WARM
Low Energy Building Practice

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ENERGY AND PASSIVHAUS REPORT

CLYDESDALE, BIRKS AND NASH BUILDINGS
STUDENT RESIDENCES

FOR

UNIVERSITY OF EXETER

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INTRODUCTION

THE PROJECT

The proposals are for the demolition of the existing Clydesdale and Nash accommodation buildings and the construction of new student accommodation buildings ranging in height from 3 to 8 storeys. Ancillary services, such as a shop, café and facilities are to be provided in the ground floor of some of the buildings.

WARM

WARM are Passivhaus specialists providing consultancy, certification, training and testing to the Passivhaus standard. WARM have been involved in nearly every non-domestic Passivhaus in the UK, with projects spanning archives, laboratory buildings, sports facilities, teaching, accommodation and offices.

BACKGROUND

EXETER CITY COUNCIL, CORE STRATEGY (ADOPTED FEBRUARY 2012), POLICY CP14: RENEWABLE AND LOW CARBON ENERGY

Policy CP14 asks that:

New development (either new build or conversion) with a floorspace of at least 1,000 sq. metres, or comprising ten or more dwellings, will be required to use decentralised and renewable or low carbon energy sources, to cut predicted CO_2 emissions by the equivalent of at least 10% over and above those required to meet the building regulations current at the time of building regulations approval, unless it can be demonstrated that it would not be viable or feasible to do so.

The University of Exeter declared an Environment and Climate Emergency, on 20th of May 2019 and published their Environment and Climate Emergency Working Group White Paper in November 2019. As part of the University's goals for reducing their carbon and energy use, it was agreed that the proposed development (Clydesdale and Birks) will be based on meeting the Passivhaus standard. This sets a new paradigm and exceeds the Target Emission Rate requirement set by the current Building Regulations Approved Document Part L2A, 2013.

The table below provides a comparison with other recent University of Exeter student accommodation schemes which were compliant with Policy CP14. A comparison with industry benchmark standards from Energy Efficiency in Buildings, CIBSE Guide F is also provided.

The difference between the standard CP14 compliance building and Passivhaus is phenomenal; there are clearly significant energy savings to be had in this approach:

	Annual estimated energy consumption (kWh/m^{2}a)	Annual estimated carbon emissions production (kgCO_2/m^{2}a)
CIBSE Guide F	240*	52*
Moberly	213**	38**
Spreytonway	192**	38**
East Park Development	185**	31**
Proposed Development - Clydesdale	60***	8 (31)***

** Figures from Energy Efficiency in Buildings, CIBSE Guide F (2012) for "Good Practice" Halls of Residence building types.*

*** Figures from BRUKL Output Document (England Building Regulations Part L2A 2013) excluding unregulated loads and using SAP 2012 carbon emissions factors.*

**** Figures from Passivhaus Planning Package including unregulated loads and using Draft SAP 10.10 2019 carbon emissions factors (following decarbonisation of the grid) and SAP 2012 carbon emission factors in brackets for comparison. Note this is the upper limit of certification, the actual buildings may end up lower.*

PASSIVHAUS STRATEGY

Passivhaus offers a proven strategy to deliver real low energy buildings. It addresses all energy consumption not just building fabric which makes it particularly well suited to optimising energy performance of larger buildings such as this. There are several examples of Passivhaus student accommodation buildings of a similar scale around the world:

Figure 1Passivhaus student accommodation. All Projects can be found on passivehouse-database.org

To comply with the Passivhaus standard a Passivhaus certifier must undertake a quality assurance assessment of the design and build against the certification criteria. The key criteria for Passivhaus Classic certification are:

HEATING ENERGY LIMIT OF ≤ 15kWh/m^2.yr

The heating energy target is the annual number of kWh of heating energy demand for every m^2 of treated floor area.

The heating energy and PER are calculated through the Passivhaus Planning Package (PHPP) software.

PER (PRIMARY ENERGY RENEWABLE) LIMIT ≤ 60kWh/m^2.yr*

As well as the heating, Passivhaus limits all other energy use within the building to ensure the design of services and selection of equipment is energy efficient through the PER assessment. The PER covers all energy use within the building, and factors in how much more energy must be supplied if it all comes from renewable sources, including all losses incurred along the way.

