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MINISTERIAL ADVISORY GROUP
ARCHITECTURE AND THE BUILT ENVIRONMENT
FOR NORTHERN IRELAND

MAG Sustainable Futures Series

MAG Reviews and the Largest Passive House Premium Building in the World - South West College, The Erne Campus

Introduction

This autumn will see the United Kingdom host the 26th United Nations Climate Change Conference, also known as COP26.. It is scheduled to be held in the city of Glasgow, Scotland from 31 October to 12 November 2021 under the presidency of the United Kingdom. This will all be against the backdrop of the recent publication of the first instalment of the Intergovernmental Panel on Climate Change (IPCC) sixth assessment report, which stated that unless there were immediate, rapid and large-scale reductions in greenhouse gas emissions, limiting Global Warming to close to 1.5°C (or even 2°C) will be beyond reach.

The United Nations has advocated the Passive House standard as a mitigation measure to reduce the significant contribution (~40%) to carbon emissions from buildings. There is continued usage growth for this standard worldwide, including the United Kingdom with almost 60 local authorities, housing associations and cities leading the way in adopting and implementing it. These include Exeter, Norwich, Norfolk, Manchester, Glasgow, and Birmingham to name a few.
The prestigious Royal Institute of British Architects (RIBA) Stirling Prize last year was awarded to a Passive House social housing development called Goldsmith Street and there are 20 UK Passivhaus certified educational buildings, including schools, colleges, and University buildings.

The publication of the 'New Decade New Approach' deal in January 2020 outlined a commitment from the Northern Ireland Executive to tackle Climate Change head-on with a strategy to address its immediate and long-term impacts, along with the introduction of legislation and targets for reducing carbon emissions in line with the Paris Climate Change Accord. This is a welcome commitment and if delivered will also address the persistent prevalence of fuel poverty in Northern Ireland.

South West College (SWC) is at the heart of the communities of Tyrone and Fermanagh. The College is physically represented at campuses in Cookstown, Dungannon, Enniskillen and Omagh. The College employs over 500 full-time and part-time staff servicing some 14,000 enrolments with a turnover of £40m and makes a major contribution to the local and regional economies.

South West College do this by providing independent, expert advice on development proposals to facilitate the planning process and deliver results that consider our built environment holistically.

Figure 1: The Erne Campus in Enniskillen – the largest Passive House Premiu*m Building* **in the world.**

The new Erne Campus replaces an existing campus building located at Fairview, Enniskillen. The existing multi-storey building was built in 1971 and has a D energy rating. This 50-year-old campus uses 152 kWh/m^2/year for heating alone. The building is heated with oil and uses approx. 100,000 litres a year costing ~£51,000.00.

The Erne Campus is the second Passive House project for the College, the first being the award-winning CREST Pavilion completed in 2016. The success of this initial scheme was the key to the decision for South West College to strive for Passive House Premium at Erne Campus. The brief was to achieve a building with world class teaching and learning facilities. The college felt it was incumbent on them to act on the Climate Change imperative to aim for the highest international environmental standards in sustainable innovation and design through by implementing Passive House Premium and BREEAM Outstanding.

It was at Concept Stage when the project team undertook the Design Briefing and Design Review process provided by the Ministerial Advisory Group (MAG).

Essentially, this is a process of engagement, affording a platform for timely input of informed, independent expertise into the initial decision making and later design process in order to promote design excellence.

Initially, this was with the Briefing Review which is a process of engagement at project inception stage. This assists in the identification of the potential within a project beyond those issues that might not be immediately apparent to the project's promoters. This was then followed by a briefing workshop and a Design Review which is a collaborative non-adversarial platform which supports the design process through timely expert independent inputs. There were three of these in 2016 to help refine the project and pave the way to such a successful outcome.

The panel appreciated and encouraged the enlightened approach to brief development, sharing of facilities, re-use of the listed building and sustainable building methods, and encourage the Project Team to follow through on aspirations towards sustainable transport.

The Independent Gateway Review Team brought recommendations to the Project Board to support the construction of the building to the highest available environmental standards of PassivHaus Premium and BREEAM Outstanding. The Gateway review panel recommended that SWC Update the Outline Business Case to fully reflect the growing significance of PassivHaus and BREEAM Outstanding to the success of the Project.

