



Advanced Construction Technology: Assignment 1

Bryn Bragl Project Review

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Introduction:

This report aims to evaluate the “Bryn Bragl” development in Bridgend, which is a pioneering scheme of 14 homes commissioned by Wales & West Housing (WWH) in partnership with Zenergy Design. DH Consultancy aims to progress toward sustainable construction practices; this review appraises the technical and economic feasibility of the methods used at Bryn Bragl to inform our potential future operational strategy.

The Bryn Bragl development is significant as it’s the first social housing application of the SOLCER (Smart Operation for a Low Carbon Energy Region) house. Originally developed by the Welsh School of Architecture the aim of the project is to exceed the “net-zero” targets by exporting more energy than the property consumes to the national grid. The Solcer standard properties are engineered to function effectively “off grid” during the summer months, relying on on-site generation and battery storage [Cardiff University (n.d)].

To achieve the exceptionally low energy & heating demand “fabric-first” approach has been undertaken. This report aims to evaluate the use Structurally Insulated Panels (SIPs) for rapid and airtight construction [BM Trada 2020] as well as the use of Transpired Solar Collectors, a perforated steel cladding system that pre-heats air before entering a building [Office of Power Technology]. Furthermore, the report will also discuss the “all-in-one” building services strategy, which combines heating, ventilation and hot water into a singular unit [Genvex (n.d)]. The successful replication of these technologies and practices is critical for meeting future legislative carbon targets while maintaining affordability for landlord.

Building Fabric and Construction Methods

To achieve the “energy positive” status –where the development inputs more energy into the grid than it consumes – the design prioritises a fabric first approach [Specific IKC (n.d)]. By undertaking a fabric first approach,

the building envelope is designed to be as effective as possible, reducing energy demand. In order to achieve the energy positive target, the property must achieve near Passivhaus standards of airtightness ($0.6 \text{ h}^{-1} @ 50 \text{ Pa}$) and thermal retention. By eliminating uncontrolled air infiltration and thermal bridging, the reliance on heating systems is reduced. This ensures that the property can operate using the energy generated by solar technologies [BRE (n.d)].

Walls:

The external walls of the Bryn Bragl development are made up of Structural Insulated Panels (SIPs) which is a modern method of construction. SIPs panels are prefabricated panels that consist of two high density facings (usually OSB) bonded to a low-density cellular foam core. SIPs panels have been used as they allow for thermal continuity as unlike timber frame buildings which can suffer from repeating thermal bridging through the solid timber studs, the continuous foam core of a SIPs panel provides a uniform thermal barrier. This ensures a consistent U-Value throughout the wall surface. Due to the energy positive model, the building will rely on Mechanical Ventilation with Heat Recovery. For the MVHR system to be efficient the building must be airtight. SIPs, with their large panel format and prefabricated precision allow for greater airtightness when joints are tape sealed, this helps to prevent draught issues common in masonry construction. Due to their offsite construction SIPs panels are quickly assembled onsite, which helps to reduce the construction time for a weathertight structure. This reduces on-site labour costs and allows for faster on-site construction times when compared to masonry or timber frame [BM Trada 2020 & British Board of Agreement (2021)].

