantly used in the industrial sector for various processes including heating, motors, refrigeration and lighting.

The remaining 16% of total energy use is comprised of manufactured fuels (such as coke), bioenergy (such as biodiesel), wastes and coal.

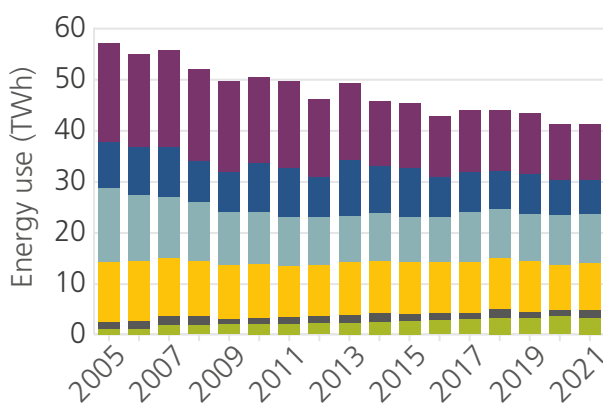
Total energy use in Wales by fuel type

Data source: (1)



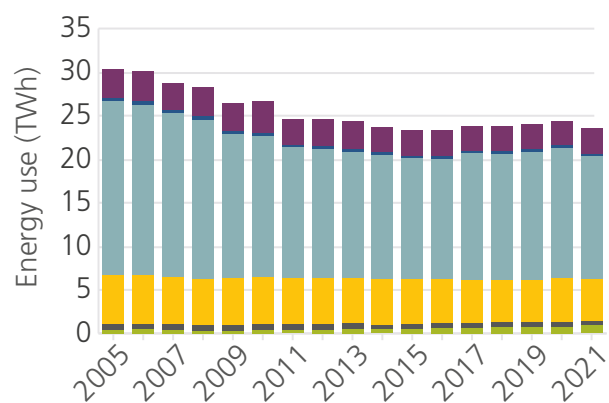
Non-domestic energy use by fuel type

Data source: (1)



Domestic energy use by fuel type

Data source: (1)



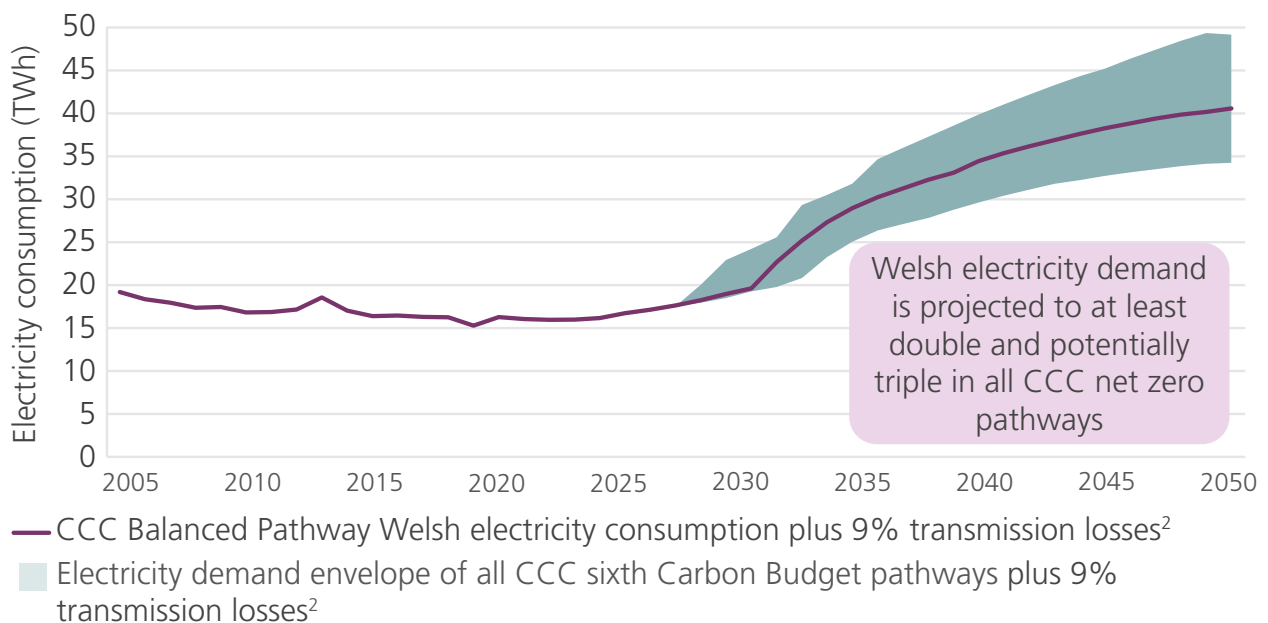
Energy consumption has reduced in both domestic and non-domestic sectors since 2005, primarily influenced by a reduction in domestic gas use and non-domestic petroleum consumption.

Welsh energy targets

This report outlines current energy consumption trends, but to plan to meet Wales’s energy targets it’s vital to consider future energy trends. Wales has a target to generate the equivalent of 70% of its annual electricity consumption from renewable sources by 2030, and 100% by 2035. Progress towards these targets is impacted equally by changes to both electricity consumption and electricity generation.

Renewable electricity projects in Wales generated the equivalent of 59%¹ of Wales’s electricity consumption in 2022, just 11% percentage points away from the 70% target. However, electricity consumption trends and progress towards these targets are set to change as Wales transitions away from fossil fuels.^{2,3} The adoption of electrification technologies, though currently modest, is gaining momentum, and their future uptake will increase electricity consumption. Consequently, electricity consumption is a moving target when considering progress towards future energy targets.

Welsh electricity demand projections Data source: (14)



In the Climate Change Committee’s (CCC) sixth Carbon Budget pathways, electricity and hydrogen consumption increase significantly in all net zero scenarios.² To minimise these increases, energy efficiency improvements and measures to reduce energy conversion losses are critical actions in all CCC net zero pathways. The same actions will also play a critical role in achieving the Welsh Government’s energy targets, by reducing the amount of renewable electricity generation required to meet those targets.

¹ Welsh Government, 2023; Energy Generation in Wales 2022

² Climate Change Committee, 2020; The Sixth Carbon Budget

³ Welsh Government, 2023; Heat Strategy for Wales

Energy use by sector

Welsh energy trends are analysed by sector within this section.

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DANSA community transport electrification

DANSA (Dulais, Afan, Neath, Swansea and Amman valleys), a community transport organisation, has successfully secured funding from the Welsh Government in collaboration with the Community Transport Association (CTA) Wales. The funding enables the purchase of two electric multi-purpose vehicles, two fully accessible electric minibuses and an electric food vehicle, as well as the installation of two charge points and the acquisition of solar panels and battery storage.

Headquartered in Neath Port Talbot, DANSA is a not-for-profit organisation that aims to support the local community with accessible and inclusive transport services.



Image credit: DANSA

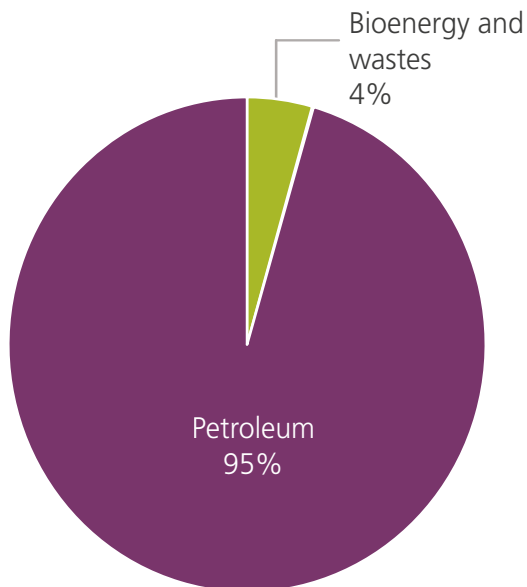
Transport

Road and rail transport energy consumption has reduced by 2 TWh since 2005, with 21 TWh consumed in 2021, compared to 23 TWh in 2005. However, transport energy consumption peaked at 24 TWh in 2019 before reducing to 19 TWh in 2020, influenced by the impact of the COVID-19 pandemic on mobility.

The transport sector accounts for 25% of the total energy use in Wales. This proportion is comparatively lower than for the UK as a whole, for which the share of total energy use by the transport sector was 30% in 2021.