The site was a former hospital, which faces south, and the site topography has informed the placement of a four-storey atrium which provides the circulation space within the building. The building can accommodate 800 full-time equivalent students and 120 staff. The concept is a contemporary lightweight transparent building facing south towards the town and the River Erne with a solid North/East/West wrap-around elevation with blue brick panels and glazing.

Building Envelope

The building envelope of the Erne Campus is excellent and in Passive House employs the fabric first approach to sustainable construction. The total thermal envelope of the building has an average thermal U-value of 0.35 W/m^2K, which includes the U-value of the windows installed. The proportions of the envelope are as follows:

TABLE 1: Building Element proportion percentage and corresponding U-Value

BUILDING ELEMENT	PROPORTION OF THERMAL ENVELOPE	U VALUE [W/M2K]
Floor	27.8%	0.11 W/m^2K
Roof	27.8%	0.15 W/m^2K
Windows	26.8%	0.85 W/m^2K
Wall	17.6%	0.15 W/m^2K

An important aspect of quality assurance in the thermal envelope was the careful, detailing and planning of the thermal bridges, particularly in the steel frame connection to the foundation/floor. There has been just less than an astonishing 4.5km(km?) of thermal bridging which was assessed in the software and the heat loss mitigated with an average Psi Value at 0.07 W/mk. In the structural steel frame, a thermal break had to be inserted at the point where it crossed the thermal envelope in order to mitigate the effect of the thermal bridging. The fixings for the steelframe to the foundation also employed a thermal separation coupled with surrounding insulation in the subfloor.

The airtightness target for the project was an n50 of 0.3 Air Change Rate (ACH) which is even lower than the Passive House limit of 0.6 ACH. This lower n50 target for airtightness is to take advantage of the favourable surface area to volume (SA/V) ratio for a large building c.4,000 m^3. The airtightness system employed on this project is a membrane and tape system applied on the warm side of the construction. The result came in at 0.36 ACH at 50 Pascals of Pressure.

Ventilation

The ventilation strategy is mixed-mode, employing both mechanical and natural ventilation systems.

SUPPLY AIR

Fresh air from the atmosphere enters a free-standing filter bank located in the external Courtyard, a minimum of 20m away from sources of pollution. Filtered air leaves the filter bank and enters a matrix of conductive underground pipes / ducts. Heat or coolth from the ground is transferred to the fresh air within the pipes, which provides free preheating of air up to 8°C in winter and free cooling to 19°C to 21°C in summer. This filtered treated air is then passed into an Air handling unit in the plant pods. Here the air is filtered again and heated if required via a thermal wheel heat recovery system within the Air handling unit. When the air leaves the Air Handling unit, it is distributed throughout the floor void to supply air for occupants to breathe in all occupied spaces of the college. The desired quantity of air is rationed via VAV boxes that decide based on temperature or CO2 levels when to reduce air flows or when to increase air flows to the occupied spaces.

EXTRACT AIR

Hot stale air from the classrooms leaves via wall and ceiling mounted transfer grilles and makes its way into the atrium space. Extract ducts remove this air from the atrium and return it to the air handling unit it was originally supplied from via return ductwork. When the return air gets back to the Air handling unit in the pod it came from, this stale warm air is passed through the same heat exchanger mentioned previously to temper the incoming air (without contaminating the incoming air as the air streams do not mix) and then it is exhausted to atmosphere. The cycle then continues.

HRUS (HEAT RECOVERY UNITS)

On the third floor, heat recovery units are utilised. Intakes and exhausts are located 10m away from each other to avoid cross flow. The intakes are located 20m away from sources of pollution. The rooms are brought up to temperature by the radiator heating system. Whilst getting up to temperature and prior to occupation, the HRUs are operated in re-circulation mode for approximately 20 minutes until the return air returning to the HRU is at room temperature. At this stage, the HRU brings in the outside air and the heat recovery process can commence as the room air exhaust is at a temperature that it can temper the incoming air.

ATRIUM (NATURAL VENTILATION)

The atrium is ventilated by natural means with motorised opening vents at high level, which are connected to the BMS and can be opened automatically when temperatures dictate or by the user (Facilities Manager) of the BMS.

