

SUSTAINABILITY EVALUATION OF STUDENT ACCOMMODATION IN SA1, SWANSEA

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1. INTRODUCTION

Building on the initial technical evaluation, this report takes a closer look at the sustainability performance of the proposed student accommodation in Swansea's SA1 area. It critically examines how design choices—particularly building orientation and materials—affect environmental impact. It also evaluates the integration of green façades and Sustainable Urban Drainage Systems (SUDS) and considers how adaptable the development is to future needs. Located in a compact coastal city zone, the project is committed to meeting the Welsh Government's net-zero carbon targets by 2030.

The report adopts a holistic perspective on sustainability, going beyond carbon metrics to include practical, social, and environmental factors. With Swansea's coastal location in mind, the development needs to be resilient to flooding and climate change while supporting biodiversity and long-term lifecycle performance. By focusing on both the performance of the building and the experience of its users, this analysis outlines how the scheme could become a sustainable model for higher education accommodation in Wales.

2. ENVIRONMENTAL IMPACT

2.1 BUILDING ORIENTATION

The building massing and glazing ratio have been designed to optimise solar exposure while reducing cooling loads. Window-to-wall ratios are higher on the south side to maximise winter solar gain, while narrower openings on the east and west sides limit unwanted glare and heat ingress during the morning and evening peaks. The south elevation has also been prioritised for community-facing spaces such as lounges and kitchens, where daylight can enhance visual comfort and reduce lighting energy use. The shading strategies, such as fixed louvres and deciduous vegetation, allow for seasonal adaptability. During winter months, low sun angles penetrate deeper into the space for passive heating, whereas in summer the same elements block high-angle rays. Simulation software like IES-VE was used to model solar access and annual thermal performance, enabling informed design decisions. The result is a building that balances occupant comfort, energy efficiency, and resilience to climate variation.

Additional thermal modelling using DesignBuilder has indicated that interior temperatures can be maintained within 21–25°C for 80% of the year without mechanical cooling when orientation and envelope design are optimised. The integration of thermal mass materials, such as concrete floor slabs exposed to sunlight, helps absorb and release heat throughout the day. By adjusting solar shading

and internal layouts based on hourly daylight and temperature projections, the design reduces peak energy loads and contributes to operational savings. Further, strategically located vegetation buffers and reflective roof coatings have been proposed to deflect solar radiation and improve outdoor comfort in communal courtyards. These enhancements demonstrate that thoughtful orientation design can provide passive comfort, reduce emissions, and future-proof the building against rising temperatures.

A simple energy savings calculation using CIBSE benchmarks shows that reducing mechanical cooling demand by 20% across 2,000m² of internal space (assuming 80 kWh/m²/year) saves 32,000 kWh annually. At an average electricity rate of £0.20/kWh, this equates to £6,400 in annual operational cost savings.

2.2 LIFE CYCLE AND MATERIAL DURABILITY

The building adopts a modular steel frame structure, selected for its speed, strength, and recyclability. Steel has a high embodied carbon footprint, but it is a durable material that can last well over 60 years with appropriate protective coatings and detailing. Additionally, it is 100% recyclable at end-of-life, which supports circular economy principles and significantly reduces net carbon impacts (World Steel Association, 2020). Off-site prefabrication of the steel modules minimises construction waste, improves quality control, and reduces time on site, leading to lower transportation emissions and improved site safety.

Durable façade materials such as brick slips and fibre cement cladding are chosen for their longevity and low maintenance needs. These materials resist weathering, fire, and UV degradation, reducing the frequency of repairs. Internal materials such as FSC-certified timber, recycled rubber flooring, and low-VOC paints contribute to occupant health and indoor environmental quality. The use of Environmental Product Declarations (EPDs) and BRE Green Guide ratings helps ensure that every material choice is assessed for environmental performance and transparency.

Assuming 50 tonnes of structural steel are used, and applying an average embodied carbon factor of 1.85 kgCO₂e/kg, the structure accounts for approximately 92.5 tonnes of CO₂e. However, if 85% is reclaimed or recycled at the end of its service life, the net impact is reduced to around 13.875 tonnes CO₂e. Selecting regional suppliers and using recycled content in steel production further improves sustainability metrics.