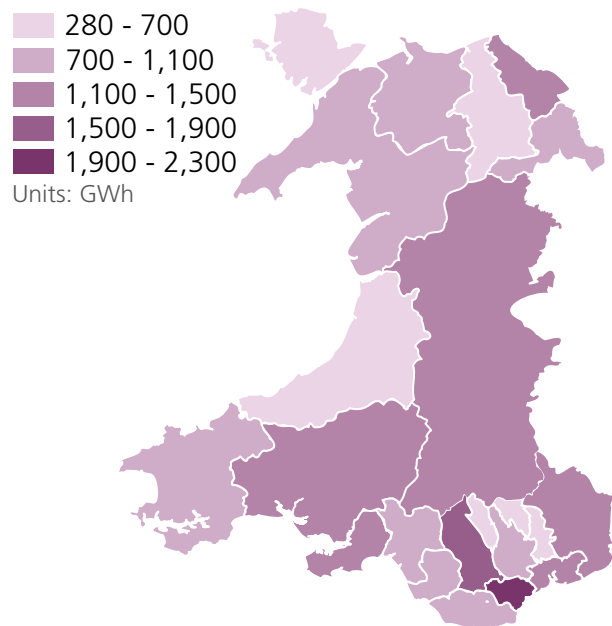
Transport consumption by fuel, 2021

Data source: (1)



Annual transport energy use by local authority area, 2021

Data source: (1)



DESNZ energy consumption data does not currently capture electricity consumption for electric vehicles within its transport sector data reporting. However, if it is assumed that Wales's 18,500 battery electric cars⁴ drive an average of 8,500 miles annually,⁵ with an average efficiency of 3 miles per kWh consumed,⁶ it can be estimated that battery electric cars in Wales currently consume approximately 0.16 TWh annually. Consequently, the energy consumption of battery electric cars is currently equivalent to less than 1% of total transport energy consumption. Other electric vehicles archetypes have not been included in this high-level estimate.

⁴ Department for Transport, 2023; VEH0142 licensed plug-in vehicles (PIVs) at the end of the quarter by body type, fuel type, keepership (private and company) and upper and lower tier local authority.

⁵ Department for Transport, 2023; TRA8902 motor vehicle traffic (vehicle miles) by local authority and selected vehicle type in Great Britain.

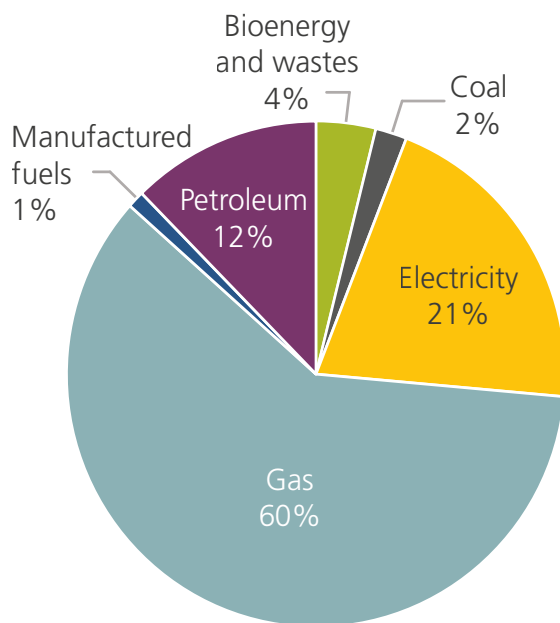
⁶ National Grid ESO, 2023; Future Energy Scenarios.

Domestic

Domestic energy consumption in Wales steadily reduced between 2005 and 2011, from 30 TWh to under 25 TWh. Between 2011 and 2020, consumption remained between 23 TWh to 25 TWh, representing 27% of total Welsh energy consumption.

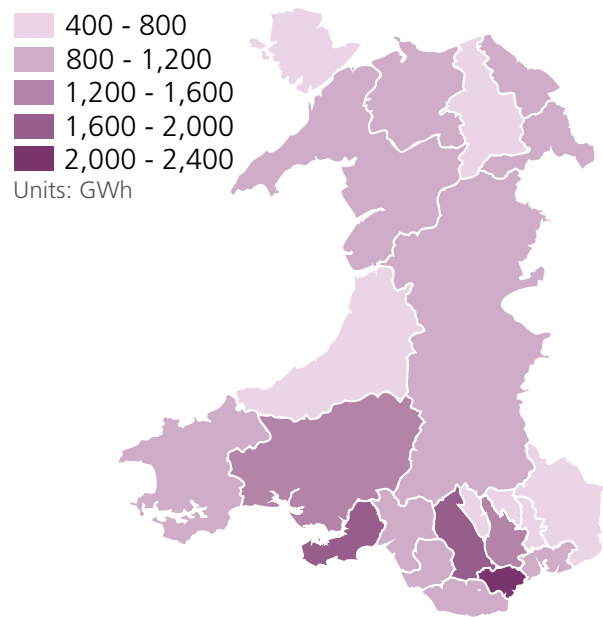
Domestic consumption by fuel, 2021

Data source: (1)



Annual domestic energy use by local authority area, 2021

Data source: (1)



Improvements in energy and heating efficiency have contributed to a reduction in the overall demand for domestic energy. The average proportion of houses with an EPC Band C or higher in Wales has steadily increased from 26% in 2013 to 45% in 2021. In contrast, the corresponding figure for England has risen from 33% to 52% during the same period.

The majority of domestic energy consumption comes from fossil fuels. Gas continues to be the primary fuel consumed in domestic buildings. However, the proportion of gas in the fuel mix has reduced from 66% in 2005 to 60% in 2021 due to a fall in domestic gas consumption.

The three most populous local authority areas of Wales – Cardiff, Rhondda Cynon Taf and Swansea – represent 27% of Wales’s population and accounted for 26% of all domestic consumption in 2021 (2.4 TWh, 1.8 TWh and 1.8 TWh respectively). Urban areas in Wales have higher average EPC ratings than rural areas. Newport, Torfaen and Cardiff having the highest percentage of homes with an EPC band C or higher, in comparison to Gwynedd, Ceredigion and the Isle of Anglesey that have the lowest.⁷

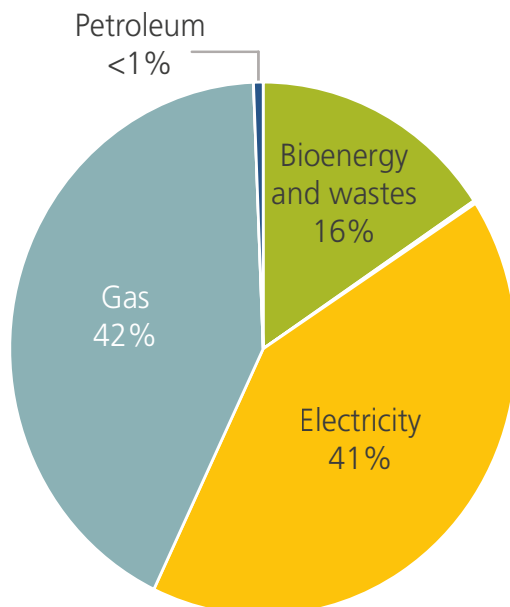
⁷ Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government, 2021; Live tables on Energy Performance of Buildings Certificates.

Commercial

Commercial energy use represents private sector activities outside of industry, including offices and retail. Commercial energy consumption steadily reduced from a peak of 4.4 TWh in 2005, to a low of 3.6 TWh in 2014. Between 2015 and 2021, energy use has consistently remained below 4 TWh. The decline in commercial energy use is attributed mostly to energy efficiency improvements.

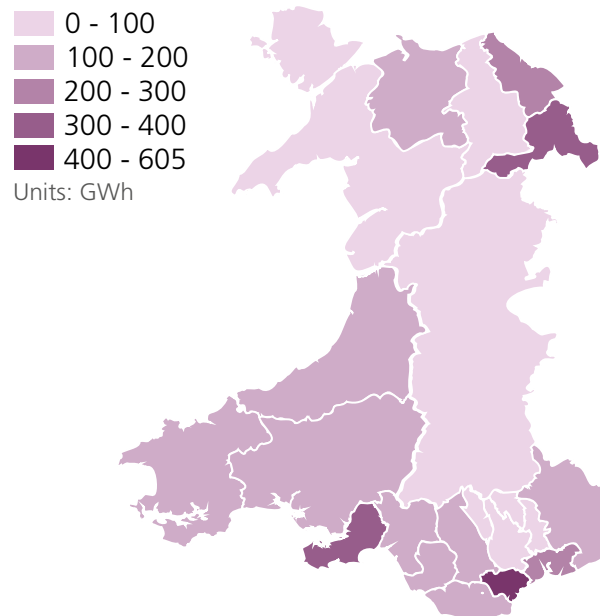
Commercial consumption by fuel, 2021

Data source: (1,3,7)



Annual commercial energy use by local authority area, 2021

Data source: (1,3,7)



The largest concentrations of commercial energy use are within the most urbanised areas: Cardiff, Swansea and Wrexham. Despite a growth in employment within this sector across Wales, there has been a decrease in commercial consumption. Commercial employment has increased by 11% from 2005 to 2019, with the greatest increase in sub-sectors in the professional, scientific and technical activities sector at 60%.⁸

The commercial sector has consistently represented approximately 4% of overall energy consumption in Wales. In 2021, gas was the most consumed fuel in the commercial sector, comprising 42% of the total. Electricity was the second most consumed fuel, comprising 41% of the total. Petroleum, gas, electricity and manufactured fuels saw a decline in consumption between 2005 and 2021. Notably, bioenergy and waste use has risen from 4% in 2005 to 16% in 2021 of commercial energy consumption.