*Primary Energy can be as high as 75kWh/m^{2}yr but the difference (15kWh/m^{2}yr) must be offset with renewables.

OVERHEATING LIMIT OF NO MORE THAT 5% OF THE YEAR AT OVER 25ºC

Overheating in densely occupied student accommodation is a common problem and will become more so as our climate warms. The Passivhaus approach will ensure that all opportunities to get the best out of the design are considered.

PASSIVHAUS IMPLEMENTATION

Low energy design and Passivhaus imposes constraints on design and materials selection, this has informed the illustrative design and will continue to be an essential part of the design development.

The proposed building layout and appearance is fundamental in meeting the energy performance and design choices have been carefully considered to take account of these constraints. Any changes from the design may impact on the likelihood of meeting the standard.

Below are examples of how various aspects of the design have been incorporated.

STEP 1: SHARING IS BETTER

Heat loss is a function of surface area, so going for a compact shape means that heat loss can be minimised before the building fabric specification is considered.

The Form Heat Loss Factor (Form Factor for short) is the ratio of heat loss area (walls, roof, floor) divided by the nett internal floor area; this s a way of indicating the efficiency of the shape.

Clydesdale

For the Clydesdale project compact form has been balanced against access to windows for daylight, view out and ventilation for each block. The Form Factors range from 1.14-1.55.

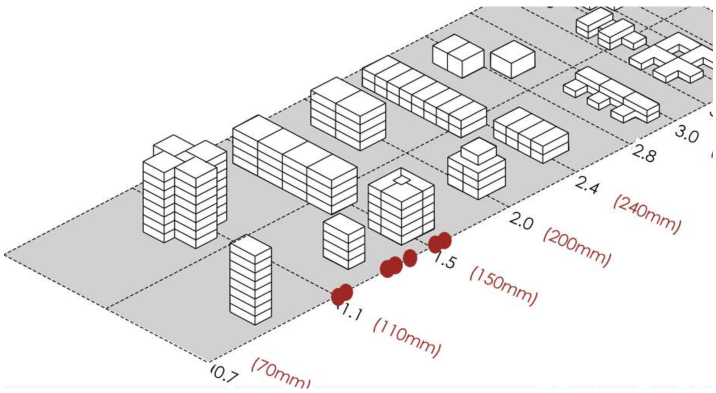

Figure 2 Form Factors in black with typical insulation thicknesses to meet Passivhaus in red. The red dots represent the buildings on the site

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STEP 2: SIMPLICITY

For larger buildings the complexity of the build is critical to the ease of meeting Passivhaus. Simple shapes mean it will be easier to build well, so there is a much better chance of meeting the stringent airtightness & thermal performance.

Clydesdale

This has been carefully considered in the design, as can be seen from the outlines below; the building forms are consciously a lot simpler than other student accommodation buildings.

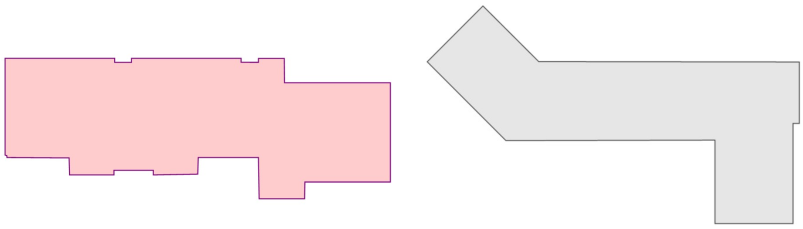

Figure 3 outlines of Spreytonway in red and a typical block on the Clydesdale site in grey

STEP 3: DESIGN FOR COMFORT

To make sure the building is comfortable in the summer the heat gains should be reduced as far as possible. Heat gains come from occupants, equipment, building services and the sun. For densely occupied buildings such as student accommodation the gains can be high, so opportunities to reduce should be embraced. Window design is therefore crucial.

Orientation has a striking impact on solar gain in the summer where windows facing South and North have lower solar gain than those facing East and West; for this reason the former is preferred.

Clydesdale

Window designs have balanced overheating, view out, ventilation and daylighting – there will be no fully glazed stairwells or walls of curtain walling, rather a careful amount of glass that is optimised for purpose.

