



PUBLIC SECTOR PROGRAMME OVERVIEW



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MESSAGE FROM THE MINISTER FOR COMMUNICATIONS, MARINE AND NATURAL RESOURCES



Buildings have a large part to play in the abatement of greenhouse gas emissions in order to meet our Kyoto commitments, as well as reducing our reliance on imported energy. It has been estimated that lighting, space heating and cooling of buildings is responsible for 45% of final energy use in Ireland. EU research has indicated a potential energy efficiency improvement in the

building stock of over 20% by 2010, through applying stricter standards to buildings undergoing refurbishment and to new buildings.

Against this background, it is salutary to note that energy use in Ireland's commercial and public services sector grew by 70% over the period 1990 to 2004. This of course reflects a dramatic growth in the services sector of the economy, but also highlights the associated challenge of restraining energy demand and of employing best available technologies and practices to meet the functional service needs of heat, cooling, light and power for a high quality working, business or leisure environment. Success with this particular challenge is an important part of the process of achieving the imperatives of national energy policy. With the outlook of high fuel prices and the imminence of building energy performance rating under the EU Energy Performance of Buildings Directive, the benefits of improved practices – and the penalties of inferior practices – are now set to become ever more visible in the marketplace.

Sustainable Energy Ireland's (SEI) Public Sector Programme recognises the diversity of buildings in this sector, their potential for improvement, impending regulations and directives, and the capacity to lead and influence other sectors

of the economy. Support for exemplary demonstration buildings, for capability building by design professionals, and dissemination of results through case studies, seminars, and print and electronic publications is central to the activities of the programme. The buildings supported – in the central government, local authority, education, health, defence and non-commercial semi-state sectors – can be seen as a microcosm for much of the services sector as a whole.

Through its 151 approved projects, the programme promotes energy efficient designs, technologies and services in new and retrofit projects, on a shared cost basis with the beneficiary client organisations. Under the programme energy performance is enhanced through design, investment and management. The portfolio of supported projects act as inspiring examples of best practice, as a demand leader for the services and technologies involved, and help build sustainable energy capabilities among key service professionals.

The programme has three funding elements: the Design Studies Support Scheme, the Model Solutions Investment Support Scheme and the Energy Management Bureaux Scheme. The Design Studies Support Scheme provides support for professional expertise to examine the technical and economic feasibility of design and technology options that extend beyond established practice. The Model Solutions Investment Support Scheme supports capital investment in energy management and technology solutions in new build projects or upgrades to existing buildings. The Energy Management Bureaux Scheme supports groups of organisations in procuring outsourced energy management services to manage energy usage in a structured manner, and to identify and implement cost-efficient energy saving opportunities.



In order to disseminate the results of the programme into the wider services sector, the programme has also funded a number of more generic studies and publications, including evaluation of a selection of substantial capital investment projects, publication of model design studies and case studies, research of possible Irish building Energy Performance Indicators and publication of a guide for energy managers.

To capitalise on the exemplar role by the State in procuring expertise in energy efficient building design, technologies and services, and their subsequent demonstration within its estate of buildings, the forward focus of the programme will be on replicating and amplifying the findings, lessons and capabilities developed from the programme into the wider market of public and commercial services buildings.

This brochure provides a shop window on the projects funded to date under the SEI Public Sector Programme. I hope and expect that these projects will inspire and inform building owners and operators in all sectors to make more intelligent energy investment and management decisions. Doing so will make sense, for their own pockets in terms of affordable running costs and the future value of their properties, for the nation in terms of meeting our international obligations on climate change in particular, and for our fragile planet.

Noel Dempsey, T.D.

Minister for Communications, Marine and Natural Resources.



BACKGROUND INFORMATION

Sustainable Energy Ireland (SEI), Ireland's national energy authority, promotes and assists environmentally and economically sustainable production, supply and use of energy, in support of Government policy, across all sectors of the economy.