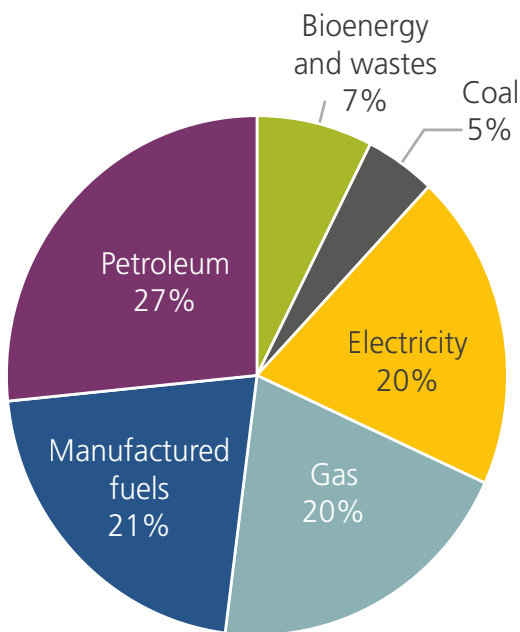
⁸ StatsWales, 2019; Workplace employment by industry and area.

Industrial

The industrial sector has seen the most significant reduction in energy consumption since 2005 with a 31% reduction, from 46 TWh in 2005 to 32 TWh in 2021. This reduction in industrial energy demand is attributed to several factors, including a reduction in energy intensive activities such as steel production, changes in the industrial fuel mix, and energy efficiency improvements.⁹ Industrial employment fell 5% between 2005 and 2019, which is attributed mostly to a 15% employment decrease in the manufacturing sub-sector.¹⁰

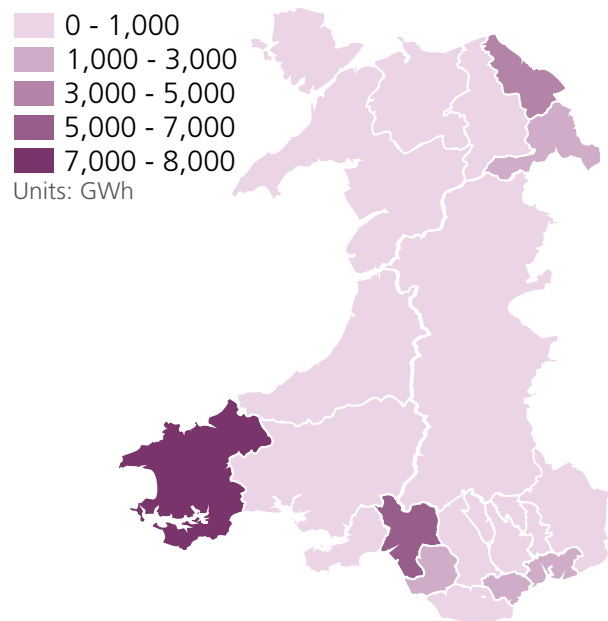
Industrial consumption by fuel, 2021

Data source: (1,3,7)



Annual industrial energy use by local authority area, 2021

Data source: (1,3,7)



Demand for petroleum, manufactured fuels, gas and electricity has seen a reduction from 2005. Petroleum use in industry has reduced by 50% since 2005; however, it is still the most consumed industrial fuel. Manufactured fuel represents the second most used fuel in 2021, at 21% of all industrial energy demand. Coal still represents 5% of industrial energy consumption.

Industry in Pembrokeshire represents nearly a quarter of Welsh industrial energy demand, predominantly due to hosting a large oil refinery, making up 24% of the total industrial energy use in Wales in 2021.

⁹ Climate Change Committee, 2023; Progress report: Reducing emissions in Wales

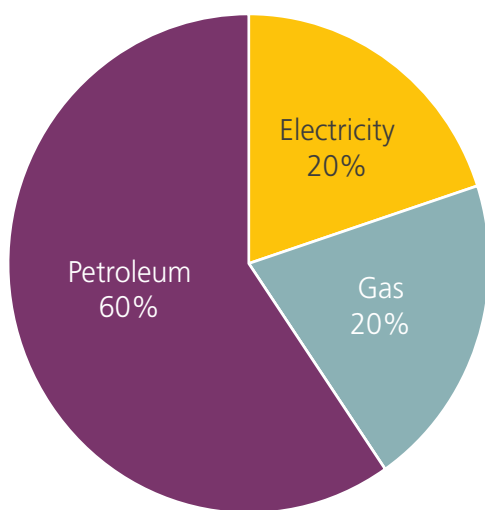
¹⁰ StatsWales, 2019; Workplace employment by industry and area.

Agriculture

Between 2005 and 2021, the agriculture sector's share of energy demand has increased from 3% to 5%. Overall, there has been an upward trend in consumption within this sector, a pattern observed throughout the UK. Powys, Carmarthenshire and Pembrokeshire are the local authority areas with the most agricultural energy use in Wales.

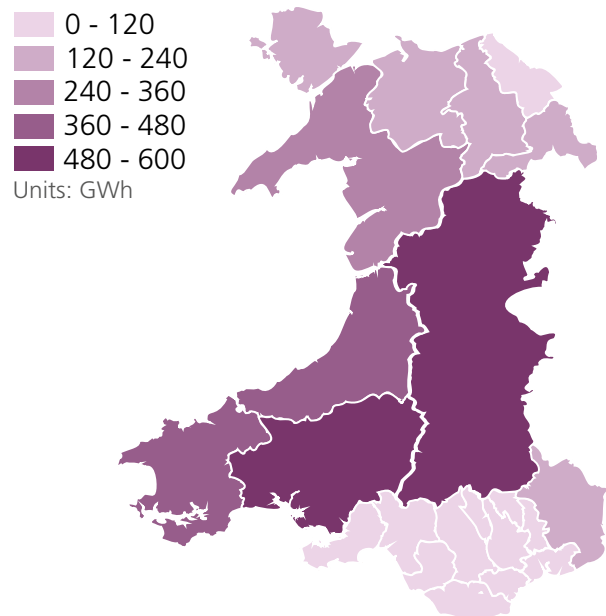
Agriculture consumption by fuel, 2021

Data source: (1,3,7)



Annual agriculture energy use by local authority area, 2021

Data source: (1,3,7)



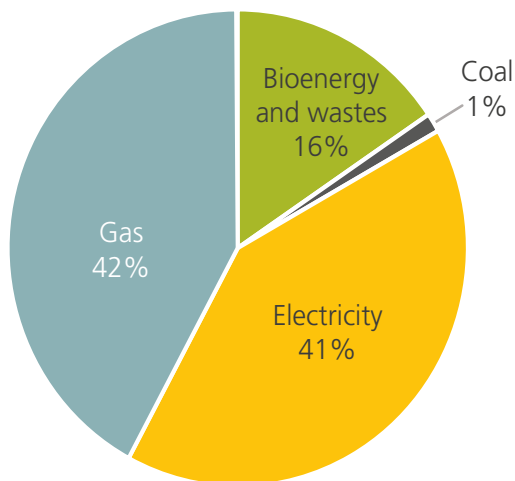
With the exception of coal, which has no recorded consumption in agriculture since 2012, all other agricultural fuel type use has been relatively consistent between 2005 and 2021. Absolute demand for gas, petroleum and electricity have increased by 6%, 7% and 25% respectively. Petroleum accounted for the majority (60%) of the total agricultural energy consumption in 2021, fuelling both mobile agricultural machinery and stationary combustion.

Public sector

Since 2005, the public sector has represented 2% of total energy consumption; during this period there has been a reduction of 1 TWh in actual energy use, to 1.6 TWh in 2021. Gas, electricity, coal and petroleum fuel types have seen a decline in demand since 2005: 33% for electricity, 43% for gas, 79% for coal and 95% for petroleum. In contrast, bioenergy and waste fuel use has almost tripled since 2005.

