Penrhos Farm

Mr James Owen

Energy and Sustainability Appraisal

Final Issue

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Scotch Partners LLP
Building Services Engineering | Sustainability | Acoustics

90 High Holborn
London
WC1V 6LJ

+44 (0) 203 544 5400
www.scotchpartners.com

Project Particulars

Client Name: Mr James Owen

Project Name: Penrhos Farm

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01	Update following comments	02.12.2020	IC	KE
02	Final Issue	08.12.2020	IC	KE

Contents

1 Introduction

This energy and sustainability appraisal report has been produced to support the application proposal for the erection of a steel portal frame building and all associated works in replacement of two smaller agricultural use buildings (retrospective).

The information included within this statement is intended to appraise and demonstrate the sustainability credentials of the new building and therefore the positive contribution it makes to the local and national agenda for environmental protection and climate change.

2 Development Context

2.1 Previous Development

Mr Owen is the Founder and Managing Director of an online retailer and owner of the agricultural property of Penrhos farm which previously had several redundant and ageing storage buildings.

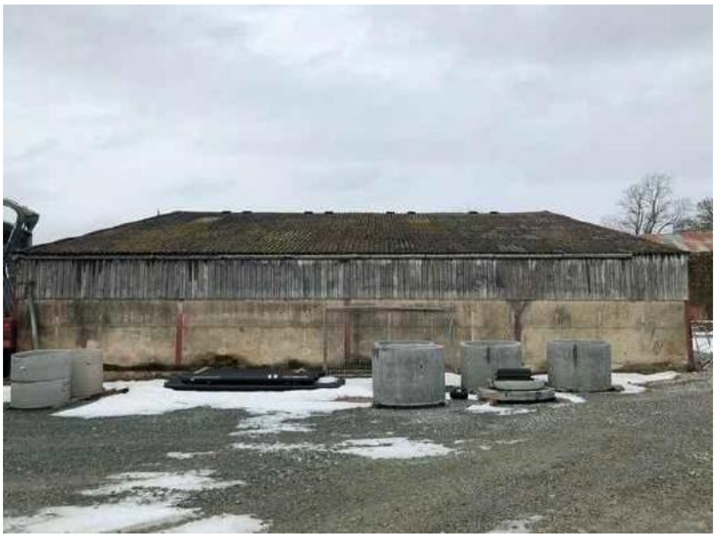

Figure 2-1 Image of the previous structure

2.2 New Development

Figure 2-2 Image of the new warehouse

The redundant buildings on the site have been replaced to make them suitable for the requirements of the business.

The new warehouse building has concrete walls and box profile sheets to eaves with the roof consisting of box profile sheeting. The site for the new warehouse building is adjacent to the retained farm buildings.

3 Energy Appraisal

3.1 Energy Efficiency

The development aims to be a high-quality space that is built to last and will create an internal environment that would be suitable for the storage of goods and be comfortable for people working within the building. In addition, the Applicant wishes to improve upon the energy efficiency of the previous buildings in terms of the building fabric and building services systems. This would help reduce carbon dioxide emissions whilst also creating a better controlled internal environment with better thermal comfort for occupants using the space.

To create a building that is sustainable and has a high performance there are two areas of energy efficiency that have been considered:

1. Building Fabric - The form and design of the building envelope and the physical properties (and condition) of the construction materials and components.
2. Building Services and Equipment – Lighting, equipment and appliances.

In this section we outline how focussing on these areas will not only result in a high-quality new development, but also improve the performance in comparison to the replaced warehouse buildings.

To quantify the improved performance, we have undertaken high level energy modelling to understand the improvement in terms of the expected CO_2 emissions. The presented results from modelling do not intend to provide operational energy usage and are provided as a demonstration of how the newly built warehouse would perform in comparison to the previous structures.

3.2 Building Fabric Performance

Figure 3-1 Picture of old and new warehouse

In terms of energy efficiency, fabric performance is seen as the starting point for creating an efficient building. Good fabric performance through insulation and good air tightness helps to reduce the risk of damp, maintain internal thermal conditions, and reduce the demand for heating. As no space heating is proposed for this building, the need for good fabric performance is essential.

Figure 3-1 above shows the before and after pictures of the buildings. The new building has been constructed using concrete walls with box profile sheets to the eaves, with the roof also consisting of box profile sheeting. This construction will have a good air-tightness value as well as having a good thermal performance value. This will therefore result in an energy efficient, thermally controlled, and comfortable internal environment for occupants of the space.

