PEB Exchange, Programme on Educational Building 2004/08

Low Energy Schools in Ireland

Martin Heffernan

https://dx.doi.org/10.1787/617451000554

OECD

PEB Exchange Programme on Educational Building

LOW ENERGY SCHOOLS IN IRELAND

Out of a commitment to reducing carbon dioxide emissions, Ireland's Department of Education and Science has designed and constructed two low energy schools, in Tullamore, County Offaly, and Raheen, County Laois. With energy use in buildings responsible for approximately 55% of the CO_2 released into the atmosphere and a major contributor to global warming, the Department researched the latest construction techniques and systems that lower energy consumption. It is hoped that the lessons learned from the construction and monitoring of these buildings will assist in reducing the energy usage of future schools. Ireland's national energy supplier partly funded the buildings' energy saving features and the costs of monitoring the buildings. A third low energy school is at the planning stage.

The benefits of low energy schools go beyond reduced CO_2 emissions. The environmental impact of the Gaelscoil and Raheen school buildings throughout their life will be a fraction of that of a traditional building construction, and the occupants will have the satisfaction of knowing that their building respects the environment. Low energy buildings also improve comfort associated with increased daylight levels and the users' ability to control natural ventilation. In addition, these schools provide an ideal opportunity for students to learn about responsible building technologies.

The objectives for the schools were to provide quality educational facilities appropriate to their users' requirements. The project not only encompasses low energy design, but also involves providing feedback to the Department of Education and Science on the schools and their systems' operation, and using the buildings as active resources for learning about energy conservation and sustainability.

Through the use of advanced energy and daylight simulation software, the design team were able to gain a better understanding of how the buildings would react with their environments, and understand how these reactions could be used to improve the school environment while minimising energy consumption.

Gaelscoil An Eiscir Riada, Tullamore, Co. Offaly

The design for this eight-classroom primary school aimed to consume 20% less energy than a similar school built to current good practice standards, to generate zero CO_2 in the operation of its services and to show sustainability in its construction. The project is complete and in use since 2003.

Gaelscoil An Eiscir Riada, Tullamore, Co. Offaly

The Gaelscoil is equipped with a detailed monitoring system that provides information vital to understanding energy and water use in school buildings. The building and its systems will be monitored in detail over the coming years. An advanced building management system was installed to gather information on the building's performance and to assist the occupants in adjusting the controls to ensure minimum energy wastage.

To consume less energy, the Gaelscoil's design team gave attention to reducing infiltration, selecting building materials, using natural ventilation and daylight, and installing a rainwater recovery system and an advanced heating system. A touch-screen display teaches the building's users about the school's energy use.

Infiltration, heat loss due to unwanted air leakage, is typically a major source of energy wastage, particularly when a building is unoccupied overnight. Heat slowly leaks out and more energy is needed to bring the building back up to temperature the following day. This school had its air tightness tested by forcing air into the building under pressure and measuring the leakage. Leakage routes were also tracked using smoke tests. The thermal insulation levels specified were double those required by the building regulations, to reduce the energy escaping from the building fabric.

Consideration was given both to the energy used during the building's construction and to selecting **materials** that are responsive to the environment. A lightweight timber frame structure was chosen that minimised the environmental impact of construction.

Particular attention was paid to providing adequate **natural ventilation**. Engineers carried out detailed simulations to optimise distribution of ventilation air within the classrooms.

The building plan was arranged with most of the windows facing east to benefit from the sun's free heat. Using **natural daylight** in all classrooms also makes it possible to turn off the energy consuming lights for most of the year. During daylight hours, artificial lighting should not be required in classrooms for at least 80% of the year. Careful design of the windows, using advanced computer calculation methods, insures that the correct daylight levels are achieved. In addition, advanced lighting controls have been used to prevent lights from being left on when they are not required.

Rainwater is collected from the roof of the building and used for flushing toilets.