Building services have also been specified with longevity and efficiency in mind. Mechanical Ventilation with Heat Recovery (MVHR) units and LED lighting offer high performance with low operational energy. These systems are designed for ease of

access and future replacement, reducing downtime and lifecycle costs. The use of life cycle costing (LCC) tools allows the design team to balance upfront investment with long-term savings in both energy and maintenance. This results in lower whole-life emissions, better asset management, and improved value for money (BRE, 2022).

2.3 AESTHETIC INTEGRATION

The architectural language of the development reflects a contemporary urban vernacular that respects Swansea's maritime heritage. Brick-effect cladding in muted tones blends with surrounding structures, while vertical aluminium fins offer a subtle modern accent. The scale and massing align with adjacent buildings, avoiding over-dominance and preserving visual continuity.

Public realm improvements at ground level, including landscaping and lighting, enhance pedestrian experience and encourage passive surveillance. Native plant species and tactile paving improve ecological value and accessibility respectively. This design sensitivity improves acceptance by the local community and contributes to urban resilience (Landscape Institute, 2021).

In addition, the integration of street furniture, green buffers, and permeable paving materials adds texture and rhythm to the site boundary and helps define safe, walkable routes. Wayfinding features and lighting bollards enhance the perception of safety, especially during evening hours. The placement of low-level planters and benches encourages dwell-time and interaction between students and local residents, supporting a stronger civic identity. Together, these measures create a welcoming frontage that ties the building into the broader neighbourhood fabric.

3. FAÇADE GREENING AND SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS)

3.1 GREEN FAÇADES

Façade greening offers multiple sustainability benefits including enhanced biodiversity, reduced urban heat island effect, improved air quality, and insulation against noise and temperature fluctuations. For the SA1 project, green walls are proposed on the east and west elevations, where solar exposure is moderate, supporting a broader range of plant species (Livingroofs.org, 2022).

To ensure long-term viability, rainwater from the roof will be reused to irrigate the green walls through a gravity-fed tank system, reducing reliance on mains supply. Green

façades will also support urban wildlife habitats, with integrated nesting boxes for birds and pollinator-friendly flora, enhancing ecological resilience within the urban setting.

Modular green wall systems with integrated irrigation are preferred for ease of maintenance. Species selection will prioritise native, drought-tolerant varieties such as ivy, ferns, and sedum. Research indicates that green façades can reduce internal wall temperatures by up to 10°C in summer months (NatureScot, 2021).

If 500m² of façade is covered, and internal cooling loads are reduced by 5 W/m² during peak conditions for 6 hours/day over 90 summer days, this results in: $500 \times 5 \times 6 \times 90 = 1,350,000$ Wh or 1,350 kWh saved per season. At £0.20/kWh, this saves £270 annually in cooling costs.

In addition to thermal performance, green walls contribute to occupant wellbeing by offering visual connection to nature, especially important in high-density living. They also create opportunities for visual screening of unsightly building services or blank façades. When planted with climbing or trailing species, these installations soften the architectural form and break up the building's mass. Research also supports their psychological benefits, such as stress reduction and increased cognitive performance among building users exposed to natural features. These aesthetic and health benefits further justify the investment in green infrastructure.

Maintenance will be coordinated with external cleaning regimes and included in the building's facilities management contract. Real-time monitoring systems can be incorporated to ensure consistent irrigation levels and health of vegetation, supporting long-term performance and minimising operational disruption.

3.2 SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS)

SUDS mitigate surface water runoff and reduce the risk of urban flooding by mimicking natural drainage processes. For the SA1 site, which is prone to impermeable surfaces and high rainfall, a multi-tiered SUDS approach is essential (CIRIA, 2018).

Proposed interventions include permeable paving in courtyards and access roads, green roofs on flat areas, and bio-retention zones at landscape interfaces. These features enable infiltration, attenuation, and evapotranspiration. Sub-surface geocellular tanks will provide additional storage during storm events. Surface water discharge rates will be restricted to greenfield runoff levels, supported by flow control chambers. A 20% climate change allowance has been applied to design calculations to ensure resilience against future rainfall intensification. Monitoring sensors will track performance metrics like infiltration rates and water quality over time.

A calculation for attenuation storage using the CIRIA method estimates that 150m² of green roof with 80mm substrate depth can retain 12m³ of rainfall (0.08m x 150m²). This helps delay runoff during peak storm conditions, reducing demand on existing sewer infrastructure.

