

BRILLIANT BUILDINGS

CAERPHILLY PASSIVHAUS

Masters of warm

Willmott Dixon delivers the first Passivhaus homes in South Wales for Caerphilly County Borough Council



A NATURAL STEP

With energy prices soaring and the impact on household finances being felt by millions of people, the cost-of-living crisis has become the number-one priority for the government and local authorities.

With this in mind, it's little wonder that Caerphilly County Borough Council (CCBC) chose the Passivhaus approach for its first development of homes in nearly two decades – after all, heating a Passivhaus can cost as little as £1 a day. In so doing, CCBC has become the first council in South Wales to use this ultra-efficient standard for a housing project.

The new development consists of 18 homes – the first tranche in the council's major housebuilding programme – and is split across two sites: Treceynydd and Trethomas. The knowledge gained is now a platform for wider Passivhaus use by the council.

The adoption of Passivhaus is part of a council-wide Decarbonisation Strategy. In 2019, CCBC became the second council in Gwent to declare a climate emergency and commit to becoming carbon-neutral by 2030. Opting for a standard that will mean its new homes barely use fossil-fuel energy was a natural step.

In addition to cutting emissions and investing in energy efficiency measures, the council aims to generate financial and social benefits, such as reducing energy bills for tenants. "We want to offer our tenants homes they can afford to live in and provide the best value for council taxpayers," explains Shayne Cook, CCBC cabinet member for housing. "Passivhaus means we can do just that."

Brilliant Buildings tells the story of this new generation of low-cost, low-energy homes, how they will improve the lives of local people, and how Willmott Dixon helped to make it happen.

Right: The development comprises 18 homes split across two sites. The estimated annual energy cost for each home is £362.

CAERPHILLY PASSIVHAUS: KEY OUTCOMES

1

The average air permeability on both sites is 0.55m³/m²hrs @50Pa, compared with a limit of 8m³/m²hrs @50Pa in Part L of the Building Regulations (2022).

3

The estimated annual energy cost is £362, based on recent EPC cost factors.

5

The homes' energy use is monitored in partnership with the Active Building Centre to ensure they perform as designed.

7

Overall social return on investment:
Target: £652,536
Actual: £1,246,486

2

The average property on site produces one tonne of carbon emissions per year, compared with six tonnes for an average UK household, based on Energy Performance Certificate (EPC) data.

4

The estimated energy used for space heating, which is electrically generated, is 313KWh/a. For hot water, provided by air-source heat pump, it is 1,951KWh/a.

6

11 jobs were created as a result of the scheme.

8

17 suppliers and supply chain partners were based within 20 miles of the site.

Key facts

- Number of sites: **2**
- Number of homes (one-bedroom apartments): **18**
- Completed: **2022**
- Main contractor: **Willmott Dixon**
- Architect: **Holder Mathias**
- Steel frame manufacturer: **Caledan**



IT'S ABOUT MAKING A DIFFERENCE

CCBC is no different to other local authorities in having to tackle acute social housing needs.

The development of 18 new one-bedroom apartments across two sites using the Passivhaus standard was a crucial part of the solution. "This is the start of our plan to deliver 400 affordable homes over the next few years," says CCBC cabinet member Shayne Cook.

Local supply was also important, he adds: "We want to promote local businesses wherever possible. We believe in providing support to our local economy and helping innovative businesses to create jobs and apprenticeships."



"WE WANT TO PROMOTE LOCAL BUSINESSES WHEREVER POSSIBLE. WE BELIEVE IN PROVIDING SUPPORT TO OUR LOCAL ECONOMY AND HELPING INNOVATIVE BUSINESSES TO CREATE JOBS AND APPRENTICESHIPS."

SHAYNE COOK, CABINET MEMBER FOR HOUSING, CCBC



The 18 homes were developed with help from the Welsh Government's Innovative Housing Programme – a funding source for the use of modern methods of construction (MMC) and low-carbon housing.



WHAT IS PASSIVHAUS?

Passivhaus uses proven approaches to deliver net-zero-ready new and existing buildings, optimised for a decarbonised grid. Homes built to the standard provide high levels of comfort while expending very little energy on heating and cooling.