SEI aims to improve energy efficiency, advance the development and competitive deployment of renewable sources of energy and combined heat and power, and reduce the environmental impact of energy production and use, particularly in respect of greenhouse gas emissions.

Activities include providing policy support, operating grant support schemes and delivering information support aimed at increasing public awareness of energy related issues.

Arising from the EU's ratification of the Kyoto Protocol, Ireland is committed to limiting the total emission of greenhouse gas (GHG) to 13% above 1990 emission levels by the period 2008-2012. However, as shown in Figure 1, Ireland's Kyoto target was already breached by 1997, with 2004 emissions 28% above 1990 levels. Thus Ireland's Kyoto commitment represents a significant challenge to all sectors of the economy.

The service sector is the most heterogeneous of all sectors of the economy and includes both commercial service activities (banking, cinemas, hotels, retail outlets, swimming pools, etc.). Buildings are the predominant point of energy consumption (for space heating, lighting and water heating) within this sector, the balance being mainly represented by certain municipal and civic facilities.

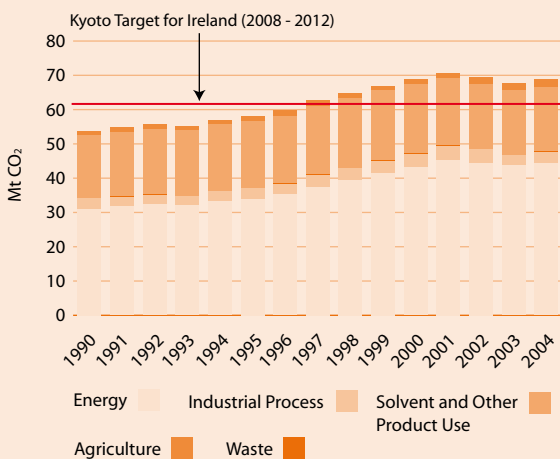
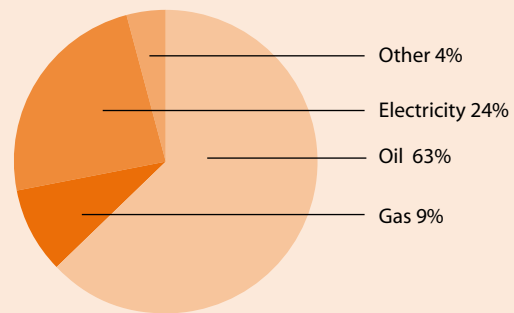


Figure 1: Projected Greenhouse Gas Emissions from Ireland under business as usual scenario. Kyoto limit is 60.159 Mt CO₂ equivalent per annum in period 2008-2012.

Shares % of final energy consumption 1990



Shares % of final energy consumption 2003

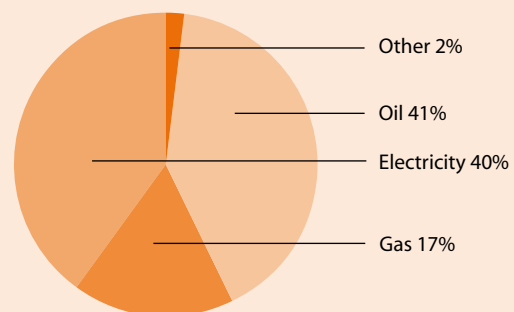


Figure 2



Final energy use in the commercial and public services sector grew by 70% over the period 1990-2004. Energy related carbon dioxide emissions from the sector grew by 62.5% during this period. Electricity related emissions accounted for two thirds of total emissions, with the balance arising from the combustion of oil and gas for heating purposes.

Between 1990 and 2003 the changes in the relative shares in each of the fuels, shown in figure 2, point to the increasing importance of electricity in the services sector. The number of buildings has increased considerably during this period. Total electricity consumption increased by 192% between 1990 and 2003, making it, after oil the most significant energy source in the fuel mix. Electricity consumption grew by 17% in 2003 alone as a result of the proliferation of office equipment including computers, printers, photocopiers and air conditioning.