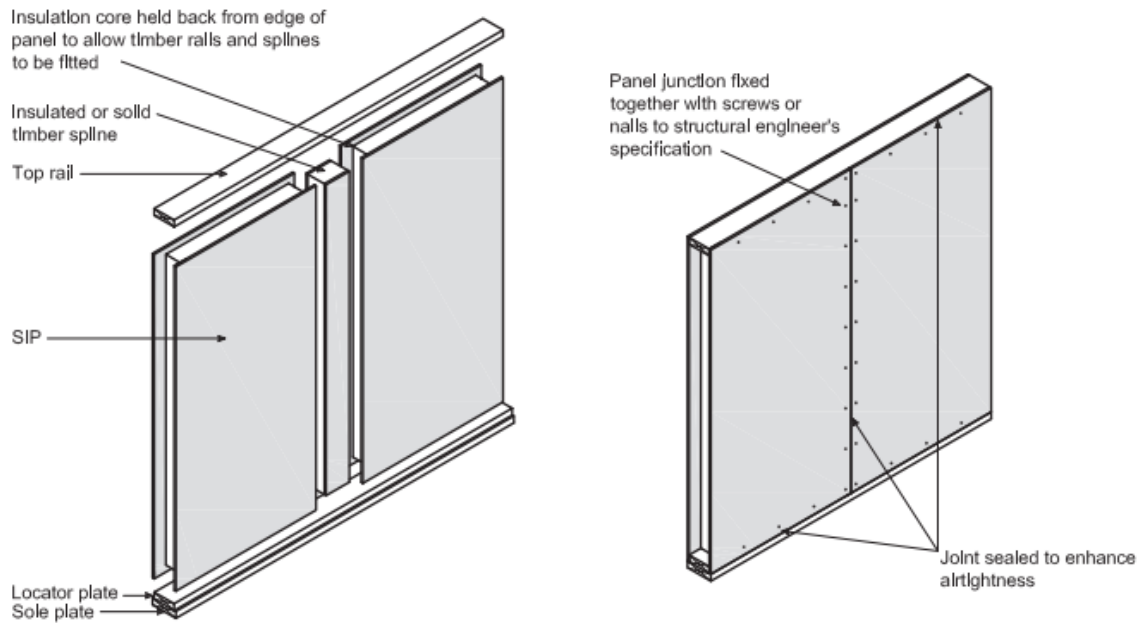


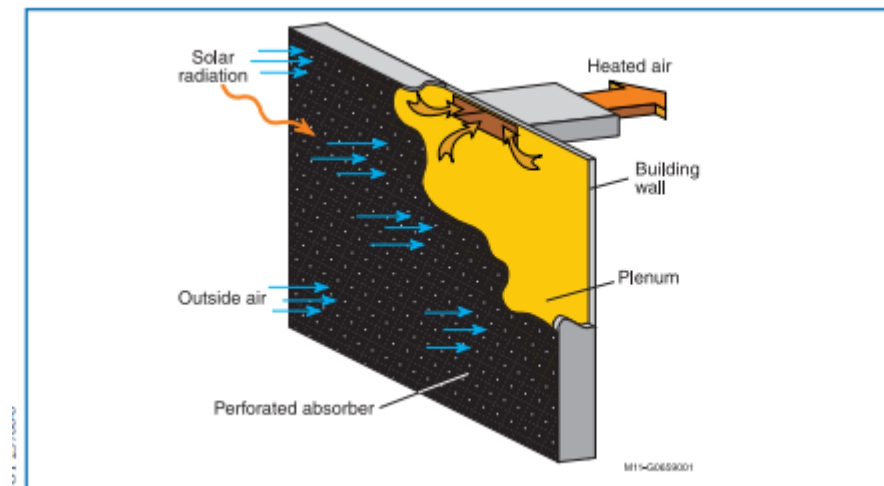
Figure 2: Joining panels

[BM Trada 2020]

External Facade:

A brick facade has been installed to the ground floor on all elevations [Wals & West Housing]. The brick facade offers high durability with a fast construction time which aligns with the choice of SIPs panels [Kingspan (n.d)]. A durable facade also reduces maintenance throughout the building's life span.

The first floor of the south elevation features Transpired Solar Collectors (TSCs), this cladding system uses the solar energy to heat up fresh external air prior to entering the property. This is an example of active building components where the weathering facade also acts an energy generator. The weathering face is made up of a metal cladding system which provides a good durability and allows for the system to be recycled at the end of life [Cladspray Solutions (n.d)].



With the exception of the fans, the transpired collector has no moving parts and requires no maintenance.

[U.S. Department of Energy (1998)]

Roof:

The roof is made up of photovoltaic cells (PV), unlike traditional PV panels where the panel are mounted to the structure, Bryn Bragl uses panels integrated into the roof structure [Federation of Master Builders (n.d)]. This system provides a more desirable aesthetic with its standing seam design when compared to traditional PV systems. Additionally, due to the integration within the roof structure there are less potential failure points for leaks when compared to traditional PV systems, as the mounting hardware is fixed to the roof covering [Pester, S. (2012)]. This method reduces material usage by removing the need for a roof covering beneath the PV system, this helps to reduce the embodied carbon of the project and helps to reduce the load on the roof members helping to reduce their size and cost.

