THE MODULAR HOUSE - PLOT 15 - SCOTLAND’S HOUSING EXPO

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“A state-of-the-art, carbon neutral living space as natural as the environment, which considers carbon reduction from every angle.

High thermal performance air tight external structure with complementary heating/ventilation system. Factory assembled long panel construction, high quality finish, quick on site assembly, minimised waste during construction.”

This is the tag line that accompanied the house designed by Architects Bracewell Stirling Consulting at Plot 15 of the Scottish Housing Expo in 2010 - the house known as The Modular House.

With a predicted annual running cost for the space heating of less than £400, the technology in the construction of the house has certainly been selected with low running costs and reduced carbon generation in mind.

The house boasts under floor heating, increased thermal insulation levels and an innovative ventilation system which is centred on a Swedish NIBE heat pump, around which the house is quite literally built. The system recycles heat from kitchen and bathroom extract air and redistributes it around the remainder of the property, so bringing energy bills down and at the same time reducing CO₂ emissions.

The technology and systems adopted in the house were all selected on the basis that they were viable solutions that could be rolled out on larger commercial housing developments.

The Modular House was described as “a cutting edge exploration in air-tight prefabricated design” by Building Design magazine whose critic positively spoke about its contribution to the “cause of progressive residential architecture”.

The Practice

Bracewell Stirling is a long established Scottish based architectural practice with a strong background in designing energy efficient solutions for both mainstream and affordable housing.

The practice strives to push the boundaries of new and existing building materials and technologies using them in new ways to provide efficient and comfortable homes that are within the reach of everyone.

The Practice’s Expo house was an opportunity to design a bespoke house with features that were transferable to mainstream housing, embracing the philosophy of off-site manufacturing and stepping toward ‘zero carbon’ building.
History

The Scottish Housing Expo was held in August 2010 on an elevated site to the South of Inverness, attracting significant numbers of visitors during the month that its doors were open to the public.

Bracewell Stirling was awarded Plot 15 to develop in May 2007 following the submission of a successful competition design entry, made in conjunction with Inverness based Developer/Contractor Tulloch Homes Express.

The Design Competition for the Expo dictated that various zones within the overall 52 house development followed specific design codes. Plot 15 was located on North Street in the ‘North Zone’, an awkward corner site where the building form was obligated to follow the street frontage. The Energy Efficiency theme of the North Zone was Carbon Neutrality, targeting zero CO₂ emissions in use.
Carbon Neutrality

The Practice’s design targeted the Expo’s Carbon Neutrality aspiration by adopting a ‘fabric first’ approach, following the basic principle of minimising heat loss through the building envelope. This concept was achieved in practice by:

- Maximising off-site manufacture to improve thermal performance and air tightness;
- Adopting highly insulated wall, floor and roof constructions; and
- Specifying components such, as windows and doors, with high thermal performance.
The above concepts are all passive solutions and were fundamental to the effectiveness of the solution at Plot 15 - a principle based on getting the building fabric right first before considering heating, ventilation and any on-site energy generation that might be adopted to offset energy use.
At the early design development stages, the plan had been to connect the house into the Expo site’s proposed district communal heating plant. The establishment of the communal system was however abandoned by the Expo organisers and resuitantly the house at Plot 15 was required to ‘stand alone’. The target of Carbon Neutrality suddenly became much more difficult to achieve, requiring energy generation within the plot. However, due to both budget and practical constraints, the planned adoption of on-site generation was abandoned and the focus moved towards reducing CO₂ emissions as opposed to achieving a target of zero emissions. While budget had been a leading factor in the decision to drop on-site energy generation, the decision was also influenced by the fact that the ridge line of the house ran north to south, due to plot location, meaning that opportunities to adopt roof mounted solutions such as solar or photovoltaic panels were limited.

Once the decision was made to adopt the ‘fabric first’ approach the next stage was to balance this with a suitably efficient and cost effective solution for the heating and ventilation, a system that would continue the principle of reducing heat loss, while minimising running costs and at the same time minimising the property’s long term reliance on finite fossil fuels.