PROGRAMME ELEMENTS

The aim of the public sector programme is to stimulate the application of improved energy efficiency design strategies, technologies and services in public sector construction and retrofit projects, acting as both an exemplar for good practice and as a demand leader for the services and technologies involved. The programme was launched in 2001, with a budget of €12.7 million, funded through the National Development Plan.

The programme consists of three elements:

1. DESIGN STUDY SUPPORT SCHEME

(Grant support of up to 50% of cost of study, maximum €20,000)

The primary objective of the Design Study Support Scheme is to encourage the inclusion of energy efficient design and technology solutions in the specification of new build and refurbishment projects. The scheme provides grant support towards the procurement of professional expertise to examine such options in both existing and proposed public sector buildings.

2. MODEL SOLUTIONS INVESTMENT SUPPORT SCHEME

(Grant support up to 50% of cost of implementation, maximum €500,000)

The objective of the Model Solutions Investment Scheme is to demonstrate the use of energy efficient solutions in new and existing public sector buildings, thereby offering examples of good practice that encourage replication into the wider commercial building market. The scheme provides investment support for such solutions in both existing buildings and new build projects.

3. ENERGY MANAGEMENT BUREAU SERVICE

(Grant support up to 50% of cost of service)

The objective of the Energy Management Bureau Service is to encourage the development of private sector energy management services, to provide specialist off-site energy control and management for public sector organisations that lack the critical mass to meet this need from internal resources. Towards this end, the scheme supports the establishment of a number of bureaux to collect, monitor and report on energy usage in large groups of non-commercial public buildings. Successful demonstration of this exemplar approach in the public sector is expected to lead to replication into the wider commercial buildings sector.



PROGRAMME STATUS AND SPEND

Market response to the Public Sector Programme has been very encouraging, with considerable progress being made in terms of projects completed and the resulting reductions in energy usage and emissions. The breakdown of funding committed to each of the project elements is as follows:

Scheme	Applications approved	Budget committed
Design Study Support Scheme	79	€650,000
Model Solutions Investment Support Scheme	71	€10,680,000
Energy Management Bureau Service	3	€1,300,000

The pie chart in Figure 3 illustrates the sectors supported as a percentage of total programme funding commitments. Health, education and local authority applications account for the majority of projects under the programme, with each of the three sectors receiving similar levels of funding.

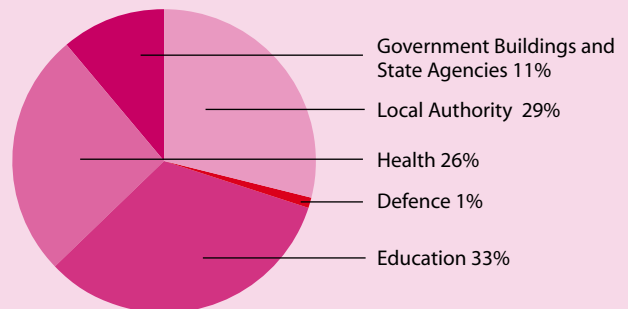


Figure 3: Funding Commitments as a percentage of total

The design study and model solution investment support schemes were closed early in 2004 as all available funds were committed at that stage.





PROGRAMME ACTIVITIES TO DATE

The programme has enabled public sector clients to assess and appropriately invest in technology solutions to reduce ongoing energy demand and costs, making considerable progress both in terms of projects completed and the resulting reductions in energy usage and emissions.

In order to disseminate results of the programme into the wider tertiary buildings sector, the programme has also funded a number of more generic studies and publications, including evaluation of a selection of model solution investment support scheme projects, publication of model design studies and case studies, development of Irish building Energy Performance Indicators and publication of a guide for energy managers.

