LISNAHULL TERRACE, DUNGANNON

IRELANDS FIRST CERTIFIED SOCIAL PASSIVE HOUSING SCHEME

Five houses recently constructed at Lisnahull Terrace, Dungannon are amongst the most energy efficient homes in Northern Ireland. The innovative development by Oaklee Homes Group has resulted in the first social houses to be built to certified 'Passivhaus' standard, which produces a virtually airtight building with the effect of maintaining comfortable living conditions without, or with much reduced, traditional heating or cooling systems.

Lisnahull Terrace, Dungannon

Background

In autumn 2010, the Northern Ireland Housing Executive (NIHE) set a competition for Housing Associations to develop a scheme with the aim that it should achieve the Passivhaus standard. NIHE owned a development site with outline planning approval for five dwellings at Lisnahull Terrace, Dungannon, and it was proposed that the scheme would be developed on this site, which is in an area of high housing need.

Oaklee Homes Group have taken a number of measures relating to sustainability in recent years, appointing an Energy Officer, Brian Rankin, in 2008 and setting a number of targets as part of a five year Energy and Sustainable Development Strategy. One of the goals within this Strategy was to develop to higher standards than required and so the opportunity to develop a scheme to Passivhaus standard was very appealing. At the time of the NIHE competition Oaklee had already developed the first homes in Northern Ireland to Level 4 of The Code for Sustainable Homes and was at design stage with properties to Code Level 5. Oaklee therefore entered the NIHE competition and were subsequently successful – they then appointed the design team including Kennedy Fitzgerald Architects.

One major challenge before starting on site was to ensure that all of the necessary consents were in place within a very limited time frame, with work commencing on site towards the end of March 2011 and a development timeframe of one year. The process was also complicated by the fact that the homes had to be designed to meet a number of standards: in addition to planning and building regulations they had to achieve Level 4 of The Code for Sustainable Homes, Lifetimes Homes, Secured by Design and meet NI DSD Guidelines. Oaklee was also keen that this scheme would achieve full Passivhaus certification in order to ensure a high quality trial project and NIHE supported this decision.

The Passive House Concept

A '*passive house*' is simply a building built using the principles of passive design - a concept based on minimising heat losses and maximising heat gains, thus enabling the use of simple building services and without the use of significant active space heating or cooling systems. Typically this includes optimising insulation levels with minimal thermal bridges, high thermal performance windows, very low air-leakage through the building envelope, utilisation of passive solar and internal gains and good indoor air quality maintained by a mechanical ventilation system with highly efficient heat recovery. This results a dramatic reduction for space heating and cooling.

The word '*Passivhaus*' originates from the German Passivhaus Institut (PHI), founded in 1996 by Dr Wolfgang Feist as an independent research institution. Following increased international interest in the standard, the Passivhaus Institute formed the 'International Passive House Association' - Ireland, America and some other English speaking countries then adopted the PHI's translation 'passive house'. The German spelling is still used in the UK to distinguish an architect using the Passivhaus Institute's scientific standard from an architect using standard passive design techniques. A certified Passivhaus must be built with meticulous attention to detail according to principles developed by the Passivhaus Institute, and certification can only be achieved through an exacting quality assurance process, for example:

- Total energy demand for space heating and cooling must be less than or equal to 15 kWh/m2 per year, as calculated by the Passive House Planning Package (PHPP)
- Total energy demand for appliances, hot water, and space heating and cooling must not exceed 120 kWh/m2 per year, as calculated by the PHPP
- Total heating load less than or equal to10W/m^2, as calculated by PHPP
- Airtightness must be less than 0.6 air changes per hour when subject to a force of 50Pa

To achieve the Passivhaus standard in the UK climate, a house generally would require:

- Very high levels of insulation
- Extremely high performance windows with insulated frames
- Airtight building fabric
- 'Thermal bridge free' construction
- A mechanical ventilation system with highly efficient heat recovery

The Passivhaus Institute has developed a series of certification processes to ensure the quality of any official Passivhaus buildings and practitioners:

- The Passive House Planning Package (PHPP), used to inform the design process and to assess or verify compliance with the Passivhaus Standard
- Certification for designers who have the expertise to deliver Passivhaus buildings, although not mandatory
- A certification process for Passivhaus buildings, which applies both to the proposed design and the completed building certified by Passive House Certifiers

The Lisnahull Project

The Site

The Lisnahull site is on the western outskirts of Dungannon, Co.Tyrone on land previously used as open public space. The site is bounded by the Lisnahull Road to the north, residential housing to the east and west, and an embankment to the south which rises above an adjoining low lying and poorly drained area of marshland. The site was ideally suited to passive design in that the homes could be planned on a south facing plot with deciduous trees along the southern boundary which would help with shading. The terrace was therefore orientated along an east-west axis to ensure that one facade would be facing directly south to maximise solar gains and accommodate solar panels. Car parking and the front covered entrance from the Lisnahull Road face north with limited windows to this elevation. Specific climate data generated for the Passive House Planning Package (PHPP) 2007 was obtained for the site. Existing trees and hedges were retained where possible with additional hedging planted to new boundaries. A new 1.8m high fence was erected to the west, south and east boundaries.

General Design

The development consists of two house types - three 5 person/3 bed and two 6 person/4 bed terraced houses. Each house type has identical ground floor layouts accommodating the entrance hall, toilet and shower room, single bedroom and an open plan living, dining and kitchen area. The first floor consists of double bedroom, twin bedroom, bathroom and linen store with an additional single bedroom in the 4 bed house type. A double height area over the dining area helps south sunlight penetrate further into the building.

Front Panoramic Elevation

Access from the dwellings to the rear south facing patio area and rear enclosed gardens is via triple glazed doors with sun shading brise soleil to the large south facing glazing.

There are two covered ground level walkways providing shared bin storage access to the rear of the dwellings. This allows all tenants to have access from the front gardens/parking areas to the rear enclosed gardens without having to enter the houses.

There was a rigorous approach to the principles of solar passive design - all internal services spaces and circulation are located on the north side of the building with habitable rooms located on the south side, minimizing windows on the north elevation and maximising windows on the south elevation.

The modern design of the terrace incorporates the use of traditional building materials throughout. Timber frame construction has been used for its ability to achieve the required U-values to wall thickness. Externally the timber frame is clad in self coloured rendered block walls, concrete roof tiles and PPC aluminium rainwater goods.

Grey PVC triple glazed windows with Iroko rainscreen cladding and Iroko brise soleil and solar shading are also used to achieve the Passivhaus standards and minimize overheating.

Rear Elevation

Key Features

Ground floor: Piles required due to poor ground conditions with strip concrete foundations. 150mm concrete slab, DPM and airtightness membrane, 200mm Springvale Platinum Floorshield insulation 0.03W/mk, 100mm sand cement screed.

U-Value 0.143W/m^2K

Walls: 100mm rendered blockwork, 50mm ventilated cavity, breather membrane, factory-built timber frame with 9mm OSB board all joints taped and sealed, 140mm timber studs at 600ctrs with 140mm Ballytherm/Xtratherm PIR insulation tightly fitted between studs, Protect barriAir airtightness/vapour control layer, 50-60mm Xtratherm PIR continuous insulation held with 50x40mm timber battens creating service cavity filled with insulation where required around window reveals etc. and 12.5mm taped and jointed plasterboard.

U-value: 0.125W/m^2K

Roof: Plain concrete roof tiles on battens on breather roofing membrane on 50mm counter battens creating ventilated air gap, followed underneath by 9mm OSB board, all joints taped and sealed, 140mm timber studs at 600ctrs with 140mm Ballytherm/Xtratherm PIR insulation tightly fitted between studs, Protect barriAir airtightness/vapour control layer, 50-60mm Xtratherm PIR continuous insulation held with 50x40mm timber battens. Service void and plasterboard only to underside of roof where exposed and not in roof storage space.