In comparison, the existing buildings are thought to have previously been used for agricultural purposes, such as storage of farm and equipment and animal feed. With a concrete and timber construction the original structures would likely have been highly energy inefficient with a poor thermal performance that would create an uncomfortable internal environment for occupants. The structure would have had no insulation and poor airtightness and whilst this may have been suitable for the intended purpose of the space at the time it would not be fit for purpose for most alternative uses.

The extent of works required to improve the energy efficiency of the original buildings, given their poor condition, was deemed inappropriate for this structure type and in terms of cost and payback.

3.3 Low Energy Lighting

To create a building with a low energy demand, multiple roof lights have been added to the new building. This maximises the amount of natural light that the warehouse receives and therefore greatly reduces the number of light fittings that are needed.

Additionally, the light fittings that have been installed are all LED which will use significantly lower energy than the compact fluorescents that would have been installed in the previous buildings. Absence detection sensors have been installed which result in the lighting switching off when an area is not occupied for a period of time.

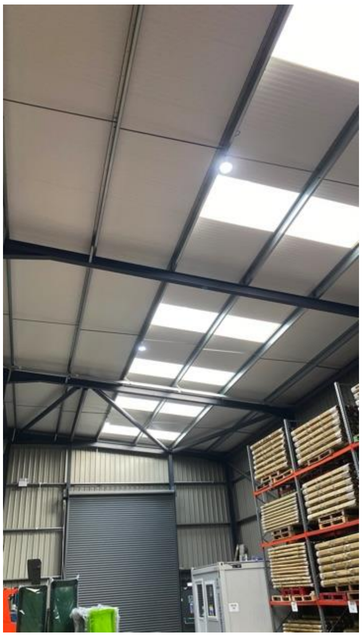

Figure 3-2 New warehouse lighting and roof lights

3.4 Heating

The previous buildings were unheated, and it is the intention for the new warehouse building to also not be heated. This will help keep energy demand to a minimum. However, this is only viable due to the good fabric performance of the new building, discussed in Section 3.2. It would not have been possible to have utilised the previous buildings for the intended use without first installing a form of heating, which would have been highly ineffective and inefficient due to the poor fabric performance.

3.5 Energy Modelling

To understand how well the new building is performing and to demonstrate the energy and carbon savings that the above measures could result in, we have undertaken high level indicative modelling of the old and new warehouse buildings. As the building has no heating or cooling system, formal Building Regulations Part L Building Regulation modelling is not applicable.

The two parameters addressed by the model are as follows:

- U-values for the various envelope components to reflect the improved fabric performance (external wall, ground floor, roof, rooflights, external door)
- Compact fluorescent lighting to LED lighting.

Fabric Improvement

Both the previous buildings and the new warehouse are unheated spaces. However, to understand the impact of the improved fabric performance, we needed to understand how much heating would be required to heat the space. Therefore, to calculate the improvement from the fabric performance we modelled the same speculative gas heating system for both the old and new warehouse. Table 3-1 demonstrates that the improved fabric performance would result in an estimated 74.1% carbon emission as a result of requiring less gas to heat the space. This demonstrates that the new warehouse has a high air-tightness which would result in less heat loss from heating systems.

Table 3-1 Estimated carbons (fabric performance)

	Estimated Annual Total Carbon Emissions *(regulated energy)*	Estimated Carbon Emission Saving
Old Warehouse	187,651 kgCO_2	-
New Warehouse	48,262 kgCO_2	**74.3%**

Lighting Upgrade

Table 3-2 demonstrates the electricity savings that are estimated to have been achieved as a result of the upgrade to LED lighting with occupancy sensors. This has resulted in a reduction in estimated carbon emissions for the building of 73.9%.

Table 3-2 Estimated carbon savings (lighting only)

	Estimated Annual Electricity Carbon Emissions *(regulated energy)*	Estimated Carbon Emission Saving
Old Warehouse	74,011 $kgCO_2$	-
New Warehouse	19,307$kgCO_2$	**73.9%**

Total Estimated Carbon Emission Savings

Table 3-3 demonstrates the total carbon savings that are estimated to be achieved as a result of the upgrade to LED lighting and the savings that would be achieved as a result of the fabric performance from the heating system.