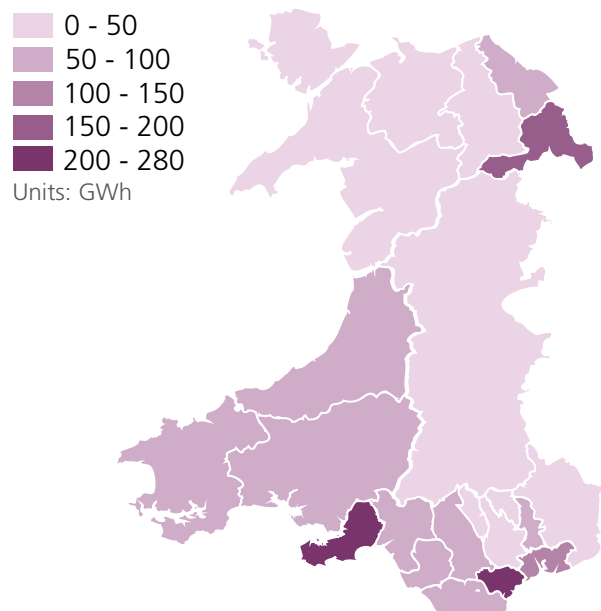
Public sector consumption by fuel, 2021

Data source: (1,3,7)



Annual public sector energy use by local authority area, 2021

Data source: (1,3,7)



Cardiff, Swansea and Wrexham were the local authority areas with the highest public sector energy consumption in Wales in 2021.

Geothermal heating

Ffynnon Taf Primary School, located in Rhondda Cynon Taf, upgraded its heating system in 2022 with council funding. The school now uses a geothermal heating system fed by Wales's only thermal hot spring. The water from the spring is passed through heat pumps to partially heat new and existing teaching blocks. The geothermal heating system has replaced the previous gas heating system. This transition not only enhances the school's sustainability efforts but also results in cost savings.

Energy use by fuel

Welsh energy trends are analysed by fuel types within this section.

Energy use by fuel

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Llanfendigaid Estate

Llanfendigaid Estate, a collection of Grade II listed properties in Gwynedd, has been transformed into sustainable holiday accommodation. Through the estate’s sustainability projects, all electricity supplied to the properties is from renewable sources and a ground-source heat pump system has been installed.

The ground-source heat pump has replaced a fossil fuel system and will be used to heat all of the estate’s buildings and a swimming pool.

Future plans for the estate include installing ground-mounted solar PV and fast-charging EV chargers.



Image credit: Wikipedia

Fossil gas

Gas consumption

Total gas consumption in 2021 was 24 TWh, of which 14 TWh was used in the domestic sector and 9 TWh in non-domestic sectors. Between 2005 and 2021, the proportion of domestic to non-domestic gas consumption has remained consistent: 61% of total Welsh gas consumed is used for domestic space heating, cooking and hot water.

Gas consumption in Wales has reduced by 31% since 2005, compared to 26% in England and 23% in Scotland. This is a result of changes in domestic energy and heating efficiency, as well as a fall in industrial demand for gas.

From 2019 to 2020, gas use increased by 0.8 TWh, possibly due to COVID-19 restrictions resulting in increased time spent at home. From 2020 to 2021, gas consumption decreased by 1.1 TWh, falling back to 2019 levels.

On-gas homes

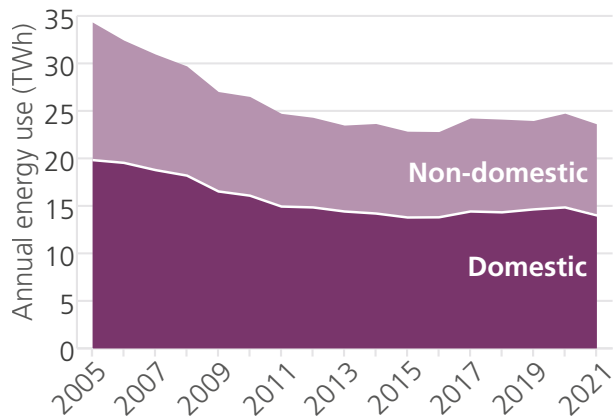
The distribution of on-gas homes across Wales is closely related to how urban or rural an area is. The gas distribution network has been developed across the more densely populated local authority areas, particularly the Cardiff Capital Region and the more industrial areas of northeast Wales. The consumption of gas can be correlated with this distribution, where urban areas consume a greater amount when compared to rural areas.

Regional gas consumption

In 2021, the Cardiff Capital Region had the greatest gas consumption, comprising 53% of the total. This is attributed to the region representing 49% of the entire Welsh population. Gas consumption is lowest in Mid Wales, primarily because this region constitutes only 7% of the national population and has limited connectivity to the gas grid.

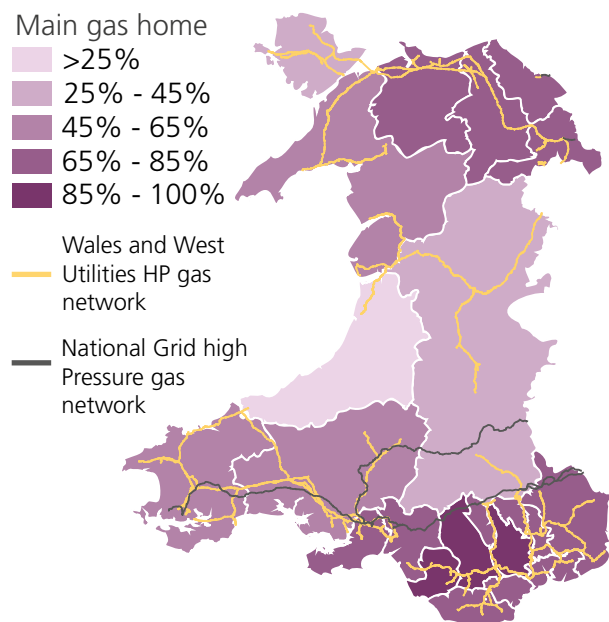
Gas consumption in Wales, 2005 - 2021

Data source: (8)



Percentage of on-gas homes by local authority area in Wales, 2021

Data source: (5)



Temporal gas consumption trends

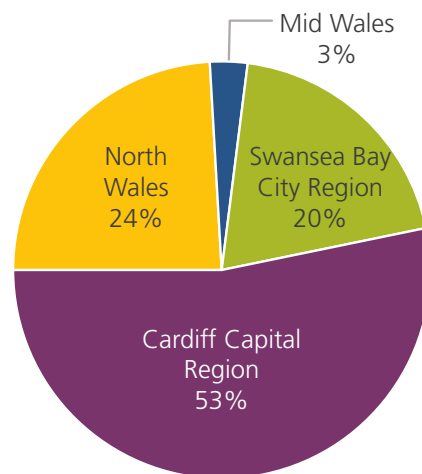
Gas consumption data reporting from Wales and West Utilities is split into two types of customers: those whose meter records gas consumption daily, and those whose meter doesn't. 'Daily metered' customers tend to be larger industrial premises, while 'non-daily metered' customers tend to be domestic and commercial premises.

'Daily metered' consumption of gas remains relatively consistent throughout the year, accounting for approximately 2% of overall annual consumption in each month. In contrast, 'non-daily metered' customer's gas consumption shows distinct seasonal variations, with significantly greater demand during winter months. 'Non-daily metered' winter gas consumption totals nearly two-thirds of the year's total gas demand, while its consumption in the warmer months of June to September represented just 13% of total annual gas demand.

In contrast, 'daily metered' consumption of gas, representing larger industrial premises, remains relatively consistent throughout the year, accounting for approximately 2% of overall annual consumption in each month. Similar to 2020, daily metered use saw a decline in consumption throughout 2021, dropping from 640 GWh in January to 550 GWh in December.