DESIGN STUDY SUPPORT SCHEME

A total of 79 studies being completed under the Design Study Support Scheme. The portfolio of design studies supported under the scheme cover a wide variety of projects, both new and existing buildings, across a range of sectors. The pie chart in Figure 5 illustrates the number of projects supported under the Design Study Scheme by sector. Public buildings in the education, Local Authority and health sectors attracted the highest number of successful applications under the scheme.

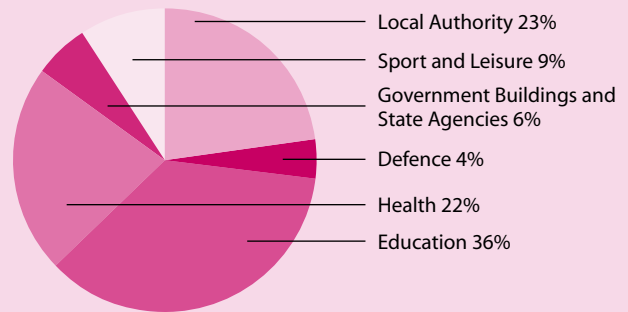


Figure 4: Design Study Support Scheme Projects by sector

The studies examine and report on the technical and economic feasibility of a wide range of energy efficient design and technology solutions. They also provide information on aspects of design that would lead to an improvement in energy performance over and above that required by present Building Regulation Standards.

48 of the design studies supported under the scheme went on to become model solutions.

MODEL SOLUTIONS INVESTMENT SUPPORT SCHEME

A total of 71 projects of varying size and complexity were approved under the scheme, all making a significant statement in terms of building performance, energy savings and associated benefits. Applications were supported by an independently commissioned design study or a feasibility study.

Table 1 shows a breakdown of the technologies supported under the scheme. Note that most of the projects incorporated a number of different technologies.



TABLE 1: RANGE OF TECHNOLOGIES SUPPORTED UNDER MODEL SOLUTION SCHEME

Technology	No. implemented
Improvements to Building Fabric	37
Natural Ventilation Measures	24
Passive Solar Measures	14
Maximising Use of Daylight	19
HVAC Systems and Controls	14
Electrical Energy Use incl. Motive Power	26
Efficient Lighting Systems and Controls	35
BEMS	19
Occupancy Controls	20
Monitoring and Targeting Systems	17
Heating Controls	25
High Efficiency Boilers	17
Heat Recovery	10
CHP	7
Solar Water Heating	12
Renewable Energy Technology	15
Improvements to Heating System	24
Other	7

SEI has commissioned an independent evaluation of model solution investment support scheme projects. The purpose of the evaluation is to investigate the selected projects in detail, looking at the lifecycle of the projects through construction and into the first years of energy use including how changes in cost, difficulties in commissioning and other difficulties influenced the project. In so doing, the evaluation aims to identify a series of 'lessons learned', which will serve to influence how future programmes might be structured and administered.

ENERGY MANAGEMENT BUREAU SERVICE

3 energy management bureaux have been approved onto the scheme:

1. OPW network (office buildings sector);
2. Universities network (4 Dublin universities);
3. Hospitals network (5 Dublin teaching hospitals).