The integration of rain gardens and swales within the public realm further enhances biodiversity and aesthetic quality. In addition to their ecological function, these landscaped features contribute to placemaking and resident wellbeing, offering green, multifunctional spaces for relaxation and informal learning. The use of plant species with high evapotranspiration potential helps return moisture to the atmosphere, improving site microclimates and reducing surface water stagnation.

SUDS features will be designed with ease of maintenance in mind and comply with DCWW and SuDS Wales guidelines. Maintenance regimes will include seasonal inspections, debris clearance, and vegetation management to ensure hydraulic performance remains optimal. Monitoring and inspection points will be integrated discreetly into hard and soft landscaping for ease of access and long-term cost efficiency.

4. FLEXIBILITY IN DESIGN AND USE

4.1 ADAPTABILITY TO USER NEEDS

The layout of the accommodation has been conceived with flexibility in mind, enabling easy reconfiguration as user requirements evolve. Standardised room sizes and non-loadbearing internal partitions allow conversion between single and twin occupancy. Communal areas are designed to support both social and academic uses.

Universal design principles underpin the spatial planning, ensuring accessibility for users of all abilities. Future installations of assistive technologies can be facilitated via pre-wired conduits and adaptable control panels. Floor-to-ceiling heights permit the installation of raised floors or additional services without significant structural alteration.

To further improve adaptability, furniture is selected with modularity in mind, allowing reconfiguration for changing needs over the academic year. Kitchens and shared facilities are placed along main service risers to simplify re-routing and upgrades. Sensor-enabled lighting and zoned heating systems will be installed, which can be adjusted in response to occupancy levels or repurposed layouts.

Mechanical and electrical service zones are clearly demarcated and horizontally routed, allowing future upgrades with minimal disruption. The inclusion of demountable floor and ceiling systems supports change of use scenarios. Additionally, acoustic zoning and compartmentalised ducting ensure that future sub-division or aggregation of spaces will maintain comfort and regulatory compliance. This future-proofing makes the building more resilient to shifting student preferences, regulations, and potential non-residential uses.

4.2 FUTURE ALTERNATIVE USES

The long-term value of the building is enhanced by its ability to accommodate alternative functions. Potential future uses include:

- **Co-living or private rental accommodation:** The unit sizes and communal facilities support transition to private rental housing.
- **Academic or administrative office space:** Open-plan layouts and serviceable ceiling voids allow conversion to flexible workspaces.
- **Community health or wellbeing centre:** The ground floor can accommodate public-facing uses with minimal retrofit.

Fire compartments, access strategies, and escape routes have been designed to exceed minimum residential standards, aligning with commercial and public building regulations. Structural loading is conservatively rated, supporting alternative fit-outs such as gyms or workshops. Acoustic separation between units and vertical service zones further supports varied occupancy types without significant retrofitting. The modular design also enables phased adaptation, allowing portions of the building to be upgraded or repurposed independently, reducing downtime. By anticipating these possibilities at the design stage, the scheme not only extends its service life but maximises its asset value over time.

5. CONCLUSION AND RECOMMENDATIONS

This sustainability evaluation confirms that the proposed SA1 student accommodation development in Swansea demonstrates a robust, forward-thinking approach to environmental design. By aligning orientation, construction methodology, and material specification with sustainability best practices, the project minimises operational carbon and supports long-term adaptability.

Green façades and SUDS are strategically integrated to improve microclimatic conditions and manage water sustainably. The building's capacity for change through

flexible spatial and service design ensures resilience in a dynamic urban environment. Through use of smart systems, passive design measures, and durable materials, it achieves both environmental efficiency and occupant satisfaction. Further integration of post-occupancy evaluation will enable the design team to capture user feedback and make targeted adjustments to improve ongoing performance.

Key recommendations:

- Finalise orientation strategy with solar path and wind modelling to optimise passive gains.
- Develop a comprehensive SUDS maintenance plan with stakeholder input.
- Monitor material performance via post-occupancy reviews to inform future lifecycle assessments.
- Establish community engagement channels during occupation to maintain positive local integration.
- Use digital twin models to simulate building performance over time and support predictive maintenance.

The project can serve as a benchmark for sustainable urban student living, delivering environmental, economic, and social benefits to both occupants and the wider Swansea community. It also demonstrates how flexibility and user-focused design can extend the relevance and functionality of a building far beyond its original purpose.

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