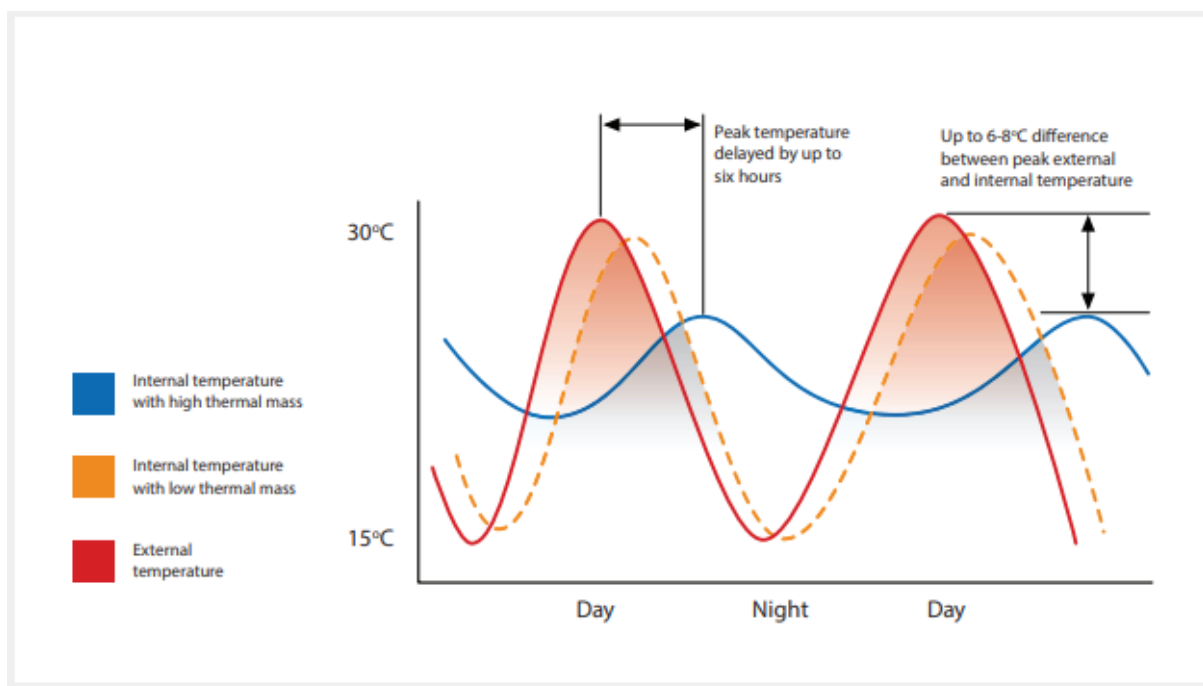
Windows & Doors:

The windows & doors at the Bryn Bragl developments are Aluminium Clad Timber (composite) units. These windows are made up of timber internally, with aluminium cladding externally to act the as weathering face. Due to the make-up of these windows/doors, they have long lifespans with minimal maintenance which is beneficial to the landlord throughout the property's lifecycle. Additionally, the timber core & aluminium external are 100% recyclable further helping to reduce the embodied carbon of the development [Idealcombi (n.d)]. The use of triple glazing further aligns the

property with its fabric first approach, due to the higher performance over double glazing. Triple glazing also benefits from a reduction in external noise as well as reducing solar gain helping to prevent overheating during the summer months [Glass and Glazing Federation (2016)]. By reducing solar gain to prevent overheating, reducing noise pollution within the property and outperforming double-glazed window occupant comfort is increased, this is seen as one of the core principles of an Active Building [Specific IKC (n.d)].

Floor:

The ground floor used throughout this development is a traditional insulated concrete slab, this is beneficial to the development due to the high thermal mass of a concrete slab, this allows it to store energy during the day and release energy during the night helping to regulate temperature [de Saulles, T. (2019)].