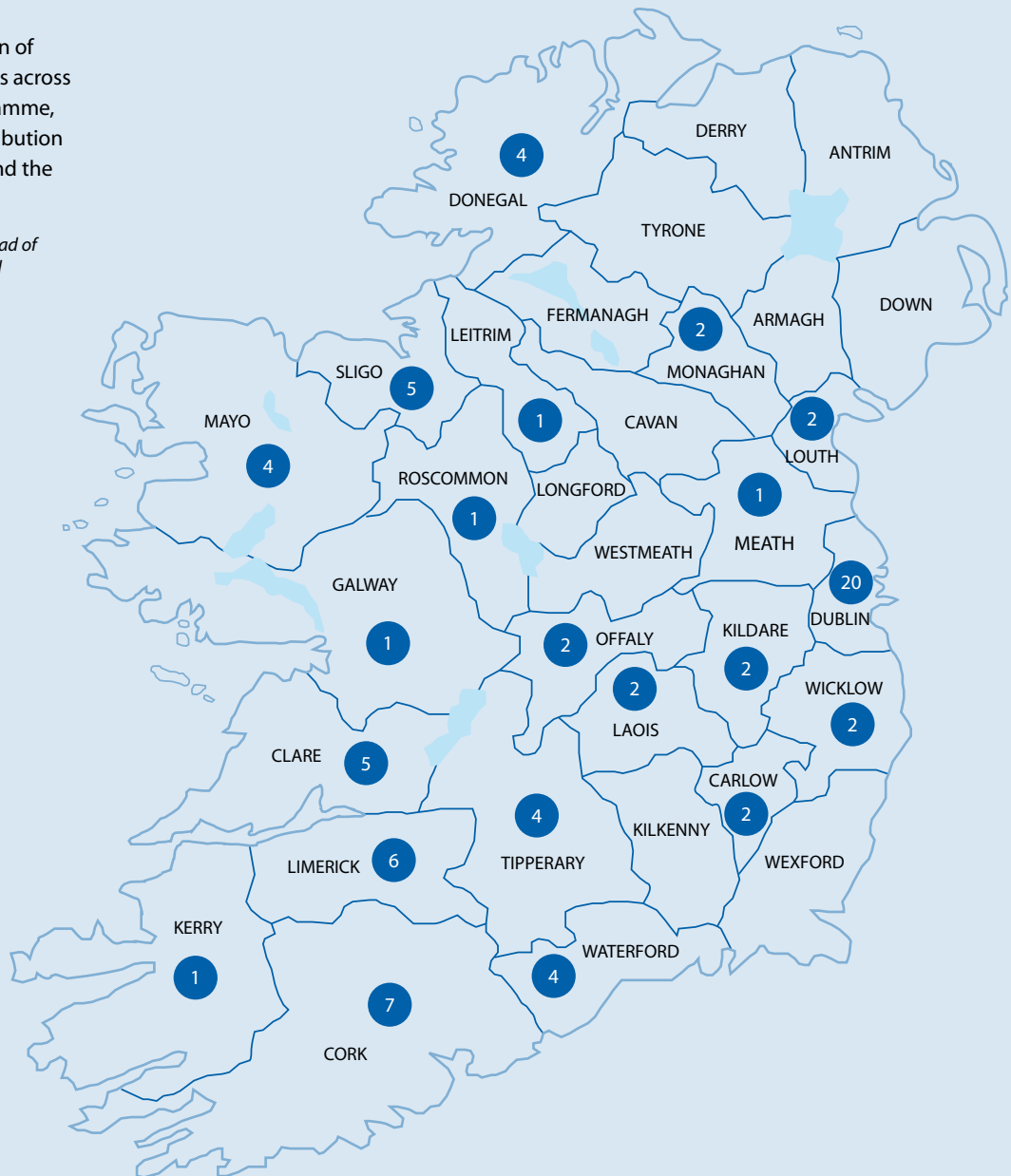
The Universities network e3 is in the third and final year of implementation, with a final target of achieving a 10% reduction in the energy requirement of 30 buildings across the campuses when compared to 2003 usage. The other two networks are at an earlier stage of advancement. Work to connect the 150 or so individual sites in the OPW network to the BMS is complete; the monitoring system is now in place and bureau management service will commence shortly. The Hospitals network is in the early stages of development.



NATIONAL COVERAGE OF BUILDING PROJECTS

Figure 5 illustrates the geographical distribution of grant-supported projects across Ireland under the programme, showing the broad distribution of funded projects around the country.

Figure 5: Geographical spread of projects supported





EXAMPLES OF PROJECTS FUNDED TO DATE

This section of the report provides a selection of the projects funded by the Public Sector Programme. The projects presented are chosen to illustrate the range of projects funded, covering a wide variety of sectors, geographical locations and technologies.