The design layout has sought to strike a balance between optimising orientation of buildings in line with the principles of Passivhaus and addressing the specific context of the site, particularly at boundaries with neighbours. The design proposals were fundamentally changed as a result of the Passivhaus input on orientation.

v.5	Width	Height	Shading
	m	m	m
Window (W)	0.800	1.625	0.400
Vent panel (V)	0.450	1.625	0.400
Total area =	2.031		

Orientation	Heating Energy kWh/m²annual	Overheating % of time over 25°C
22° from South	**10.4**	**0.6%**
True West	**11.2**	**2.5%**

Figure 4 Example of the window design development & results from testing

STEP 4: NOT JUST FABRIC

To meet the Passivhaus Primary Energy Renewables (PER) requirement the services & equipment need to be designed & selected on best efficiency. It is not an easy requirement to meet for student accommodation and means the servicing strategy must be considered at building layout stage.

The PER requirement has an essential co-benefit of further reducing gains to improve summer comfort.

Clydesdale

The impact of plant location and distribution has been a part of the design work to date and will continue throughout the design.

Possible servicing options have been reviewed and the PER calculated, a selection of the options are shown below. At present all of these are possible.

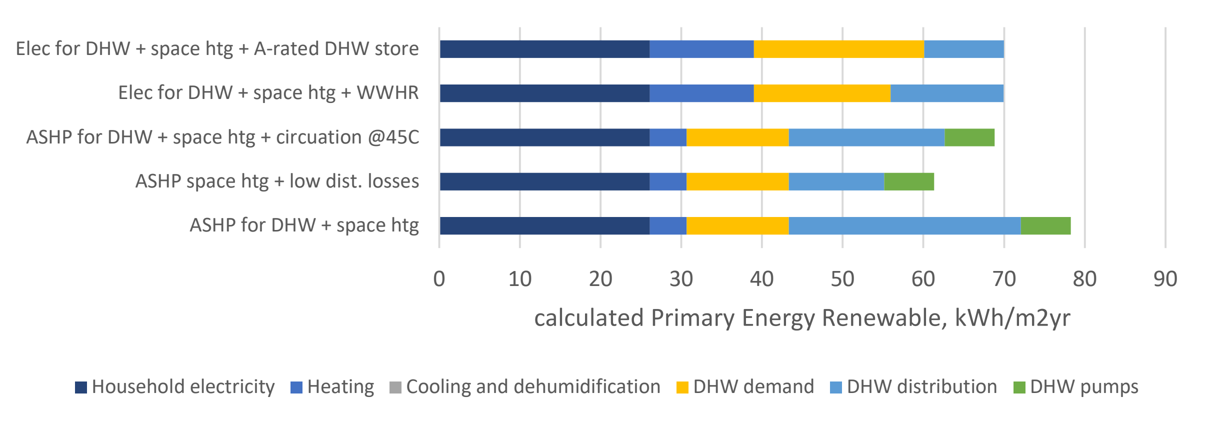

Figure 5 Some of the services options considered and their PER values. The limit for certification is 60kWh/m2yr

BIRKS GRANGE RESIDENCIES A TO E REFURBISHMENT

The existing accommodation will be refurbished to the Passivhaus EnerPHit standard. The EnerPHit standard has been developed by the Passivhaus Institut to apply to refurbishments where it is not possible to achieve all the stringent requirements of the Passivhaus energy standard.

Typically this would include:

- Changes to the roof design, either raised or changed to a flat roof to allow additional insulation to be added.
- Changes to the stairwell glazing, to reduce the amount of over-heating in summer. Replacement of windows throughout.
- Cladding to some or all the façade, to increase insulation in the walls.

Details of these changes are reserved for future consideration and would be applied for at a later Reserved Matters application.

CONCLUSION

The comparison between the Passivhaus standard and the other student accommodation buildings on the site is stark; and the benefits are not just limited to this development. The size and typography of Clydesdale is typical of other student accommodation planned for Exeter and across the UK, this is a fantastic opportunity to set a precedent for what can be achieved.

Whilst the focus of this report is on reducing energy demand the opportunity to improve the comfort for the residents, both in terms of air quality and summer comfort are both important.