At approximately 30 m^3/h per person, the ventilation has been designed to meet the

passive house specifications for hygienic air change. This is classified as IDA3 according to the DIN EN 13776. This ensures a high air quality of approximately 600 - 1,000 ppm/ CO2 /m^3 at velocities where the noise levels in the room remain inaudible. This ventilation system also corresponds with the latest best practice regarding Covid control and mitigation through quality assured ventilation.

The frequency of overheating events is generally regarded as a good indicator of the summer comfort in buildings. The passive house standard requires the indoor temperature to not exceed 25°C for more than 10% of the year, i.e. 876 hours. The lower the frequency with which 25°C is exceeded, the greater the level of comfort. Less than 5% is good practice. Overheating frequency was assessed at 2.6% for the Erne Campus.

Heating

The heating system is a combination of a bio-oil micro-CHP unit producing 80% of the space heating demand as well as 100% of the DHW demand and finally an air to water heat pump technology providing the remaining 20% of the space heating demand. Both these systems will use a mix of underfloor heating sections and responsive low water content radiators as the heat emitters.

In Figure 2, we can see the energy balance for the Erne Campus. This provides a visualisation of the losses and gains from the PHPP software for the project. The key point to notice is that the windows/curtain walling system will yield gains rather than losses over a calendar year, effectively acting as additional radiators for the building. Finally, we can also see that the orange section in the gains chart demonstrates the heat that will be utilised from the internal heat gains. i.e., students and staff coupled with the various IT and AV equipment particular in an education building of this scale.