The summaries give an overview of the range of technical energy saving options available in the market place, and also to provide an understanding of the design and implementation processes.

A complete list of projects funded by the programme is included in the Appendix.





MATER AND CHILDREN'S HOSPITAL DEVELOPMENT

Public Body: Mater & Children's Hospital Development Ltd.

Completed by: Conservation Engineering Consultants Ltd.

Project Reference Number: DS/005/02

Completion Date: November 2002

OVERVIEW

The Mater & Children's Hospital Development is the largest health project in the National Development Plan. With a planned completion date of 2010, the new multi-storey development, measuring approximately 54,000 m², will incorporate a significantly extended Mater Misericordiae Hospital and a new purpose-built Children's Hospital to replace the existing hospital on Temple Street, Dublin.

The design study was initiated in the early stages of the design process in order to identify potential energy saving opportunities in the building design, and hence to set energy consumption targets for the new development.

In order to establish a reasonable order of magnitude baseline, against which potential energy saving measures could be evaluated, a review of energy consumption in similar existing hospital buildings was carried out. In particular, oversizing of heating plant was found to be a problem in the reviewed buildings. The primary reason for oversizing is that heating systems tend to be designed for a minimum outside air temperature of -4°C, significantly lower than typical mean winter temperatures in Ireland, with conservative factors of safety compounding the problem. Design codes also fail to take into account increases in the use of electrical and electronic equipment in recent years, with the associated heat output. The combined effect of all these issues results in the boiler plant being oversized and hence operating at a low load, and consequently a low overall thermal efficiency, since the heat losses are approximately constant regardless of operating load.

The following specific energy efficiency strategies were proposed for the development:

- ▶ Maximise the use of natural daylight;
- ▶ Recover heat from M&E plant such as refrigerator condenser units and power factor correctors where possible;
- ▶ Maximise the use of natural ventilation;
- ▶ Reduce electricity consumption in mechanical ventilation system by minimising system pressure drops and making use of stack effects and wind induced pressure gradients;
- ▶ Make energy efficiency an integral part of the purchasing strategy for electrical and electronic equipment.

As part of the study, a database of electrical and electronic equipment in a representative sample hospital department was developed. Operating schedules over a typical seven day period were incorporated into the database, and typical electricity consumption data then added for both standard equipment and energy efficient alternatives. In addition to focussing attention on the high energy consumers, the database allowed potential energy saving options to be evaluated and targets to be set.

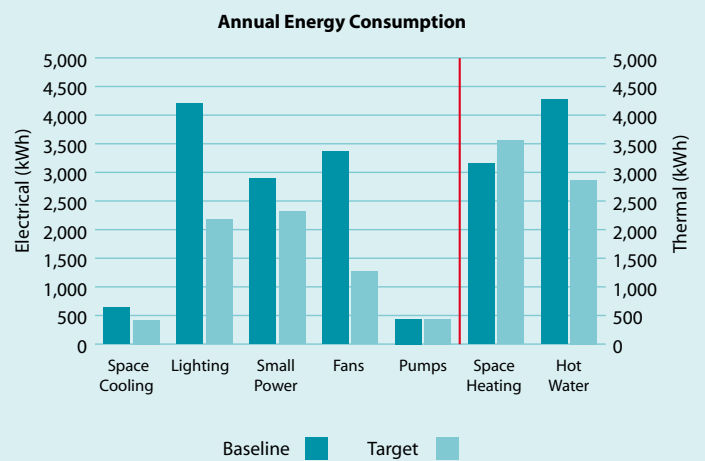
Computer simulations were used to model the effect of the most common wind speed and direction on the building structure, in order to assess the options for using natural ventilation to replace and assist the mechanical ventilation system in the new development. Again, this allowed potential design options to be evaluated and targets to be set.



