ENERGY EFFICIENCY AND RENEWABLES IN NEW HOUSING IN IRELAND

J Owen Lewis and John R Goulding

Energy Research Group,
School of Architecture, University College Dublin
Richview, Clonskeagh, Dublin 14, Ireland.
Tel +353.1-269 2750, Fax +353.1-283 8908
Email: lewis@erg.ucd.ie

ABSTRACT

Approximately 300 low energy houses have been built in the Republic of Ireland by the multi-national CRH Plc and South Dublin County Council as part of a co-ordinated European Commission-supported demonstration project, RE-Start (Renewable Energies Strategies and Technology Applications for Regenerating Towns). Significant energy savings, reductions in environmental impact and improvements in indoor comfort conditions were the project's principal objectives, achieved through a broad range of passive and active renewable energy and energy conservation measures that have been incorporated in the design of the buildings and their sites, representing considerable performance improvements by comparison with homes built to the minimum requirements of the Irish Building Regulations.

KEYWORDS

Environment conscious building, mass housing, case studies

INTRODUCTION

The RE-Start project (Renewable Energies Strategies and Technology Applications for Regenerating Towns) is a demonstration action part-funded through the European Commission's Framework Programme for Energy Research and Technological Development that aims to save over 28 MWh of energy and 5000 tonnes of CO_2 per year in new energy-efficient homes in eight European Union Member States, in addition to the creation of many jobs in the construction sector.

Approximately 300 RE-Start homes have been built in Ireland by the two principal partners in the project: CRH Plc (Cement Roadstone Holdings); and South Dublin County Council (SDCC). Other Irish participants included Allied Irish Banks plc as chair of the consortium, and the Energy Research Group at University College Dublin which provided the technical secretariat. The Irish Energy Centre provided additional funding to the Irish strand through its Energy Efficiency Investment Support Scheme; this organisation was recently re-constituted as the Sustainable Energy Authority of Ireland.

The aim of this project was to address the challenges of integrating energy efficient design principles in mass urban housing, in both public and private sectors. The consortium was designed to bring together a combination of industrial strengths and municipal responsibilities to address the issues and encourage change in construction practices and standards, and demonstrate sustainable local energy planning.

BACKGROUND

European Dimension

The Irish RE-Start project was part of a wider European action supported within EC DG TREN's Thermie Programme, and dedicated to demonstrating excellence in energy and environmental integration in urban building design and construction. Other cities participating included Barcelona, Glasgow, Greater Lyon, Torino, Rotterdam, Copenhagen, and Porto. The project was co-ordinated by RESET (Renewable Energy Strategies for European Towns, led by SOFTECH Turin). RE-Start aimed to provide the public authorities, the institutions and the professionals of these cities with exemplary urban projects concerning innovative energy-environmental integration at the city scale.

Irish Objectives

Within the overall project, the Irish strand addressed the challenges of integrating energy efficient design principles in mass urban housing. The housing sites were originally distributed throughout the country in a variety of urban environments, mainly in the capital city of Dublin but also in a number of the larger towns and cities, in Limerick, Waterford and Cork.. The houses were built by private developers, housing associations and by South Dublin County Council as part of their social housing portfolio. The house types vary from one site to another to account for local climatic variations and residential needs.

The project constitutes the single most important initiative in Ireland to date directed at addressing the potential for the design and construction of more energy-efficient housing. It is expected to attract considerable attention from local authorities, semi-state bodies as well as the private sector. The potential to influence future norms and standards is significant.

TECHNOLOGIES

Site Layout, Envelope Materials and Components

The project aimed to optimise the microclimatic conditions of each site (wind/shelter, solar radiation), the bioclimatic design of the building envelope (form and materials) and the use of renewable energies to minimise the use of conventional fuels in the buildings, to improve thermal comfort for the occupants and to minimise environmental impact through these energy saving measures and in the selection of construction materials from sustainable sources with appropriate life-cycle characteristics, longevity, recyclability, etc.