Table 3-3 Estimated carbon savings (fabric performance and lighting)

	Estimated Annual Total Carbon Emissions *(regulated energy)*	Estimated Carbon Emission Saving
Old Warehouse	261,662 $kgCO_2$	-
New Warehouse	67,569 $kgCO_2$	**74.1%**

3.6 Future Carbon Offsetting

There is also an aspiration to offset the carbon emissions to zero in the future. To enable this the structure of the building has been designed to facilitate the installation of Solar Photovoltaic (PV) panels at a future date. The PV panels will therefore be able to provide on-site generated electricity to power the buildings and reduce the reliance on grid electricity.

4 Sustainability Appraisal

4.1 Sustainable Land Use

One of the ways in which to make buildings sustainable is to ensure they remain in use for many years whilst still being fit for purpose and providing a comfortable working environment for occupants. The new warehouse has been designed to be highly adaptable and flexible, thereby ensuring that if required, the space can be used differently in the future without significant structural alterations and thus prolonging its life span.

The old storage buildings on the site would not have provided adequate internal environmental conditions or a comfortable work environment for occupants so was effectively redundant and at the end of its life. The modern materials used to construct a highly efficient and more thermally comfortable new warehouse not only provides a healthier environment for occupants but also greatly extends the life span of the building.

4.2 Site Layout and Building Design

The building has been positioned and orientated as far as possible to maximise the use of natural daylight. Multiple roof lights have been incorporated into the building design to provide access to natural daylight for all occupants, these can be seen in Figure 4-1. As discussed in Section 3.3 this has also resulted in reduced energy demand from artificial light.

Figure 4-1 Roof lights in new warehouse

4.3 Materials

The materials used in buildings can have a major environmental impact. Concrete as a material is extremely tolerant of flooding and adverse weather conditions such as storms, as well as temperature extremes. It also has a high thermal mass which will keep the internal conditions cool without the need for mechanical cooling. These properties therefore make it resilient to a changing climate.

Additionally, the aluminium cladding is weatherproof, corrosion-resistant, and immune to the harmful effects of UV rays, ensuring optimal performance over a long period of time.

The concrete, aluminium and steel used within the building all contribute to the current shift towards a circular economy. The concept of a circular economy is that there is a shift from the traditional linear economic concept of "take, make, dispose" to one where is a looping of resources, which have lost their former need, back to the society. The main materials used in the new warehouse can all be "looped" to contribute to the circular economy:

- Aluminium and steel can both be 100% recycled and are capable of being recycled multiple times without losing their original properties.
- Concrete can be recycled into aggregates which can be used in landscaping or mixed with new concrete to create new structures.

By using materials that can be recycled at the end of its life span, the new warehouse will help the transition to a circular economy.

4.4 Health and Wellbeing

Thermal comfort is defined as "the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation." According to the WELL Building Standard[1], "Thermal comfort greatly influences our experiences in the places where we live and work and is one of the highest contributing factors influencing overall human satisfaction in buildings impacting individual levels of motivation, alertness, focus and mood."

The upgrade in fabric performance will result in an improved internal environment for occupants. This will therefore improve the health and wellbeing whilst in their working environment.

Furthermore, the access to natural light in the warehouse will also have benefits for occupant's health and wellbeing. Light is the main driver of the visual and circadian system which regulates physiological rhythms throughout the body's tissues and organs, such as hormone levels and the sleep-wake cycle. Providing indoor access to adequate light can positively influence the productivity and mood of individuals, while supporting the alignment of their circadian rhythms with the natural day-night cycle

[1] https://v2.wellcertified.com/wellv2/en/thermal%20comfort

5 Conclusion

A range of design solutions have been incorporated into the development of the new warehouse at Penrhos Farm that has resulted in a range of environmental benefits. The following sustainability performance indicators have been achieved:

- High thermal performance and efficient lighting to reduce carbon emissions.
- The design ensures a health internal environment for all occupants, including good indoor air quality, good thermal comfort and good access to natural daylight.
- The materials have been chosen for their resilience, durability and recyclability.

The strategy outlined in this Energy and Sustainability Appraisal therefore demonstrates the benefits that the new development has brought for the local and global environment.

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90 High Holborn
London
WC1V 6LJ

T 0203 544 5400

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