TARGETS

Measure	Target
Natural daylight	Daylight lighting alone in 30% of gross floor area Overall reduction of 22.5% in electricity consumed by lighting
Natural ventilation	Naturally ventilate 25% of gross floor area
Mechanical Ventilation System	Reduce by 33% compared to conventional system <ul style="list-style-type: none"> ▶ Pressure Drop ▶ Stack effect & wind induced pressure gradient
Boiler plant	Average utilisation of 85% of gross thermal energy input

The various energy saving proposals and targets are predicted to have the following impact on energy consumption in the building:





TEAGASC HEADQUARTERS

Public Body: Teagasc

Completed by: Brendan Dervan Engineering Ltd.

Project Reference Number: DS/010/02

Completion Date: June 2002

OVERVIEW

The Teagasc headquarters building in Sandymount was constructed in 1972, with a gross floor area of 2,900 m² over 4 floors, including a basement. The building is of cavity wall construction with solid concrete floors. Original windows are single glazed, although a number of the sash sections have been upgraded to double glazing. The building is used for office purposes, with 110 occupants during normal office hours.

The design study was initiated to investigate possibilities for improving the energy efficiency of the building. As an occupied building, the scope of the study was limited to measures that could be implemented with limited disruption. Specifically, the study looked at lighting, glazing and boiler plant upgrades.

The existing lighting installation comprises recessed modular fluorescent fittings with fluorescent lamps throughout the office areas, and CFL lamps in the circulation areas. The study looked at the options for upgrading both the corridors and office areas to high efficiency fittings. A major design constraint was that any proposed alternative be capable of being fitted to the existing suspended ceiling grid, to avoid both the cost and disruption of replacing the ceiling.

Lighting calculations were carried out using Cymap software to ensure that any proposed alternatives provided adequate lux levels and lighting distribution. The possibility of using occupancy detection and daylight sensing to minimise unnecessary consumption was also investigated.

The impact of upgrading all single glazed window sections was assessed by calculating the impact on heat loss from the building, firstly using standard double glazing (with a U-value of 3.6W/m² °C), and secondly using double glazed low emissivity glass with a U-value of 1.62W/m² °C.

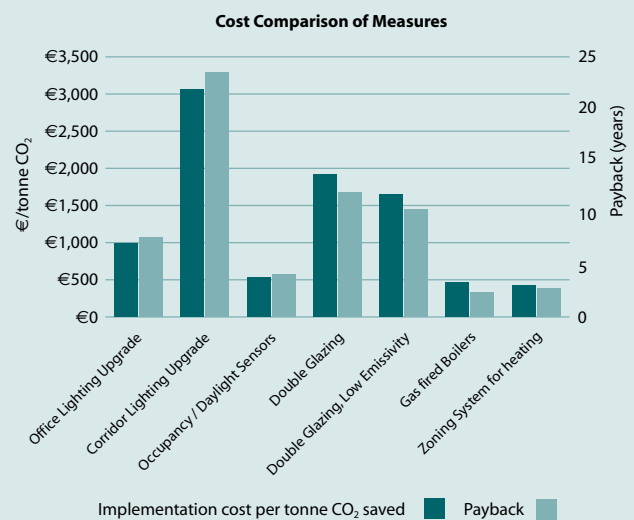
Finally, options for energy savings in the heating plant were investigated. The existing heating plant comprises two oil-fired boilers, with an estimated efficiency of 70%, which serve radiators throughout the building. The radiators are divided into five separate zones, served by a common heating pump. The system is controlled using basic time switches – meetings outside office hours require the time switches to be overridden and the entire building heated unnecessarily.

The design study investigated the energy savings and cost of replacing the existing boilers with two high efficiency natural gas fired boilers, with separate variable speed high efficiency pumps to serve each zone instead of the single main mixed temperature circuit pump. The potential increase in energy efficiency by implementing a zoning system with individual weather compensation and optimum start control for each radiator zone was also investigated. This system would be controlled by a dedicated building energy management system outstation.