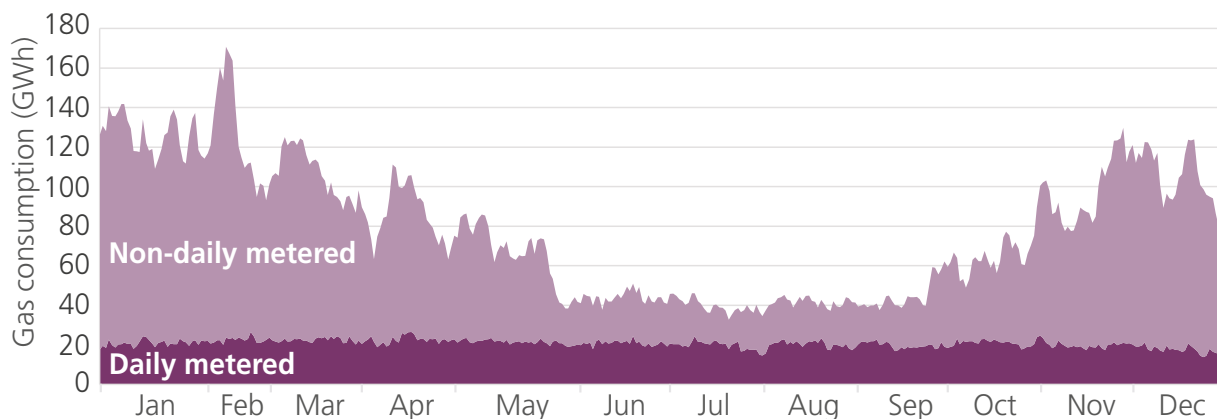
Proportion of annual gas consumption by region 2021

Data source: (8)



Daily gas consumption in Wales 2021

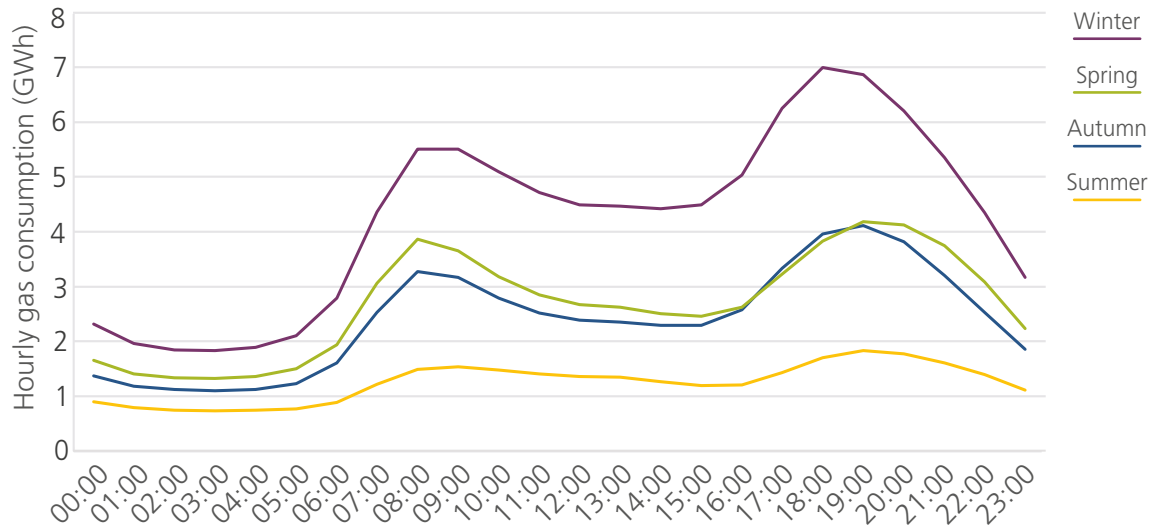
Data source: (9)



Gas demand forecasting

Weather has a large influence on domestic gas consumption. When predicting future demand, factors such as daily temperature, wind speed, effective temperature and the variation from seasonal normal temperatures are all considered. The effective temperature, calculated as half of yesterday's temperature added to half of today's temperature, is included to capture consumer behaviour and their response to weather conditions. For instance, if the weather has been consistently cold, domestic consumers are more inclined to turn on the heating.

Variation in daily gas consumption by season in Wales Data source: (10)



Variation in gas consumption

As well as seasonal variations, demand for gas, varies significantly within each day. Demand for gas for heating buildings, hot water and cooking typically results in two distinct 'peaks': a morning peak between 7am and 9am, when many people are starting their day, and an evening peak from 5pm to 9pm, when people are most likely to be at home. Gas consumption is lowest overnight, when domestic and commercial activity is low. This demand profile is particularly prevalent during the winter but can be seen across all seasons, even in the summer when demand for building heat is minimal, as demand for hot water and cooking remains.

Electricity

Electricity consumption

Overall electricity consumption in Wales has gradually decreased from 18 TWh in 2005 to 14 TWh in 2021. This decrease is primarily attributed to a reduction in non-domestic energy use. Similar trends are observed in England and Scotland.

Non-domestic electricity consumption reduced by 12% between 2019 and 2020, while domestic electricity consumption increased by 5%. This shift is likely influenced by COVID restrictions and changes in people's work and leisure patterns. Between 2020 and 2021, these trends reversed.

As the uptake of electrification technologies such as heat pumps and electric vehicles gathers pace, electricity demand is projected to increase in Wales. In the Climate Change Committees Balanced Pathway, electricity consumption nearly doubles between 2021 and 2035.

Regional electricity consumption

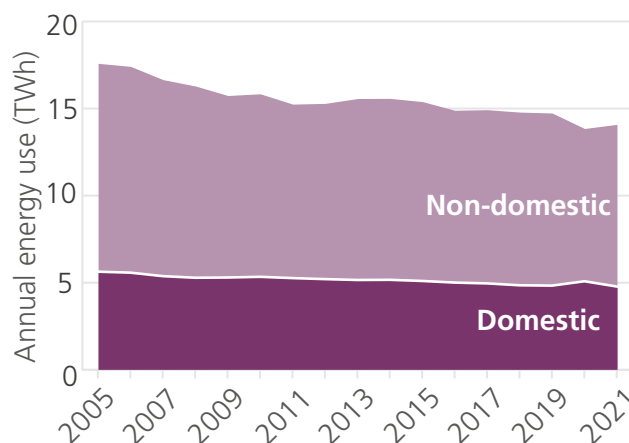
Between 2005 and 2021, the proportion of Wales's electricity consumption attributed to each region has remained broadly the same. The Cardiff Capital Region uses more than any other region of annual electricity consumption, at 41%, due to the region representing 49% of the national population.

However, on a per-household or per-capita

basis, electricity consumption is higher in rural areas due to a greater number of homes and businesses using electricity for heating. Consequently, Ceredigion is the local authority with the highest per-household domestic electricity consumption.

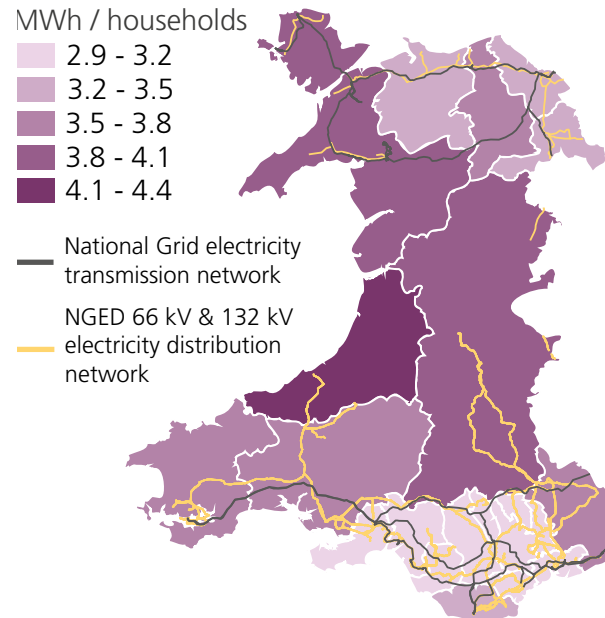
Electricity consumption in Wales, 2005 - 2021

Data source: (11)



Average domestic electricity consumption per household, 2021

Data source: (11)



Temporal electricity consumption

Analysis of intraday (half-hourly) electricity demand in the National Grid South Wales licence area shows two clear 'peaks' during the daytime across the year. The first peak occurs in the morning around 8am, while the second peak occurs during the evening between 5pm and 9pm. Weekends show a dampened electricity consumption, due to lower non-domestic demand.

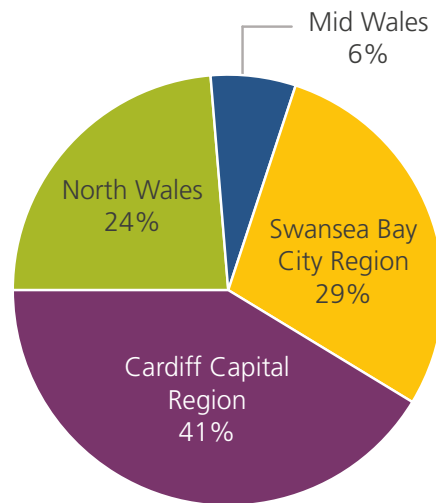
These peaks are more pronounced during the colder seasons, due to increased electricity use for heating and lighting. Similarly, the winter shows higher demand during the night. This is likely to be a result of night storage heating in homes and businesses.

While electricity consumption exhibits some seasonal variations, as discussed above, the variation is not as pronounced as gas use. This difference is attributed to the fact that a smaller proportion of electricity demand is allocated for heating. On average across England and Wales, 9% of households use electricity for heating. Within the South Wales licence area, this figure is 5%.

To achieve net zero, the number of households and businesses using electricity for heating and electricity will increase, as the uptake of heat pumps and electric vehicles increases. Seasonal and intra-day electricity consumption trends will consequently change – an outcome energy system stakeholders will prepare for with actions including network investment, new market arrangements, and storage and flexibility measures.