Site planning while important to more than the overall energy strategy, included

- the development of neighbourhood planning, design and building technology guidelines for energy efficient urban design

- a bio-climatic approach which seeks to integrate local climatic studies, the enhancement of local natural features, wind breaks, shelter belts and optimum orientation, with energy efficient estate layout and house design in a comprehensive neighbourhood approach towards energy efficiency.

To achieve an integrated design, getting several aspects and approaches right were perceived as essential to the successful achievement of the project's objectives:

- Complete team involvement from the early stages.
- Site layout and orientation.
- The building envelope and structural elements.
- Thermal capacity.
- Building detailing.
- Energy supply to include active solar system.
- Ventilation.
- Lighting.
- Meeting market requirements vis-à-vis house design.

Excavated material from the house sites (topsoil etc) was retained on site to provide berming as part of the wind shelter belts. The significant cost savings (estimated at about €400 per dwelling) were applied to the cost of energy systems in the buildings. In addition, new design standards for roads, paths, etc., in response to the microclimatic analysis and a re-evaluation of site layout considerations resulted in lower site development costs These savings also reduced the cost of energy systems in houses.

The Dutch Environmental Preference Method was used to evaluate the life-cycle environmental impact (from mining/extraction through manufacture to use in the building and disposal or recycling after demolition or removal) and energy saving potential of construction materials and systems specified. Recycled materials and those which have better environmental performance and less impact were preferred materials. Materials containing harmful substances, CFCs, toxins or giving rise to volatile emissions were rejected.

The higher building construction costs, as indicated by comparison with standard house costs (1991 Building Regulations) and those of houses constructed in Ireland under a previous THERMIE-funded project could be offset in both social and private developments by:

- More economic site design considerations
- Reduced road / street widths
- Lower building maintenance costs
- Health improvements: reduced health and in-care costs due to higher comfort standards and higher quality environments created.

The elemental cost breakdown of typical energy components identified an extra over-cost of between €1000 to €3000 per dwelling as achievable target off-sets which could come within the range of savings described above when comparing a more energy efficient house with a current standard local authority dwelling; the re-use of excavated material for berms alone more than paid for the extra insulation involved.

Integrated Services

In addition to electronic control of condensing gas boilers linked to thermostatically controlled radiators for example, the occupants are provided with an operations manual

clearly explaining how each of the systems (passive, active, auxiliary, etc.) should work and the implications for comfort and energy use of improper operation. A series of workshops was planned to demonstrate the systems to occupants, and to give some basic information on energy efficiency and environmental impacts of energy use.

In the CRH SafeWarm Home system there is an integrated energy management system which (a) maximises the amount of solar energy used for space and water heating; (b) minimises the amount of electricity used by the fans and (c) controls the temperature of the house and the DHW.

Renewables

Passive solar gain is optimised through appropriate sizing of windows, orientation of the buildings and through careful site design to ensure maximum solar access to buildings. Overshadowing of buildings and other obstructions is an important consideration in site layout. The Kollectaire system, which is installed in a proportion of the houses, is a fully integrated active solar heating system which, the promoters claim, when incorporated in full production in the SafeWarm Home will be economic to the volume builder in that the cost of building per square meter will not be different. The energy savings achieved with the SafeWarm Home technology are reportedly substantial -85% savings in the costs of space heating and DHW. These savings are made up as follows: 25% due to the extra insulation, 25% due to the air tightening and heat recovery ventilation and 50% due to the active solar heating system.

CASE STUDIES

Brookview

In the housing boom still being experienced in Ireland, one of the particular challenges facing those seeking to improve energy performance is in selling the benefits of energy efficiency to private sector builders, since demand for any housing meeting basic Building Regulation Standards is high. In other EU Member States, where the market is more competitive, energy efficiency has become a selling point differentiating the RE-Start developments from conventional housing.

Yet it is this backdrop of rapid growth in the housing sector that makes home energy efficiency of particular importance in Ireland. The RE-Start Ireland project partners set out to work together to promote high standards of energy efficiency and environmental design in Irish buildings and to see these design and implementation principles applied both in private and local authority schemes nationwide.