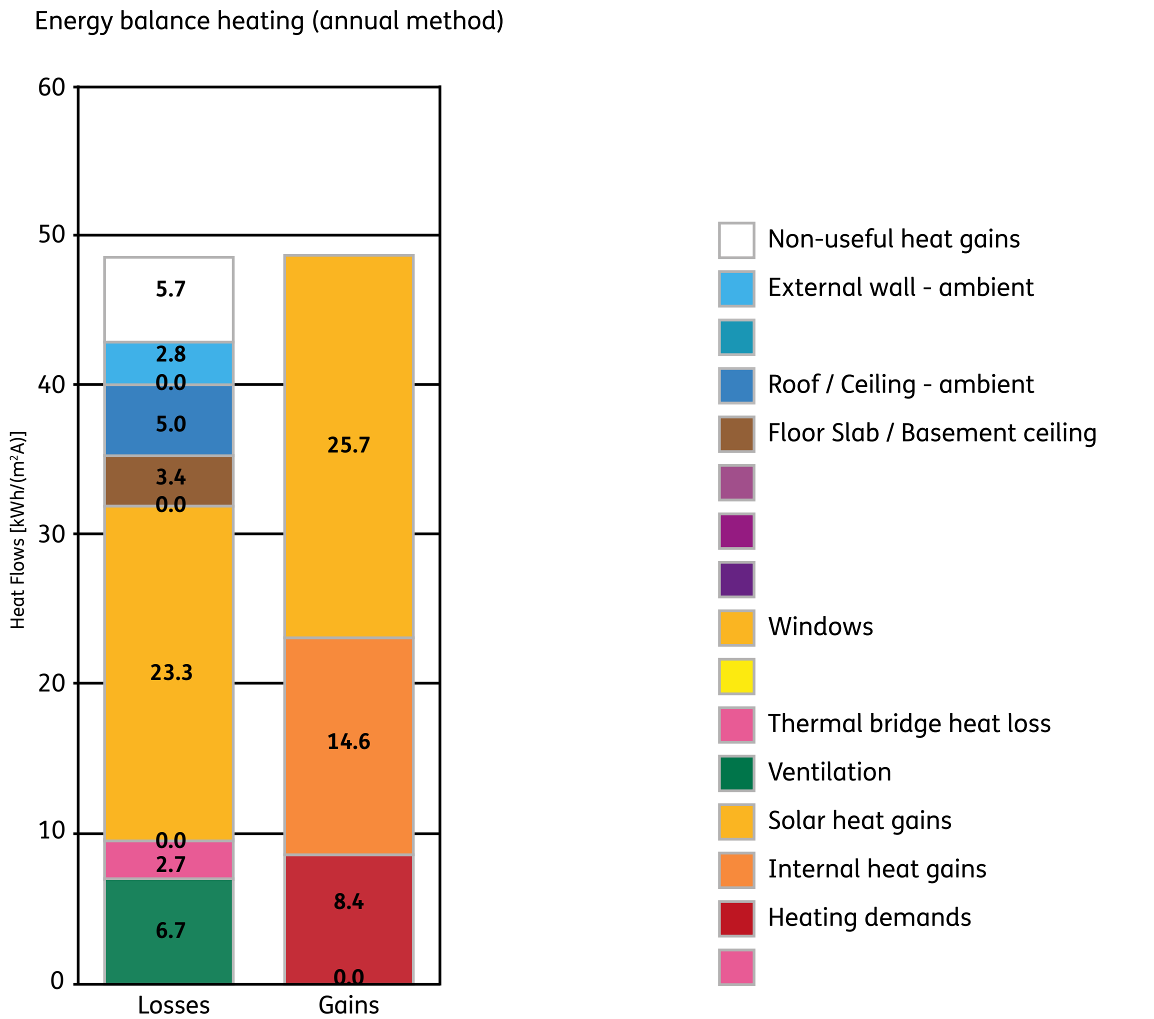


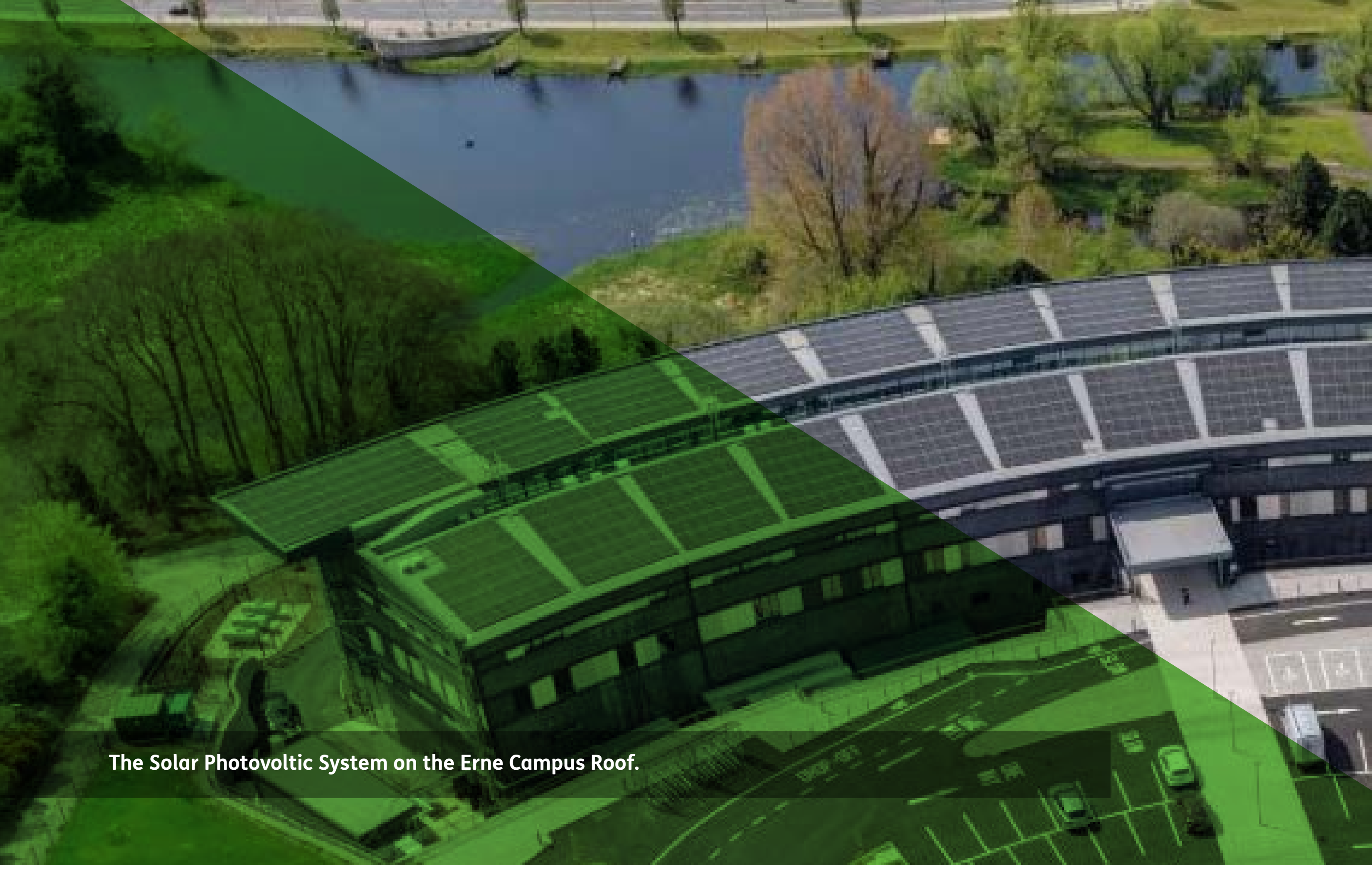
Figure 2: Energy balance heating (annual method) for Erne Campus