[de Saulles, T. (2019)]

In a high performance building thermal bridging should be considered to help prevent heat loss, this can be achieved by linking the insulation detail between the wall & floor as shown in the below figure.

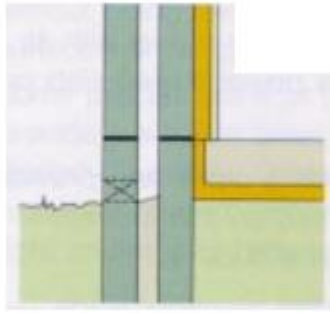


Figure 3 Strip of vertical insulation
overlapping or linking with wall insulation [BRE 2001]

The first floor is made up of open web joists; due to the large diameter ducting required for the Genex Combi 185 system (125-165mm) [Genex (n.d)] a service duct would be required between the joists and ceiling on a traditional suspended timber floor, however with the posi-joist system the ducting and any additional M&E services can be run between the joists. Additionally, these joists allow for longer spans compared to traditional timber joists. This construction is common for high-performance housing as it allows for MVHR ducting and additional insulation between levels [Donaldson Timber Engineering (2024)].

Active Technologies

This Bryn Bragl development is an example of an active building, this is defined as a smart energy generating structure that aims to manage energy, support the grid, optimise occupant comfort and be net positive [Specific IKC (n.d)]

While the high-performance fabric succeeds in minimising thermal demand, the energy positive goal is realised through the whole system approach to both generation and storage. Unlike traditional construction where the systems work independently of each other this development utilises an integrated suite of technologies like Transpired Solar Collectors, BIPV, Heat pumps and mechanical ventilation systems to work in a symbiotic relationship to effectively heat, ventilate and power the home.

Transpired Solar Collectors:

The most distinctive feature of this development is the use of Transpired Solar Collectors (TSC). This system formed the cladding on the first floor of the buildings. The cladding consists of a perforated steel sheet installed with a cavity between it and the structural wall. Solar radiation heats the surface of the steel cladding heating up the within the cavity. This pre-heated air is then drawn into the building's intake, helping to increase the efficiency of the Genvex Combi 185 System.

The TSC also helps to increase the coefficient of performance for the heating system within the property. By increasing the temperature of external air by ~10 Degrees Celsius the heating system expends less energy bringing this air up to comfortable internal temperatures, therefore also reducing the energy consumed by the onsite generation. The use of TSCs also shows how a fabric first approach can heavily reduce the load on the heating systems in the property. This is also an example of active building components, as the facade acts as a weather shield and an energy generator [U.S. Department of Energy (1998)].

Integrated PV System:

This development also utilises integrated PV panels within the roof, which unlike traditional PV panels replace the roof covering. The standing seam system allows the PV panels to integrate within the roof structure; this creates a more pleasurable aesthetic when compared to traditional PV panels that are mounted directly to the roof covering. Additionally, the standing seam system increases weather tightness as no fixings are made to the roof covering, this is beneficial to the landlords it reduces potential maintenance from leaks during the properties lifespan [Pester, S. (2012)]. This method reduces material usage by removing the need for rood covering that the PV panels would usually be mounted to, this further helps to reduce the embodied carbon of the property.

The PV is used in conjunction with a Tesla Powerwall 2; this allows for the power generated by the PV panels to be stored. This benefits the tenant by giving them the ability to control when the solar power is used.

Heating, Ventilation & Hot Water:

The development uses a Genvex Combi 185 System for heating, hot water and ventilation. This single system approach helps to reduce wasted space within the property. The MVHR system is used to extract stale humid air from wet rooms (kitchen/bathroom) and supplies fresh air to living spaces whilst recovering 95% of heat from exhaust air, this is important for this development as it's high airtightness requires constant air movement to prevent damp and mould issues occurring within the property helping to improve occupant health [Passivhaus MVHR guidance]. Additionally, as this development is being used as social housing an MVHR system greatly reduces the risk of damp issues within the property, with Awaab's Law coming into effect in England in October 2025 public authorities should seek to further reduce the risk of these issues within their properties [Ministry of Housing, Communities & Local Government (2024)].