Typical design features include a highly insulated and airtight fabric, coupled with mechanical ventilation and heat recovery (MVHR). This reduces energy use and carbon emissions, while keeping buildings warm in winter and cool in summer. Renewable energy generation is now included in the Passivhaus Plus and Premium assessment, further boosting the standard's net zero credentials.

Passivhaus projects are far less prone to performance gaps than many other building types. Sound design principles, rigorous quality control and a robust certification process, overseen by the Passivhaus Institute in Germany, ensure that designed and as-built performance are closely aligned. At Willmott Dixon, we complement this approach with Energy Synergy™, our own process for monitoring operational energy use against design targets.

How does Passivhaus work?

Passivhaus requires homes to be 14 times more airtight than normal regulations. The homes use "passive" sources for energy, such as sunlight, heat recovered from extracted air, even heat from the occupants themselves.



Passivhaus measures

Achieving Passivhaus accreditation in the UK typically involves:

Accurate design modelling

High levels of insulation

Extremely high-performance windows with insulated frames

Airtight building fabric

"Thermal bridge-free" construction

Highly efficient heat recovery from mechanical ventilation system.

Below: Hot water is provided via a cylinder unit connected to an air-source heat pump.

CHOOSING THE RIGHT PARTNER

On such a pivotal development, it was important for CCBC to work with an experienced build partner.

The council opted for Willmott Dixon, largely due to our long track record in delivering high-profile Passivhaus projects. These include the first, and largest, Passivhaus secondary school, Harris Academy in Sutton, south London, and the largest non-domestic building to reach the standard, the George Davies Centre of Medicine at the University of Leicester. We are also building the UK's largest Passivhaus leisure facility, Spelthorne Leisure Centre in Surrey, for the local district council.

Passivhaus pioneer

Willmott Dixon is a founder member of the UK's Passivhaus Trust, an independent, non-

“TO DELIVER A PASSIVHAUS SCHEME, YOU NEED SIGNIFICANT EMPHASIS ON THE DESIGN, AND A HUGE FOCUS ON THE CORRECT ON-SITE INSTALLATION.”

MAL RICHARDS, SENIOR BUILDING MANAGER, WILLMOTT DIXON

profit organisation that provides leadership for the adoption of the Passivhaus standard and methodology in the UK. It also participates in regular knowledge-sharing events and technical panels, to stay at the forefront of Passivhaus developments. Several of Willmott Dixon's people have now successfully completed Passivhaus training.

Willmott Dixon has its own in-house Passivhaus design team, Collida, and also has a track record of collaborating with experienced Passivhaus practitioners, such as Architype, the UK's best known Passivhaus architectural practice, and WARM, one of the longest established certifiers and training providers.

Below: Completed in 2019, Harris Academy in Sutton was the first Passivhaus secondary school in the UK.



PASSIVHAUS PERSPECTIVES: FIVE STEPS TO SUCCESSFULLY DELIVERING THE STANDARD



“WE MADE PASSIVHAUS AN INTEGRATED PART OF OUR DESIGN APPROACH, USING THE PASSIVHAUS PLANNING PACKAGE (PHPP) AT THE EARLIEST STAGE.”

Martin Bennett, operations manager, Willmott Dixon



1. Airtightness

The minimum requirement is 0.6ACH, which means no uncontrolled airflow between the internal and external environment.



2. Super insulation

A good way of achieving this is by using an insulated raft foundation, as the foundation upstands can align with your external wall insulation.



3. Triple glazing

When specifying windows, ensure internal finishes can terminate against the frame. A minimum frame width of 50mm is needed if two layers of 15mm board are required internally.



4. No thermal bridging

Any significant thermal bridges will need to be assessed to understand the impact on the building. They should be avoided where possible.



5. Mechanical ventilation with heat recovery

The MVHR unit is critical, so position it on an external wall to ensure minimal heat loss through the supply ducting. With high levels of airtightness and insulation, Passivhaus homes are quiet places. MVHR units are relatively loud and tenants may try to switch them off, leading to negative consequences if required ventilation rates are not achieved.



Left: The George Davies Centre of Medicine at the University of Leicester, completed by Willmott Dixon in 2016.

Below: Spelthorne Leisure Centre in Surrey, which is currently under construction.