The Brookfield development in Tallaght West, Dublin can be used to provide an illustration of the –by typical European standards- modest, but nationally significant measures implemented. The development combines a mix of housing association, county council and private dwellings, incorporating bioclimatic design and improved energy conservation measures including: increased levels of insulation and low emissivity glazing. Seventy-six houses have been constructed for South Dublin County Council, completing the social housing development on the site. Private and housing association development consisting of 224 houses was also provided within the development.

The Brookview houses incorporate levels of roof, wall, and floor insulation above Building Regulation Standards; low-emissivity double glazed windows; increased mass of construction, promoting enhanced thermal inertia; condensing gas boilers, incorporating advanced heating controls; landscaping windbreaks, and draught lobbies at front and rear entrances. The houses are expected to perform more than 40 per cent more efficiently than comparable housing meeting current building regulations.

In addition to electronic control of the condensing gas boilers linked to thermostatically controlled radiators, the occupants are provided with an operations manual clearly explaining how each of the systems should work and the implications for comfort and energy use of improper operation.

Outstations to the SDCC Headquarters BEMS system (of which there are already several in outlying Council buildings) are being extended to include buildings in the scheme to provide performance data, monitoring and control. There is an established active partnership between SDCC and residents concerned with energy issues. It is envisaged that this collaboration will grow and that, in tandem with job creation initiatives and the development of energy management training programmes, the necessary skills to manage, maintain and monitor energy systems, and to carry out energy retrofit campaigns will be available locally.

Figure 1: SDCC houses, Brookview, Dublin

SafeWarm

The CRH element comprises private houses designed to be incorporated in conventional private sector developments of semi-detached dwellings using the 'Safewarm' system. Safewarm blocks weigh 235 kg per m of wall. This compares to 400 kg of concrete in normal cavity wall construction. Roadstone, the Safewarm manufacturers, is investing in crushers and screens in Belgard Quarry, the largest quarry in Ireland, to recycle concrete and concrete blocks. In these houses the thermal capacity of the concrete helps utilise the solar gains associated with the Kollectaire heating system (see below).

The wall and floor insulation is high density expanded polystyrene which is CFC-free and recyclable. Aeroboard Ltd. has installed a facility to recycle waste and reject polystyrene in their plant at Askeaton Co. Limerick.

Thermal losses are estimated to be reduced by a factor of 50%, i.e. the fabric losses combined with the air-tightening of the envelope give a specific heat loss co-efficient which is half of that in a typical house being built in Ireland today.

The Kollectaire system is a fully integrated active solar heating system. The solar panels form part of the structural roof of the house, representing a large area of the South facing roof (see Fig. 3). It is an important part of the concept that the parts of the heating and ventilating system are fully integrated with elements that form the building fabric of the house: the heating system incorporates the ventilation and the structural concrete in the house forms the thermal store for the solar heating system. The cores in the pre-stressed hollow core floors are used as air ducts for the ventilation system.

Overall, the embodied energy of the SafeWarm Home is lower than that of a conventional house as there is less concrete in the walls, there are no steel radiators, no copper distribution piping, and generally the fabric of the building is used as part of the heating system.

Figure 2 CRH Houses, Dublin

In the Safewarm Home system there is an integrated energy management system which maximises the amount of solar energy used for space and water heating, minimises the amount of electricity used by the fans, and controls the temperature of the house and DHW. The energy management system is built around the PLC which forms the intelligent core of the system -the PLC is, of course, not accessible to the householder. The controls for the user are simple and readily understandable, and consist of a programmable thermostat and a boiler timer.

CONCLUSION

Designed to influence the urban housebuilding market by demonstrating the feasibility and practicality of low energy houses, the Irish strand of the RE-Start project was intended to assist in establishing as the norm the use of energy efficient technologies and passive and active solar energy systems in new private and public sector housing which will result in substantially reduced annual space and hot water costs for the owner or tenant.

In this way the houses should act as models for influence and replication and support a widespread take-up of improved energy technologies in Ireland, and contribute to reducing emissions associated with climate change.