With this target in mind a NIBE recycled air source heat pump was selected, a system which not only delivers the heating and ventilation to the property, but also provides efficient heat recovery - and a system which has been used successfully across the Continent for many years.
Building Performance Facts and Figures

The Building Regulations demand that a new house achieves a CO₂ emission rate no worse than that of a theoretical house of the same type and construction. The Modular House not only met this target but almost halved it, with emissions expected to be around 55% of the legislative standard. Therefore, the house, while it easily met the regulations in force at the time, would also have met the more stringent regulations that came into force in late 2010, with the potential of also meeting the further enhanced standards that are expected to be released in both 2013 and 2016, as the Scottish Government strives to achieve its ambitious environmental targets.

The fabric of the building also significantly exceeds that required by the Building Regulations. With U-values, the mark of the thermal performance of a specific building element, reading as follows for the walls, maximum allowed 0.25 w/m²K, actual 0.11 w/m²K and for the roof, maximum allowed 0.16 w/m²K, actual 0.12 w/m²K.

The house was also designed to the highest Ecohomes rating of ‘Excellent’.

Off-Site Manufacture

The Modular House was constructed using a Closed Panel timber frame system, a system that Bracewell Stirling developed with manufacturer Scotframe Timber Engineering Ltd, initially as part of a roll out of affordable homes across the north of Scotland for the Highland Housing Alliance. The system utilizes a ‘Supawall’ injected polyurethane foam timber frame panel at its core and is delivered to site complete with external finishings, doors, windows and internal service zone.

Bracewell Stirling’s involvement in the development of the design of the system, including the design of the panel build-up and junctions, as well as the practicalities of transportation and erection, have gone a long way towards delivering what is a highly insulated and extremely air tight and therefore draught free house.
The construction system has the advantages of minimising on site construction periods (Plot 15 was the first house completed at the Expo); improving construction quality through factory control of panel assembly; less wastage and reduced transportation; and, reduced defects through improved quality and reduced exposure to the elements during construction.

Bracewell Stirling is proud to have been instrumental in the successful development of this product, which is now being rolled out on many development sites across the country, a product which embraces the principles of Modern Methods of Construction where the target is to provide better quality products in less time.
Plot Design Constraints and Features

The Expo brief dictated that the house on Plot 15 should follow the street frontage of North Street. This design constraint came with its own challenges as the street frontage at this plot turns slightly right halfway along the plot frontage, resulting in a ‘kinked’ front elevation to the house.

The brief also dictated that there could be no main windows on the ground floor storey on the street frontage.
The solution adopted for The Modular House was to build the house out of two 2-storey blocks, with the south-most block stepped back from the street frontage to allow south facing windows to be located on the other block, serving both the lounge and the kitchen, but sited so that they would not overlook the neighbouring property to the south. To maintain the ‘kinked’ street frontage a single storey office space was provided at ground level to the front of the south-most 2-storey block, the roof of which doubled as a south facing deck area.
Internally natural light and space are important elements of this house with a double height volume over the ground floor kitchen, providing linkage with the first floor lounge. Windows, where allowed by the brief, are sized to provide a successful balance of natural light without compromising the internal comfort of the house through excessive solar gain or glare.
The house is one of the largest units at the Expo, comprising of 3 public rooms, 4 bedrooms and an integrated office space, all within a 169m$^2$ floor area.

The house is clad in a combination of locally sourced hard wearing timber linings and white and grey render panels that are finished with a high performance thin coat render system. The external aesthetic of the building is bold and contemporary while at the same time being sympathetic to its Highland setting.
Summary

The Modular House at Plot 15 of the Scottish Housing Expo is considered to be a successful exercise in the use of an off-site manufactured construction system, delivering reduced building heat losses, reduced CO₂ emissions and reduced running costs for the occupant.

Bracewell Stirling Consulting have set a high benchmark for low energy housing at this plot, but it is a benchmark that can and should be achieved in the mainstream housing market and for that reason the house has achieved its goal.