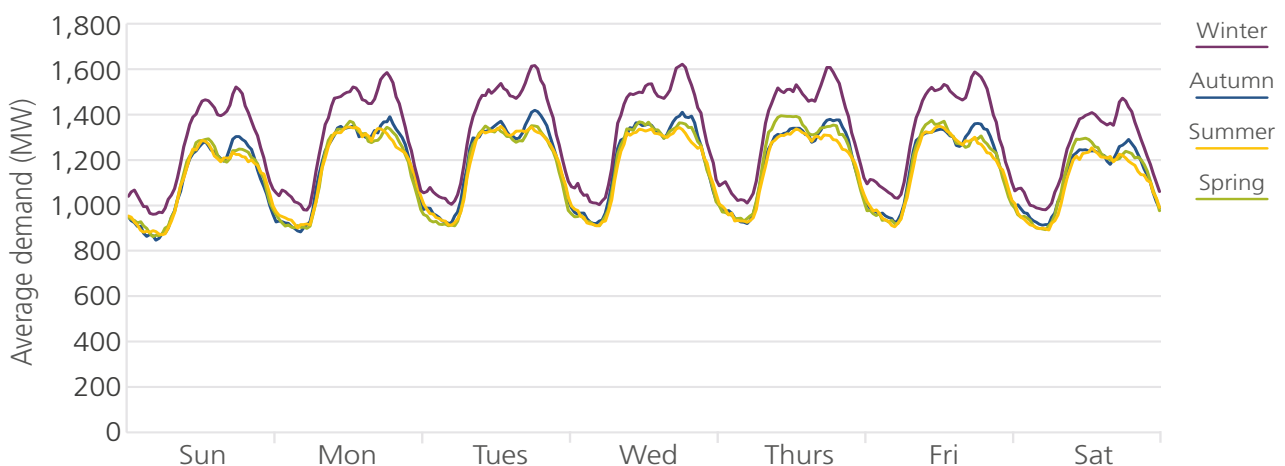
Proportion of total annual Welsh electricity consumption by region, 2021

Data source: (11)



Average half-hourly electricity demand by day and season within the South Wales licence area, 2022

Data source: (12)



Petroleum

Petroleum consumption

Petroleum consumption, predominantly for transport, heating and industrial processes, has decreased from 45 TWh in 2005 to 34 TWh in 2021. There was a sharp decrease in consumption between 2019 and 2020, from 38 TWh to 31 TWh, due to reduced road transport activity resulting from COVID-19 restrictions and subsequent changes in behaviour.

All sectors have seen a decrease in petroleum use, with the exception of agriculture, which increased its use by 0.1 TWh.

Petroleum consumption distribution

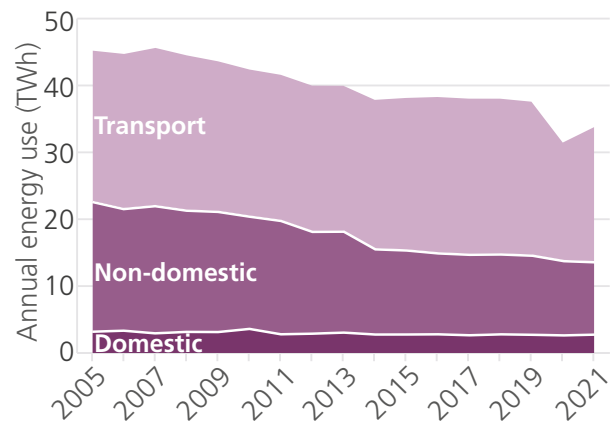
Among the 22 local authority areas in Wales, Pembrokeshire significantly outpaced the others in petroleum consumption in 2021. This is due to the substantial petroleum industry activity in Pembrokeshire, in particular the oil refinery activities around the Milford Haven Waterway. In terms of mileage relative to population, there are high levels of vehicle mileage in local authority areas containing major strategic roads, such as Monmouthshire and Newport, compared to the more rural and sparsely populated local authority areas of Powys, Ceredigion and Gwynedd.

Regional petroleum

In 2021, Swansea Bay City Region accounted for 35% of petroleum consumption, followed closely by the Cardiff City Region at 34%. North Wales comprised 21% of the consumption, while Mid Wales accounted for 10%.

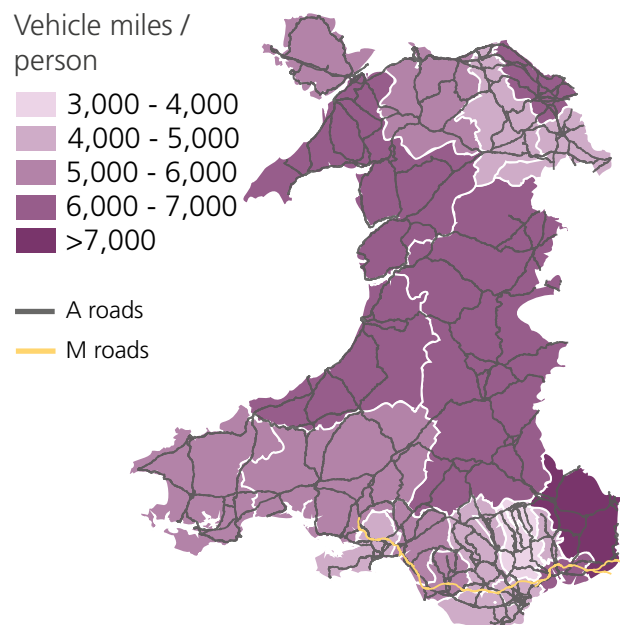
Petroleum consumption in Wales, 2005-2021

Data source: (1)



Vehicle miles per person by local authority, 2021

Data source: (13)



Energy use by region and local authority area

Welsh energy trends are analysed by region and local authority areas within this section.

Energy use by region and local authority area

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Mine water for district heat networks

Welsh Government commissioned the Coal Authority to map the potential for mine water as a heat resource, to heat homes, businesses and industry, areas are classified as good, potential or challenging opportunities.

The process of mine water heating involves extracting flood water from these abandoned mines, which is naturally warmed underground through geological processes to between 14-25 °C. This heat can then be extracted using heat exchangers and heat pumps to warm buildings within the local community through a heat network. Once the heat is recovered, the water is returned underground.

The maps are supported by technical reports for relevant local authorities and will be publicly available to help identify potential developments, it is too early to determine the specific number of addresses that could benefit from this method of heating.

Mine water heating is considered a low-carbon and sustainable technology, potentially offering significant carbon reductions compared to gas heating.