The unit contains a Micro Heat Pump; this removes the need for an external air source unit. The heat pump extracts residual energy from the warm exhaust air and the pre-heated air from the TSC to heat the domestic hot water system. The unit also contains a 185L hot water cylinder ensuring that the heat generation and storage are thermally coupled [Genvex (n.d)].

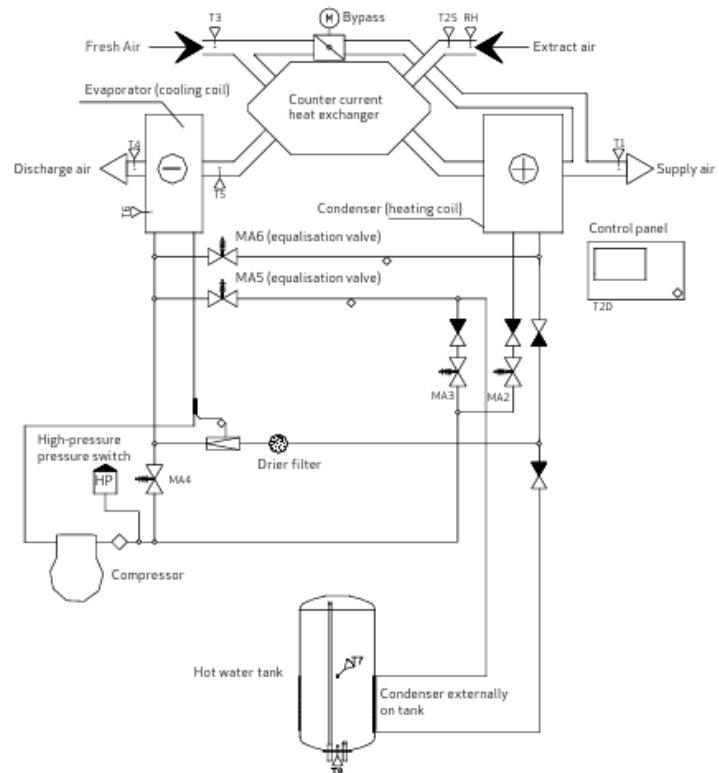
Functional diagram

Sensors

T1: Supply air
T2D: Room display
T2S: Extract air
T3: Fresh Air
T4: Discharge air
T5: Before cooling coil
T6: Cooling coil
T7: Tank, top
T8: Tank, bottom

Solenoid valves

MA2: Roomheating
MA3: Domestic hotwater heating
MA4: Defrost evaporator
MA5: purge valve (roomheating)
MA6: purge valve (DHW)



[Gonvex (n.d)]

Solar Battery:

To bridge the gap between peak solar generation and peak demand, the development uses Tesla Powerwall 2 units. These units store up to 13.5kWh of electricity allowing the property to store energy during the day when solar gain is at its highest and use the electricity in the evening when electricity is most expensive [Tesla 2019]. This unit allows the Genvex system to run off grid during busy times and allows for electricity to be stored and sold back to the grid if not used [Department for Energy Security and Net Zero (DESNZ) (2023)]. With WHQS23 stating that all social housing should be affordable to live in the use of the battery store helps to greatly reduce electrical bills in the property and reduces the cost of heating the property due to the supply to the Genvex Combi 185 System [Welsh Government (2024b)].

Critical Evaluation

Design Intent & Operational Reality:

A review of the planning register for the Bryn Bragl development reveals a contradiction between the project's energy positive intent and its operational reality. While the initial SOLCER concept specified an all-electric strategy reliant on the Genvex & TSC systems, some of the Bryn Bragl developments have since had gas fired boilers retrofitted [Bridgend County Borough Council (n.d.)].

This alteration to the properties undermines the energy positive principle that the development set out to achieve [West & Wales Housing]. The original model assumed all loads from the internal systems would be electrical and covered by the PV generation to achieve a positive export. The reintroduction of fossil fuels means the homes are no longer off-grid capable for heating, therefore increasing the operational carbon footprint.