LOCAL STEEL PROVIDER KEY FOR PASSIVHAUS

Supply chain partners also play a vital role in Passivhaus developments. At Caerphilly, local company Caledan was selected to provide its innovative Primaframe building system. This panellised load-bearing, light-gauge steel frame ticked important boxes. It helped achieve the airtightness required for Passivhaus. It is constructed off-site, thereby offering rapid erection times and accelerated completion. Plus, it was fabricated just seven miles north of the sites, at Caledan's manufacturing centre in Hengoed, making for easy transportation.

Caledan has been a Willmott Dixon supply chain partner for four years, but this was the first time we had used Primaframe. Wall panels measuring up to 3.6m long and 2.9m high were fabricated at the Hengoed factory, before Willmott Dixon's project team assembled the panels on site and managed the final fit-out.

Chris Morton, chief executive officer of Caledan, says that extensive trials were carried out within the factory to determine the most efficient and effective solutions. "These tests revealed that we could eliminate the external airtightness membrane. The manufacturing discipline imposed in the factory was matched on site, with results proving extremely positive."

This has led to new efficiencies, Morton adds. "We are looking at other areas - including manufacturing larger panels and assisting with the drywall specification - to provide even greater efficiencies, while still meeting performance requirements."

Proving its worth

As well as being a testing ground to show that Passivhaus can offer energy-efficient, affordable council homes, the development

has helped Willmott Dixon and its supply chain to gain valuable insight into the method.

"Building to Passivhaus standard has been a continuing journey for everyone involved," says Martin Bennett, Willmott Dixon operations manager. "Most had little experience in working to its demanding tolerances. We needed to reinforce the message that adopting MMC provides robust, energy-efficient buildings that are cost-effective to build and deliver better energy performance."

Now the Passivhaus system is being lined up for CCBC's next housing scheme, 100 homes on the former Oakdale Comprehensive School site. "This pilot programme is a blueprint for future developments," says CCBC's Shayne Cook. "Feedback from tenants that have moved into the Passivhaus homes has been very positive."

"THE QUALITY OF THESE NEW HOMES IS EXCEPTIONAL, AND THEIR INNOVATIVE DESIGN WILL MAKE SURE FUEL BILLS FOR FUTURE TENANTS WILL BE KEPT TO A MINIMUM, WHICH IS CRUCIAL AMIDST RISING ENERGY COSTS AND THE CURRENT COST-OF-LIVING CRISIS."

SHAYNE COOK, CABINET MEMBER FOR HOUSING, CCBC



PASSIVHAUS PERSPECTIVES: CONSTANTLY MONITOR YOUR WORK



Achieving the strict requirements of Passivhaus requires considerable attention. We arranged regular toolbox talks, delivered by consultant WARM, which enabled everyone to understand the importance of getting it right first time. This included explaining the importance of airtightness to achieve Passivhaus, and ensuring we only used approved materials.

WARM visited regularly to check the quality of installation. We constantly monitored the work and had several hold points, each with Quality Method statements. This ensured nothing was finished and covered over until inspected and signed off.

We carried out the air test when the building was watertight, which reassured us that we had identified any potential issues early and at a point when we had easy access to rectify them.

We also set up a dedicated management system to act as a "critical gateway" for document control, ensuring that we had the evidence we needed to achieve Passivhaus.

Mal Richards, senior building manager, Willmott Dixon



Three specialists to use

- 1 Passivhaus consultant.** To undertake the PHPP model and advise on the specification of mechanical and electrical equipment. Early engagement is advisable, as building orientation plays a role in achieving the standard.
- 2 Passivhaus certifier.** To check the Passivhaus documentation, in the same way that BRE checks submissions to the BREEAM environmental rating system.
- 3 Thermal analysis consultant.** All significant thermal bridges need to be calculated, including linear thermal bridges and point thermal load. Walls, floors and roofs need to be well insulated, with no gaps, to reduce the need for heating or cooling to achieve a comfortable temperature.

Left: The light-gauge steel-frame panels measured up to 3.6m long and 2.9m high. They were fabricated at Caledan's manufacturing centre before being assembled on site by Willmott Dixon.

PASSIVHAUS PERSPECTIVES: FOCUS ON THE AIRTIGHT LINE



By moving the airtightness layer to the external skin of the homes at Caerphilly, we simplified the airtightness detailing, which saved time in production.