Airtightness Measures & Insulation

U-value: 0.133W/m^2K

Avoidance of Thermal Bridges: Foamglass blocks used along the external perimeter at the floor to wall junctions and at load bearing walls. Additional foamglass blocks used at door thresholds. A 50-60mm layer of continuous rigid insulation on the inside of the timber frame studs was carried around the entire external walls and roof construction. An additional 40mm service cavity was additional filled with insulation around window, door reveals and roof to wall junction for added insulation. Split timber studs with insulation between used at window heads and cills. Special detail used at internal wall to external wall junctions to ensure airtightness and minimised cold bridging. Linear thermal bridging calculations were carried out for all details. Detailing of the building fabric is crucial in this regard. Avoiding thermal bridges ensures that mould and condensation do not occur while also contributing to the avoidance of excessive heat loss through these elements

Windows: By creating large glazed areas on the south elevation, designed to optimise solar gains, a Passive House is naturally well lit which improves the indoor living and working spaces. PVC Passive House Certified Baskil triple-glazed windows, with argon filling and an overall U-value of 0.8 W/m^2K including frame.

Airtightness: Airtightness is crucial to achieving low-energy performance. As the insulation levels are increased the percentage of heat lost through air-leakage significantly increases and as a result a very airtight building should be constructed. Passivhaus building air leakage through unsealed joints must be less than 0.6 air changes per hour @50 Pa. This has been achieved at Lisnahull.

Ground Floor Airtightness and Insulation

Ventilation: By creating a building with very low air-leakage (air-tight) the provision of a mechanical ventilation system is the key in ensuring the required volume of fresh air needed for healthy living conditions is provided. The air supply system also suffices to distribute heat throughout the property. Warm stale air is extracted from service spaces such as kitchens and bathrooms and this heats fresh air using an air-to-air heat exchanger to supply habitable rooms such as bedrooms and living areas with warm fresh air. Air is transferred between the habitable rooms and the service rooms via the circulation spaces. A 92% Passive House Certified MVHR: Paul Focus 200 has been used.

Energy Demand: In a Passivhaus the total energy demand for space heating and cooling = less than 15 kWh/m^2/yr treated floor area. The heating system used is a Vaillant, Ecotec Plus, 618 LPG, 92.40% fuel type: LPG Heating type: radiators and warm air ventilation, 280 litre thermal store with instantaneous DHW coil and solar coil. Solar vacuum tubes: 2.79 m^2 sap type TE. The total primary energy use for all appliances, domestic hot water and space heating and cooling = less than 120 kWh/m^2/yr. This is calculated by the Passive House Planning Package 2007.

During Construction

Towards 'Passivhaus' Certification

Kennedy FitzGerald employed MosArt Ltd, a leading environmental design practice, as the specialist passive house consultants for the project. They assessed the designs from an early design stage using the Passive House Planning Package and advised on the recommended U-values, construction details, ventilation systems etc. Caldwell Consulting developed the mechanical and electrical package to comply with Passivhaus certification and Code for Sustainable Homes requirements.

First Floor Panels

Detailed design progressed from the initial design stage where the houses would have complied with passive house requirements. The detailed design of the fabric was based on a timber Structural Insulated Panel System (SIPS), which avoided cold bridges. The U-value and airtightness of the fabric was set out in the specification. It was left flexible that, should a contractor wish to propose alternative methods of achieving the U-values and airtightness then this would be assessed, as it was the performance specification that was most important.

T&A Kernoghan with Benbrook Timber Frame decided to use a highly insulated traditional timber frame construction instead of a SIPS system to meet the required performance specification. Special construction details were developed in conjunction with Benbrook Timber Frame, Kennedy FitzGerald and MosArt to ensure a thermal bridge free design.

During the project Jonathan Hay, senior architect from Kennedy FitzGerald completed the eight day Passivhaus Training Course offered by the Passive House Academy and passed the exam to become a Certified Passive House Designer. Although this was not a requirement for certification, it was felt that this would be beneficial to the scheme as it gave the architect a much greater understanding of the aims, objectives and systems and details required in achieving a passive house. This was of particular benefit when assessing the timber frame details and mechanical ventilation heat recovery system.

Brian Rankin, Energy Officer with Oaklee Homes Group, also completed the Passivhaus training at an earlier stage as a commitment within the competition submission to NIHE. This ensured that the client had a better understanding of the principles of Passivhaus and helped in the education and ongoing support for tenants.