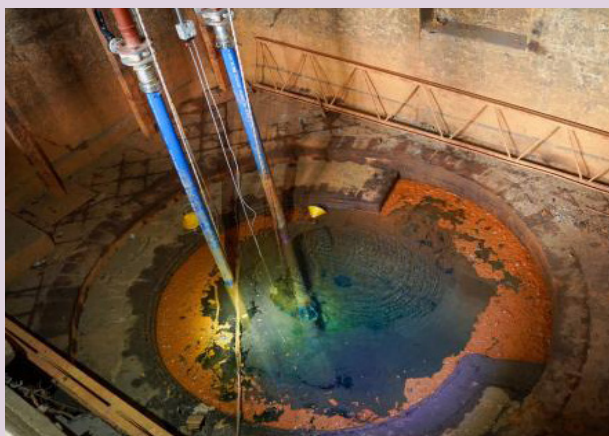
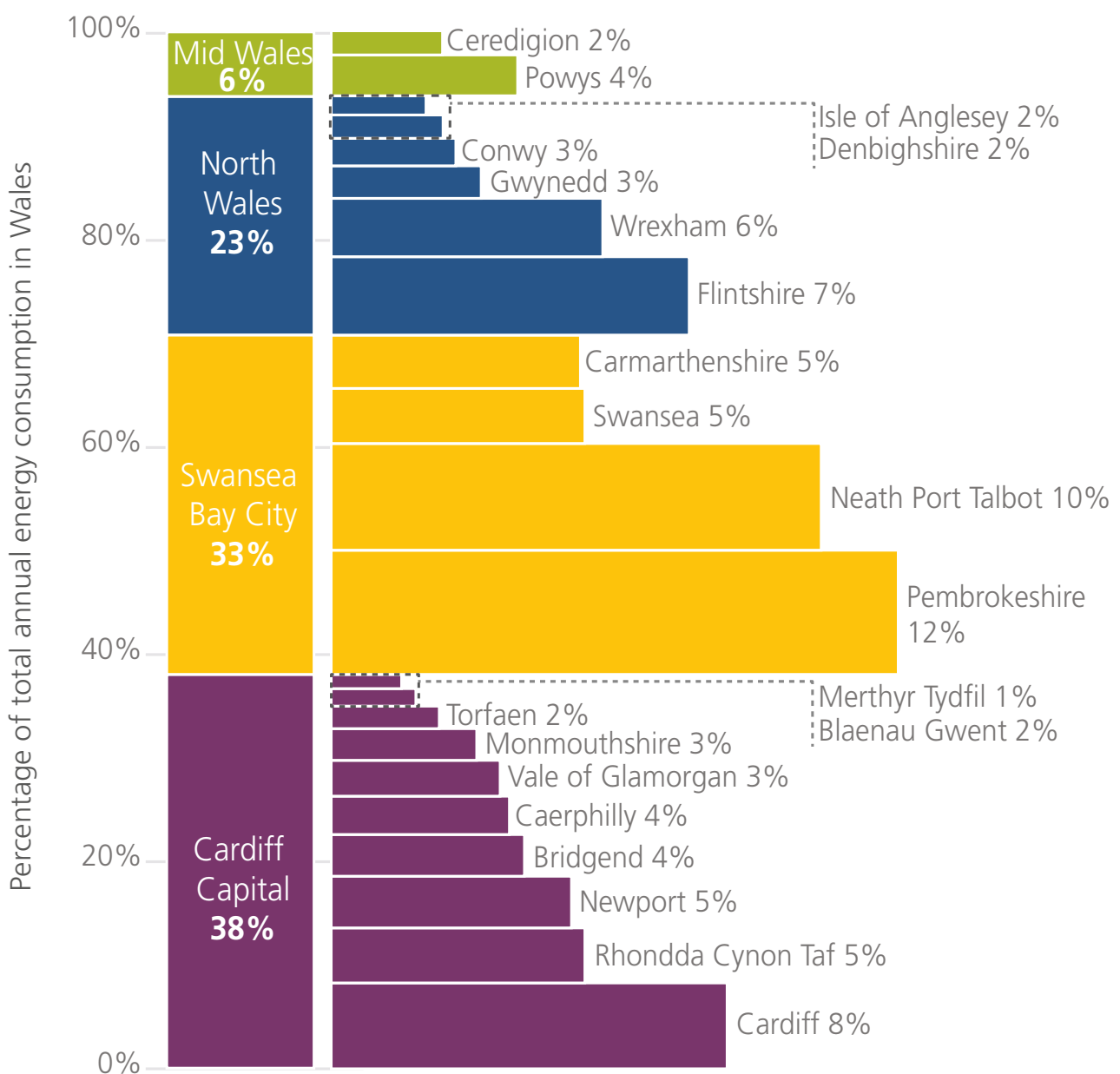


Image credit: Menter Môn

Energy use by region and local authority area

In 2021, the Cardiff Capital Region and the Swansea Bay City Region together accounted for approximately 71% of total annual energy consumption. North Wales consumed 23%, while Mid Wales consumed 6% of total Welsh energy consumption. Pembrokeshire and Neath Port Talbot are the local authority areas that consumed the most energy, predominantly due to industrial activity in those areas. Between 2005 and 2021, annual energy consumption decreased in all four Welsh regions.

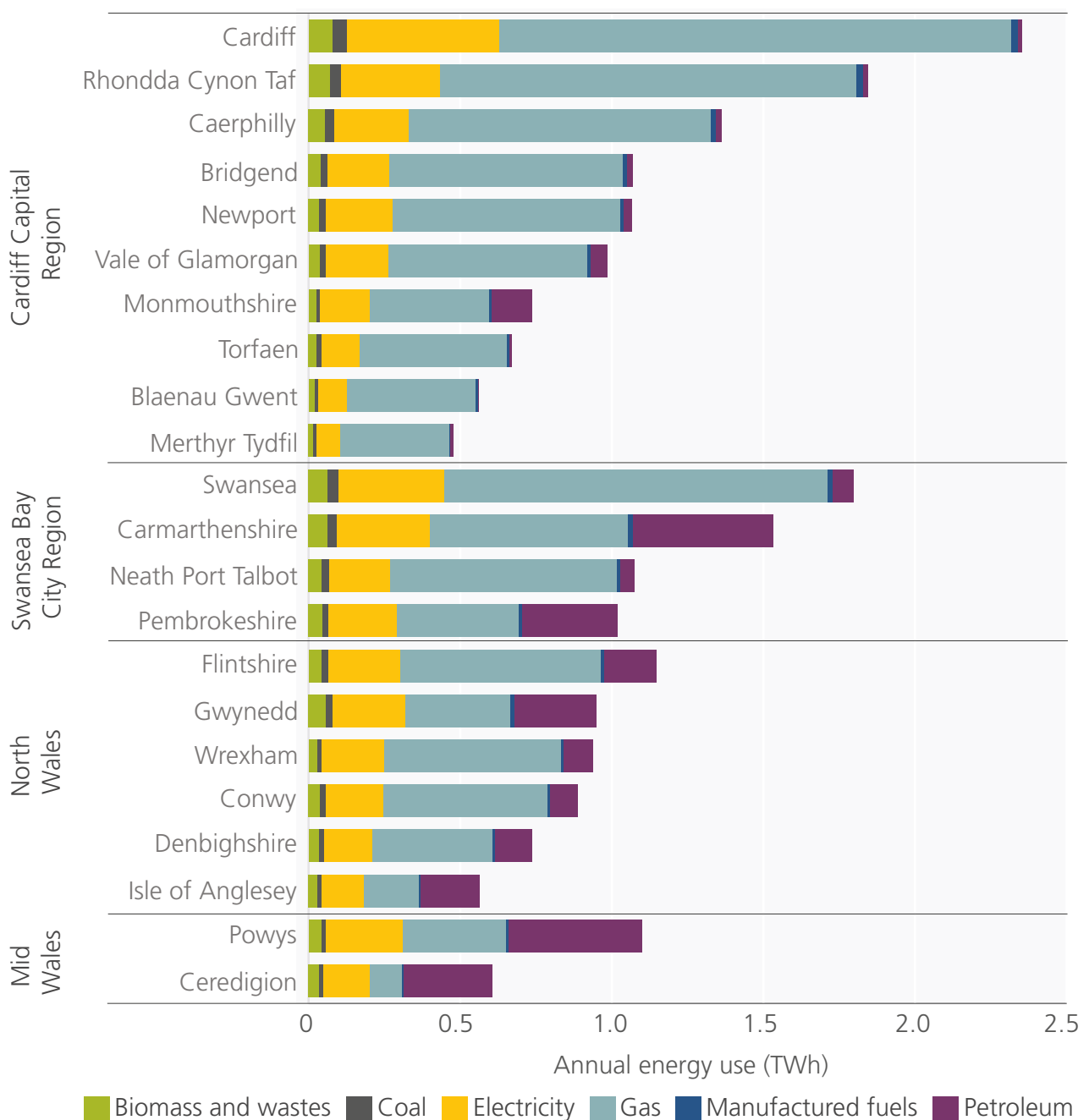
Annual energy use in Wales by region and local authority area, 2021 Data source: (1)



Energy use by local authority area

In most Welsh local authority areas, gas is the primary domestic fuel (excluding transport). However, in more rural and off-gas grid areas like the Isle of Anglesey, Powys and Ceredigion, electricity takes the lead as the most consumed domestic energy source.