The external skin – in our case, cement particle board – on light-gauge steel frame was much more robust than equivalent membranes, which can get damaged during construction.

Having the airtight line externally also eliminated the risk of service penetrations through the membrane and saved a service zone – adding useful floor area. Our airtightness layer remained visible and accessible from the outside during testing at shell completion, making it easier to carry out quality assurance checks and sign-off.

Condensation risk was also avoided through the use of externally applied mineral wool insulation. Importantly, the taped cement particle board joints delivered a very airtight structure of, on average, 0.55m³/m²hrs @50Pa.

Doug Drewniak, senior building performance manager, Willmott Dixon

WILLMOTT DIXON DISHES OUT THE HUGS

Living in a house designed and built to Passivhaus standards can have its challenges. Keeping the home warm in winter, cool in summer, sufficiently ventilated yet still reaching its full energy-saving potential can be difficult and requires major changes to occupant behaviour.

Even seemingly mundane things – opening windows, putting up pictures, washing clothes and taking baths – can impact the efficiency of a Passivhaus if simple guidelines are not followed.

“The management and control of airtightness and ventilation is key to the energy-efficient Passivhaus principle,” explains Willmott Dixon’s Martin Bennett. “If they are to gain full benefit from this, occupants need to recognise the impact that some everyday actions have.”

Willmott Dixon’s solution has been to give every tenant a HUG – a Home User Guide – which offers expert advice and guidance on every aspect of living in a Passivhaus home, as well as providing personalised handover demonstrations to each new occupier.



Right: The MVHR units draw in fresh air and vent waste cool air through the facade.

SUPPORTING SOCIAL MOBILITY IN CAERPHILLY

The Passivhaus pilot has not only benefited those now living in the homes. A collaboration between Willmott Dixon and CCBC’s Employment Support Team has helped local residents into work.

Eleven full-time construction jobs were created, with further opportunities for trainees to gain experience on a live construction site. Individuals were mentored through the construction process and given the opportunity to gain experience and recognised construction industry qualifications.

Meanwhile, at two local schools – Bedwas High School and St Martin Comprehensive School – the Willmott Dixon team delivered

team building challenges to help students’ communication skills, while career seminars outlined the diverse roles within the construction industry.

A particular focus was on preparing students for work. This involved informing and engaging students on the recruitment process – explaining not just what they can expect in the day-to-day world of work, but also the socio-economic benefits of employment. “It is part of the Willmott Dixon philosophy to work with the local community to bring real, tangible benefits beyond the site boundary,” says senior social value manager Nicola Millard.



“IT IS PART OF THE WILLMOTT DIXON PHILOSOPHY TO WORK WITH THE LOCAL COMMUNITY TO BRING REAL, TANGIBLE BENEFITS BEYOND THE SITE BOUNDARY.”

NICOLA MILLARD, SENIOR SOCIAL VALUE MANAGER, WILLMOTT DIXON (ABOVE)



Social value outcomes

11 jobs created, including one via the DWP Kickstart programme for a 16-24 year old on universal credit

Overall social return on investment of £1,246,486, nearly £600,000 more than the target figure

11 apprentices and four trainees

Partnership with Careers Wales to deliver social value workshops in local schools

Total spend in Caerphilly of £565,000

10 laptops donated to the local community

Donation of “prepare for work packs”

Donation to support a community event for the Platinum Jubilee, plus donations to local foodbanks and toys at Christmas.

Left and above: Willmott Dixon spent a total of £565,000 in Caerphilly, including donations to local foodbanks.



WILLMOTT DIXON

SINCE 1852

**BRILLIANT
BUILDINGS**

Willmott Dixon is a privately-owned contracting and interior fit-out group. Founded in 1852, we are family-run and dedicated to leaving a positive legacy in our communities and environment. Being a large company means we can create a huge and lasting positive impact on our society. This is not only done through what we build and maintain; it's achieved through the fantastic efforts of our people who make a major contribution to enhancing their local communities.

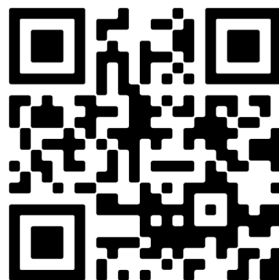
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