A ground source heat pump was selected as the building's **heating system** in order to minimise CO_2 emissions. Water arrives at the heat pump after passing through a number of pipes beneath the ground outside the building. The pump moves heat from the ground, which effectively acts like a huge solar collector, into the building. An underfloor heating system is used to create a low flow temperature from the heat pump. The underfloor system stores heat, thus allowing the heat pump to be operated during the night when electricity rates are cheaper. The performance of the heating system is carefully monitored.

At the Gaelscoil, the electricity to run the heat pump and the rest of the building is taken from a group wind scheme, therefore generating no CO_2 in the building's operation.

The Gaelscoil project incorporates a **touch-screen display** positioned near the school's entrance that is linked to the Building Energy Management System (BEMS) and provides the children and visitors with energy and environmental information related to the building. A cartoon character is used on the screen to encourage the children to learn about the building construction and its day-to-day energy use. The touch-screen system is also connected to the Gaelscoil's ICT system and can provide BEMS information to any computer in the school for classroom-based project work.

Raheen National School, Raheen, County Laois

Raheen National School, Raheen, County Laois

Raheen National School is a new three-classroom school designed for sustainability. The building promotes low energy use and good daylighting levels through attention to insulation, air leakage, rainwater, heating, lighting methods and roofing. The school is in use since 2003.

A sophisticated dynamic thermal model of the school was created using a computer program by Lawrence Berkeley National Laboratory (United States). The program simulated over 150 different permutations and combinations of building and systems configurations and compared capital and running costs. Many of the resulting recommendations related to architecture, with a view to reducing energy needs by passive solar heating, natural lighting and so on. Building orientation was studied, as well as numerous constructions with different insulation types.

The school is of timber frame construction, which made it possible for thicker **insulation** to be used than in conventional cavity wall constructions. The wall insulation is of cellulose (recycled newspapers), which was sprayed into place once the building was water-tight. Analysis compared the advantages of a heavy structure against a light one, and the lightweight structure was found to be more beneficial, mainly due to the shorter hours and smaller number of days the school is in use compared with other institutional buildings. The lightweight structure was also preferred because it allows the school to respond more rapidly to its heating system (to heat up quickly and to benefit from solar gain more immediately), whereas a heavy inner wall leaf would take all day to store solar heat and only release it after the students had left for the day.

The mechanical and electrical engineers noted that typically a large part of the energy to heat a building serves to heat air entering the building due to infiltration. As part

of the project's architectural specifications, an **air leakage** rate and a test to verify the school's air-tightness were recommended. An "air leakage index" of 5 $m^3/hr/m^2$ at 50 Pascals pressure was specified.

Pressure testing[1] was executed, using specialist equipment. The purpose of the pressure test is to find unknown leakage paths and seal them. The first test showed leakage rates above the specified value. During the test, the building was filled with artificial smoke, and the locations where it emanated from the building demonstrated the predominant air leakage paths. A subsequent pressure test met the intent of the specifications.

Raheen uses **rainwater** for sanitation purposes. Rainwater is collected from the roof and filtered before being stored in a purpose-built storage tank. In dry weather, the tank is allowed to become almost empty at which point automatic controls maintain a minimum level of water by topping up with local mains water. The quantity of water delivered to the toilets and the quantity of mains make-up water is recorded hourly by a building management system linked to the Department of Education and Science's engineers in Tullamore, Co. Offaly. The results indicate the efficiency of the collection system and give insight into the quantity of water used in toilets. The logic for using rainwater in toilets is strong: it reduces the burden on both the local mains water delivery system and storm sewage disposal system. A detailed simulation of the rainwater collection system was carried out for various tank sizes, and a computer model was developed for the project, which estimates hourly demand and available rainwater throughout the school day.

1. Some feel a dichotomy exists in pressure testing schools. On the one hand, a leaky school will waste energy; on the other hand, a school requires permanent background ventilation to reduce the risk of condensation. Raheen's engineers Overy and Associates argue that no dichotomy exists since the permanent background ventilation openings are provided in known amounts.