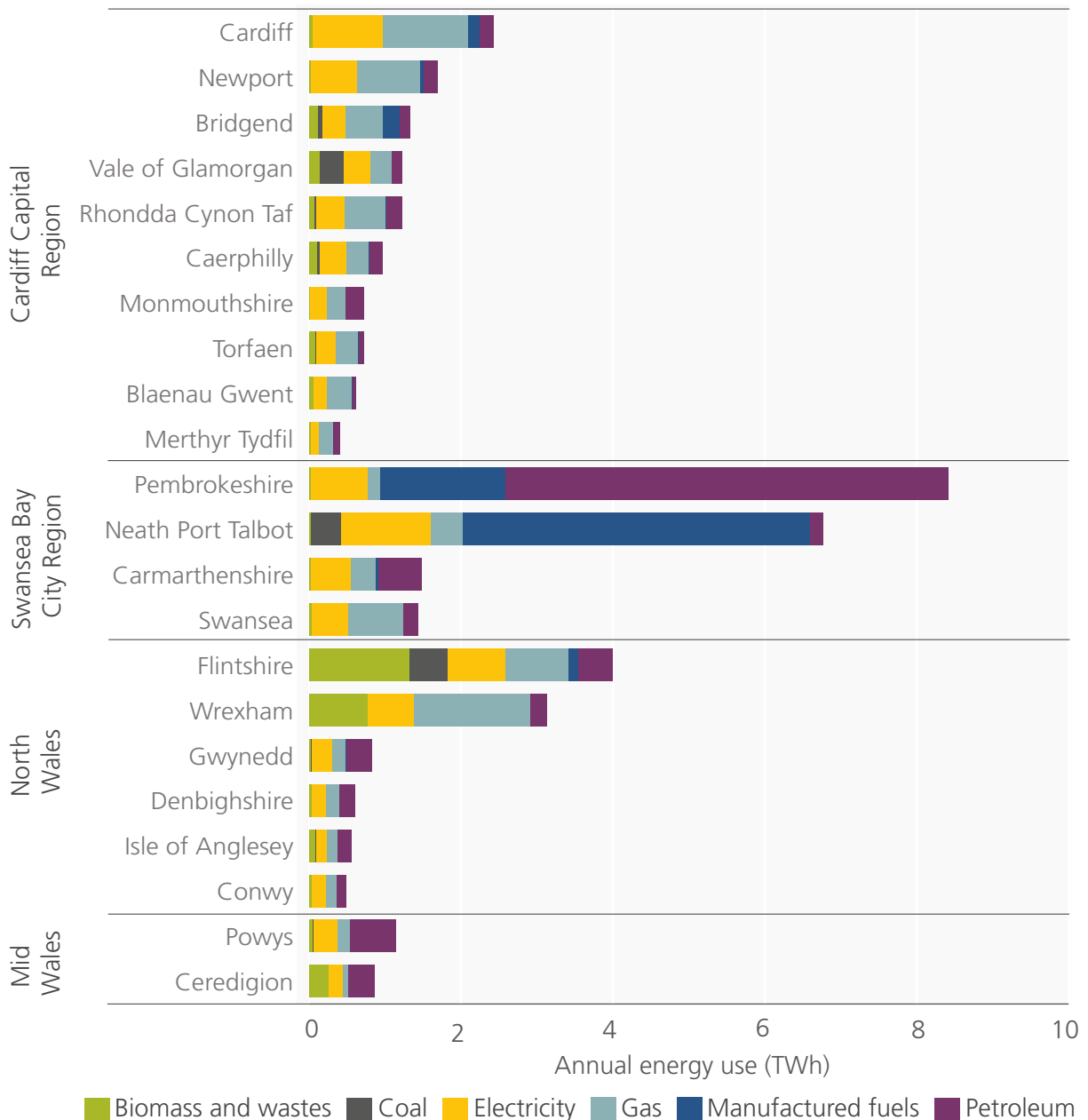
Domestic energy use by region and local authority area in Wales, 2021 Data source: (1)



Petroleum, gas and electricity make up the majority of the non-domestic energy consumption in Wales for 2021, with petroleum at 10.8 TWh, gas at 9.5 TWh and electricity at 9.2 TWh. The local authority areas of Pembrokeshire and Neath Port Talbot consumed the most non-domestic energy (8.4 TWh and 6.8 TWh respectively), mostly from petroleum and manufacturing fuels. This is likely due to the industrial operations at Pembrokeshire’s oil and liquified natural gas terminals, port and refinery, as well as steelwork activities in Neath Port Talbot. Merthyr Tydfil consumed the least non-domestic energy, at just 0.4 TWh.

Non-domestic energy use by region and local authority area in Wales, 2021

Data source: (1)



Reference pages

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Allan's Caravan and Holiday Park

Allan's Caravan and Holiday Park, located in Ceredigion, has recently installed a 240 kW water-source heat pump to provide heating and hot water to its new leisure facilities. In collaboration with Natural Resources Wales, the park leverages its proximity to the Clarach Bay estuary by using the estuary's water as an energy source for the heat pump. The heat pump will heat the park's swimming pools, lounge areas, bars and restaurants within the facility.



Image credit: Hughes Architects

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) has categorised the greenhouse gas emissions arising in Wales into eight sectors:

- Electricity and heat generation
- Transport
- Residential buildings
- Industry and business
- Agriculture
- Land Use, land use change and forestry
- Waste management
- Public sector

This aligns closely with the sector definitions employed in the analysed data (DESNZ).

Following methodologies commonly adopted by many government institutions, this report excludes certain sources of energy use. These exclusions may lead to an underestimation of actual energy consumption in Wales. The exclusions are challenging to quantify and include:

1. Gas used for power generation: UK government datasets on sub-national fuel consumption do not include the gas used by power stations for electricity production, as the electricity itself is considered a fuel.
2. Gas used by very large industrial plants: Some of the most significant energy consumers in the UK have their gas consumption omitted from the data sources used in this report to prevent disclosure. However, information is not available on whether any of these plants are in Wales. Emissions from these sites are likely addressed through the UK Emissions Trading Scheme (UK ETS).
3. Transport and aviation: Consistent with the DESNZ methodology, aviation, shipping and electricity for trains and cars are not accounted for in these datasets, as this energy consumption cannot be attributed at a local or regional level.

Data sources

1. DESNZ Sub-national total final energy consumption statistics 2021
2. DESNZ Energy Consumption in the UK (ECUK) 2021
3. StatsWales Workplace employment by industry and area 2019 (UK and Wales)
4. ONS Energy use by industry, source and fuel, 1990 to 2021
5. ONS UK and Wales Census 2021
6. DESNZ Sub-national road transport fuel consumption tables 2021
7. ONS Energy use in the United Kingdom, 1990 to 2021
8. DESNZ Sub-national gas consumption statistics 2021
9. National Gas Transmission Data Portal 2021
10. Actual historic gas load demand as provided by Wales and West Utilities (WWU), 2021
11. DESNZ Sub-national electricity consumption statistics 2021
12. National Grid Live Data by Licence Area, 2021
13. DfT TRA8902: Motor vehicle traffic (vehicle miles) by local authority and selected vehicle type in Great Britain, annual from 1993- 2023
14. Climate Change Committee, Sixth Carbon Budget, 2020

Assumptions

Data is not always available to directly meet the analysis requirements of this report. Where appropriate, additional analysis and modelling is undertaken. This section outlines the limitations of the available datasets and the methods used for supplementary analysis.

Assumption	Source
Land use, land use change and forestry sector (LULUCF)	The LULUCF sector of the Net Zero Wales Carbon Budget 2 covers carbon emissions and sinks associated with land use. The energy consumption associated with this sector is negligible so has been excluded from this study.
Power (generation) sector	Energy consumption associated with the power sector is excluded from this study. DESNZ data on gas consumption excludes gas used in the production of electricity, as those power stations are producing electricity as another 'primary' fuel.
Estimated energy in each Net Zero Wales Carbon Budget 2 sector	Where the sectors in DESNZ energy statistics and Net Zero Wales Carbon Budget 2 do not align, a modelling exercise was undertaken to estimate the energy trends of the Net Zero Wales Carbon Budget 2's sectors. To estimate the disaggregation of DESNZ's 'Industrial and Commercial' sector into 'industrial', 'commercial', 'public' and 'agriculture', the relative energy intensity of those sectors' jobs were used as a proxy to disaggregate their energy consumption, using StatsWales employment data and ONS Energy use data. This analysis was undertaken to a local authority level.
Estimated Welsh domestic energy end uses	DESNZ energy statistics do not split Welsh energy consumption into end uses, such as for heating and appliances. It's assumed that all domestic gas consumption is used for heating (including cooking), but the disaggregation of electricity consumption into heating and appliances is modelled. Domestic electricity consumption is disaggregated by assessing the proportion of homes heated with electricity based on analysis of Energy Consumption in the UK (ECUK) and Census data. The remaining electricity consumption is assumed to be used by appliances.
Estimated Welsh non-domestic energy end uses	To disaggregate non-domestic energy consumption into end uses, ECUK energy end use tables were used to estimate the proportional split of non-domestic gas and electricity fuel use between heat and power applications. The use of other fuels is assumed to be for heat and industrial processes.



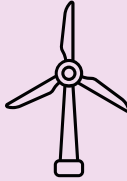

Assumption	Source
Estimated Welsh transport energy use	DESNZ transport energy use was distributed between domestic and non-domestic sectors by applying the proportion of DESNZ sub-national road transport fuel consumption categorised as 'personal' and 'freight' use in Wales respectively.
Unallocated DESNZ energy consumption	DESNZ energy consumption attributed to Wales but not allocated to a local authority has been excluded from this study. Unallocated energy consumption in Wales is estimated to represent <0.2% of total energy.
WWU Welsh temporal gas consumption data	WWU's temporal gas consumption data excludes very large daily metered sites - due to commercial confidentiality.
National Gas transmission data portal	National Gas transmission data was used to understand the seasonal trends in energy use. The total gas use data does not exactly match with the DESNZ gas consumption statistics for Wales due to differences in scope, such as inclusion or exclusion of major energy users.

Abbreviations and 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

A note on 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)