This decision is likely due to the operational performance or costs of the development; this could be due to the unfamiliarity of the cutting-edge technology used within the development. Additionally, if the TSC system fails to adequately deliver comfortable temperatures on fresh air into the property the electric only system will have an increased load, potentially leading to high grid import costs to the tenant. A gas boiler acts as a more familiar and traditional method of heating, ensuring that the tenant can operate the system more comfortable despite compromising the project's sustainability goal.

Performance Gap and User Behaviour:

The success of an active building model is always threatened by a performance gap. This is the disparity between modelled energy efficiency and actual usage [Zero Carbon Hub 2014].

The efficiency of the MVHR and TSC systems rely on the building envelope remaining sealed. If tenants, who are accustomed to traditionally constructed properties, they may open windows to allow for ventilation during heating periods, the heat recovery cycle is broken.

Post occupancy monitoring of the original SOLCER prototype house identified that some occupants heated their homes to 24+ Degrees Celsius, significantly exceeding the designed 21 Degrees Celsius

modelling assumption [Li, X., Ester, C.B., Perisoglou, E. and Patterson, J. (2020)]. This demonstrates that while the systems can deliver a zero-bill property, tenant behaviour is the critical variable. Future phases would benefit from a soft-landing approach (BSRIA 2018) to ensure tenants are adequately trained to operate these complex systems.

Buildability and Skills Shortage:

From a construction management, the Bryn Bragl development introduces supply chain risks compared to traditional construction methods. While SIPs panels offer rapid offsite assembly, they require tight tolerances for the airtightness tape and jointing to correctly function (BM Trada 2020). Unlike masonry, where errors can be corrected onsite, defective SIPs panels can compromise the critical path of the project and airtightness of the structure.

The integration of BIPV roofing systems and TSC cladding systems moves the build away from traditional trades and moves toward specialist sub-contractors. This increases the risk of delays if these specific supply chains are disrupted. This factor must be weighed against the speed of timber frame erection.

Economic Viability:

The development highlights the tension between capital expenditure and operational expenditure in social housing. The inclusion of Tesla Powerwalls, Genvex units, BIPV roofs and TSC cladding systems significantly increase the build cost per square metre compared to a standard Approved Documents Part L compliant home [Welsh Government (2024a)].

On the other hand, for a Social Landlord like Wales & West Housing the return on investment is calculated over the property's 60-year life span. By effectively eliminating fuel bills, the energy positive model reduces the risk of tenant falling into rent arrears due to fuel poverty [Department for Business, Energy & Industrial Strategy (BEIS) (2021)]. Therefore, this model is viable for a social landlord who will retain the asset; however, the high upfront costs remain a barrier for private developers.

Conclusion:

Summary of Findings:

The Bryn Bragl development serves as a critical case study in the transition from net-zero to energy positive social housing. This report concludes that the success of the project is not defined by any single technology, but by undertaking a holistic approach full system approach. The integration of SIPs fabric with active generation (TSC/PV) and storage.

The fabric first approach minimises heating demand, allowing the low-output Genvex/TSC systems to theoretically function without national grid support during standard conditions. However, as gas boilers have been retrofitted shows evidence of a performance gap potentially due to tenant behaviour. This shows that the energy positive status is fragile as it relies as much on tenant lifestyle as it does on the design.

Recommendations for DH Consultancy:

Based on this report the following recommendations are made for future developments of this nature:

- The transition to SIPs panels should be prioritised, due to the high performance, reduced on-site construction time and airtightness performance offers commercial benefits and aligns with upcoming future homes standard regulations [Future Homes Hub 2025].
- Building Integrated Photovoltaics should replace the standard roof tiles on future high-performance developments. The standing seam method is now a mature, robust technology that retains performance whilst reducing long-term maintenance liabilities.
- The Genvex/TSC system, while efficient, introduce significant complexity and supply chain risks. It is recommended that we do not adopt these for general housing stock. Instead, we should prioritise Air Source Heat Pumps and traditional MVHR systems which are more familiar to the UK supply chain and tenants.

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