Before choosing a **heating** system for the building and the domestic hot water, comparisons were carried out of different mechanical and electrical systems such as the following:

- Oil fired space heating with radiators, versus ground source heat pumps coupled with underfloor heating.
- Modular boilers using between one and four boilers.
- Heat pump water heating, versus centralised oil fired domestic water heating, versus decentralised electric domestic hot water heating.
- Weather compensating controls.

The studies concluded that in the absence of natural gas, conventional oil fired boilers with radiators would offer the lowest CO_2 emissions. One boiler serves for heating both the building and the domestic hot water.

High fluorescent **lighting** is used throughout the school; however to reduce the level of artificial light when there is sufficient natural light, automatic photocell-controlled dimming and switching of luminaries was installed. All linear lamps are equipped with electronic ballasts. The fittings near windows have dimmable ballasts whose output is controlled by a photocell mounted on the ceiling. Separate light switches are provided for the normal lights and the dimmed lights. In response to daylight, manual switching of lighting was chosen, after considering several schemes involving automatic variable dimming.

The school's circulation spaces are principally lit by daylight from above. In the corridor and lobby, photocells automatically switch the lights on when the natural lighting level drops below 150 lux. The corridors are so well lit with skylights that the lights only come on during the very dullest of days. Neon indicators on the switches serve as a reminder to switch the circuits off at night.

In the storerooms, lights with integral infra-red presence detectors are installed. No wall switch is provided for these lights, making it impossible for them to be left on when the room is unoccupied.

For exterior lighting, compact fluorescent and high pressure sodium lamps are used. Exterior lights for safe entry and egress are switched on by a photocell and off by a timer. This ensures that they only come on when required at dusk but do not remain on all night. Security lighting is provided by floodlights with PIR sensors.

The **roofing** materials were selected to achieve a balance between their ecological, energy efficient and practical functions. The roof system, the same as used for the Gaelscoil, has a lightweight green roof option that enhances the insulation performance of the build-up. The roof also has a low embodied energy, continuously processes CO_2 gases through photosynthesis and serves as a specific learning tool for the pupils through supporting micro-ecosystems. Its sedum blanket contributes to rainwater attenuation and provides external noise absorption.

Article by Jeff Colley, Construct Ireland

For further information on sustainable construction and development visit www.constructireland.ie or contact:
Martin Heffernan, Planning and Building Unit
Department of Education and Science
Tullamore, Co. Offaly, Ireland
Fax: 353 506 51119
E-mail: martin_heffernan@education.gov.ie

Roseberry Road Primary School

Poole Road School for Specific Purposes

Horsely Primary School

Source: Hansen Yuncken

AUSTRALIA'S FIRST PUBLIC PRIVATE PARTNERSHIP SCHOOL PROJECT

The design and construction of nine schools has commenced in Australia using a Public Private Partnerships (PPPs) methodology. This is the first project in Australia where social infrastructure has been acquired in this way.

PPPs are arrangements commonly used in the United Kingdom and throughout European Union countries to acquire social infrastructure such as toll roads, rail projects and bridges which derive an income for the private sector operator. However more and more projects involve developing hospitals, prisons and schools, where the infrastructure provides little or no income for the developer; the developer relies entirely on government payments for its income.

The Australian project is being managed by the New South Wales (NSW) State Government through its Department of Education and Training, the country's largest provider of educational services.[1] The PPP contract for the new schools has been let to Axiom Education Pty Ltd who is financing the design and construction of the schools and providing facilities management services including building and grounds maintenance, security, and cleaning for the 30-year period of the contract. The Department of Education and Training pays a monthly fee for the schools being "available" for classes.

The advantages recognised by the government of entering into a PPP arrangement of this type include increased attention to education and cost savings. The school's

1. The Department operates over 2 200 schools and 130 post-secondary education colleges and manages AUD 15 billion in assets.