On achievement of the final airtightness results the houses were assessed for Passivhaus certification and passed.

Going Forward

A key aim of the Lisnahull development is to ensure that the occupants are able to live comfortably with very low running costs. One area recognised as a 'make or break' factor to this was tenant attitudes and lifestyles within the homes; if tenants' fail to use their homes as designed then the potential financial savings will not be achieved. Occupants do need a reasonable level of understanding of a Passivhaus building in order to optimise comfort and performance, however as the tenants were selected from the Northern Ireland common waiting list lifestyles and environmental awareness etc. could not be factored into the selection process. Whilst this could be viewed in a negative way and as a potential risk to the schemes success, it also has a number of benefits, primarily a realistic view on how a home is lived in. A number of means were used in order to reduce the risk surrounding tenant lifestyles, for example:

- A pre-allocation information meeting for those tenants on the waiting list
- Advanced opportunity to view the homes
- Pre-handover viewing
- Tenant User Guides and posters in each home
- Industry Open Day
- Follow up support

One particular challenge was the language barrier with only two of the five families having English as their first language. Interpreters were used on a number of occasions and at times communication had to be via family members acting as translators.

Monitoring

The Department for Social Development is responsible for tackling fuel poverty and the Lisnahull project will be used to provide practical learning for future social housing developments. At the opening, Nelson McCausland, Minister for Social Development said:

"*Northern Ireland suffers from the highest level of fuel poverty in the United Kingdom with households here spending significantly more of their disposable income on energy costs. My department is committed to reducing energy inefficiency as one way of driving down on fuel poverty. For social housing tenants, in particular, rising energy costs can have a disproportionately devastating effect and I want to do all I can to make sure that people do not have to make the hard choice between eating and heating.*

"Social housing here is already at a high standard, but I want to ensure that we are concentrating on those elements that will make the most impact on energy efficiency. This latest initiative will provide valuable learning as we look to make the best choices for social housing going forward."

Brian Rankin, Oaklee Energy officer, demonstrating energy saving features of the new properties to Nelson McCausland, Minister for Social Development

The Minister continued: "*The performance of this exemplar will be closely monitored in conjunction with the tenants involved and ongoing results will inform the decision making process. Oaklee Homes Group and the Housing Executive are to be congratulated for embracing this challenge which will benefit tenants both immediately and into the future*."

Oaklee Homes Group successfully applied for funding from the Technology Strategy Board through their Building Performance Evaluation Competition and will receive funding for monitoring the Lisnahull development as part of both Phase 1 (Post Completion and Early Occupancy) and Phase 2 (In Use and Post Occupancy) studies. The study period will last for over two years.

The study of these homes will include additional analysis and testing for example, design reviews and thermal imaging, and also the provision of extensive monitoring and metering with regular reports on performance, including areas such as energy use, temperature, humidity, and CO^2 levels. There are also qualitative surveys carried out as part of the study with residents providing feedback on their homes.

Benefits of the Study

This development is unique in Northern Ireland and so the opportunity to monitor these homes in detail and learn lessons from them is greatly appreciated by Oaklee Homes Group. It is expected that the results of the monitoring will outline the success of the project in terms of resident satisfaction and reduced energy costs. The design team have been involved in the monitoring process and so are able to apply lessons from this scheme to their future developments and it is the intention of Oaklee Homes Group to share knowledge of the schemes performance to NIHE and the construction industry so that future developments across Northern Ireland may benefit.

Client:	Oaklee Homes Group
Value:	£650,000
Start Date:	April 2011
Construction Period:	12 Months
Architect:	Kennedy FitzGerald Architects
Quantity Surveyor:	VB Evans
Structural Engineer:	McAuley & Browne
Service Engineer:	Caldwell Consulting Ltd.
Contractor:	T&A Kernoghan
Passive House Consultant	MosArt Ltd

Oaklee Homes Group	http://www.oaklee.org.uk/home
Kennedy FitzGerald Architects	http://www.kennedyfitzgerald.com/
Passive House Institute	http://www.passivehouse.com