Renewable Energy and Storage

On site generation and consumption at the Erne Campus was significantly increased for the high demand of power consumption in the campus. The roof has significant capacity 3,400m^2 to allow a solar photovoltaic system (520kWp), which will provide a renewable energy generation figure of 120 kWh/m^2/year. This size of PV system is the equivalent of nearly 14 tennis courts. There is also a 460kWh/180kWpk of Lithium battery storage in the design that will allow for a reasonable amount of short-term storage. Reduced primary energy demand of all electrical appliances is part of the overall college estates strategy.

The existing campus at South West College (Fairview 8,898m^2) which as outlined already in 2018 used 152 kWh/m^2/year burning over 100,000 litres of heating oil which cost approx. £51,000 or £5.73 per m^2. If we then apply the PHPP projected costs of the heat demand of the Erne Campus which is 8.4 kWh/m^2/year and assume a price of £0.10 per/kWh, then the total cost to heat the building will be £6,037. This would then represent an annual saving of £44,963 or an 88% saving for the college. Extrapolated over 25 years, this is over £1 million in cost savings.

The total project cost was £29m, including the college fit out and AV / IT installations, plus landscaping and other items. If we consider this and compare the construction cost alone, then it seems competitive for the quality of the building. The total construction budget for the Erne campus was £29,128,000, which is equivalent to £3,552.19 per m^2 of floor area.



The Solar Photovoltic System on the Erne Campus Roof.

Conclusions

This building in Northern Ireland is extremely significant to the region. As a showcase building at South West College, it is not just the aesthetic quality of the architecture that matters, but also its high level of energy efficiency for a public building. It is the first Passive House Premium project in the UK and the largest Passive House Premium building in the world.

The most recent intergovernmental panel Climate change (IPCC) sixth assessment report has forecast that we now only have a few years left to reduce emissions, enough to avoid a catastrophic rise in global temperatures. Significantly reducing the emissions of our buildings is vital if the UK is to make a meaningful contribution and lead by example when many countries are also struggling to understand how to reduce emissions sufficiently.

The application of the Passive House Standard is still relatively new in the UK and in particular Northern Ireland. The major challenge is not to adopt the passive house concept in a physical or technical way. The barriers are in the construction culture in both minds and habits. South West College and CREST offer passive house training services in Northern Ireland which will help to break down the barriers.

As outlined the intervention and refinement of the project through the MAG design review process has contributed to a world class building and one that delivers against the vision of MAG that all communities in Northern Ireland would enjoy and benefit from exemplary, sustainable, and well-designed spaces, places, and buildings.

The review process produced a sustainable transport plan including active travel, the excellent integration of the building with its landscape and endorsed the adaptation of world leading sustainability standards. It also helped inform the improvement of the contiguous development on site.

In June 2019, the UK passed laws to end its contribution to global warming by 2050. This 'net zero' emissions target will require a significant reduction in energy-related emissions. South West College's Erne Campus represents an excellent international demonstration of how to successfully implement an energy efficient and cost effective zero energy building with passive house and renewables. South West College is developing into a centre of excellence for energy efficiency and is currently offering fully funded Passive House Designer and Tradesperson training.

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