COSTS & SAVINGS

Measure	Annual Savings	Investment Cost
Lighting		
Office Lighting Upgrade	51,700kW _e	€45,000
Corridor Lighting Upgrade	2,800kW _e	€7,500
Occupancy & Daylight Sensing	16,000kW _e	€7,500
Glazing		
Option 1: Double Glazing	118,700kW _{th}	€54,000
Option 2: Low emissivity double glazing	170,000kW _{th}	€67,000
Heating System		
Gas Fired Boilers	192,900kW _{th}	€40,000
Zoning System	217,000kW _{th}	€22,000





CASTLEISLAND AREA SERVICES CENTRE AND PUBLIC LIBRARY

Public Body: Kerry County Council

Completed by: Arup Consulting Engineers

Project Reference Number: DS/019/03

Completion Date: April 2004

OVERVIEW

This design study was instigated during the design stage of the new Castleisland Area Services Centre and Public Library, a two storey building of approximately 1620 m². The 'base case' against which potential energy saving options are assessed is a building designed to current Irish building regulations. The lighting in the base case design incorporates T26 lamp, and double glazing is fitted throughout.

The heating system is based on two 140kW oil fired boilers supplying an underfloor heating circuit, radiator heating circuit, primary hot water system calorifiers and a constant temperature AHU heating coil circuit. In addition, two chillers supply the AHU cooling circuit, and the Public Library and a multipurpose meeting room are mechanically ventilated.

The following energy saving proposals relative to the base case were investigated:

- ▶ LPG fired Gas Boilers;
- ▶ Building fabric upgrade;
- ▶ Building glazing upgrade;
- ▶ Energy efficient lighting;
- ▶ Ground Source Heat Pumps (GSHP);
- ▶ Advanced Boiler Control.

The cost benefit analysis for using LPG rather than oil-fired boilers indicated a very short payback period, of less than 3 years. Savings and payback periods for all other energy saving proposals were therefore calculated assuming that LPG boilers will be installed.

The impact of building fabric and glazing upgrades were assessed by investigating the impact of the modifications on heat loss from the building. The improved building insulation and low emissivity glazing in the 'energy efficient' case was selected to meet the standards required to meet the 2002 Irish Building Regulations for Dwellings, which require a higher level of insulation than that currently required for commercial buildings. The economic feasibility of installing blinds on the rooflights in the Library was also assessed.

The proposal for energy efficient lighting incorporated four measures, namely electronic ballast, the use of T16 fluorescent lamps, occupancy detection control to automatically switch off lighting in unoccupied rooms, and lux level control to automatically dim lighting as the level of daylight increases.

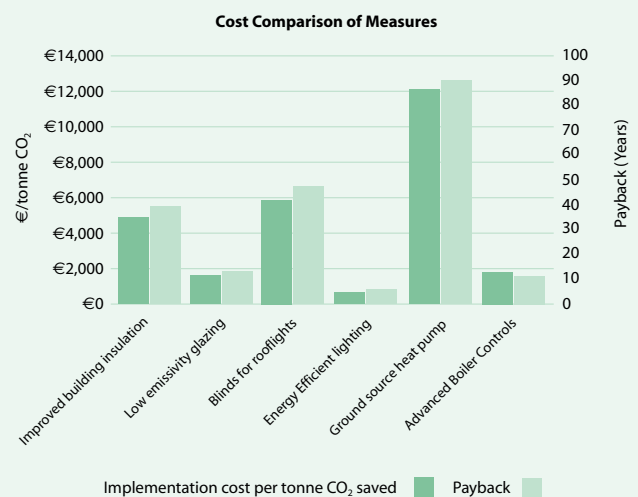
In the GSHP proposal, a GSHP would provide low grade hot water to serve the underfloor heating circuit and to preheat the domestic hot water; it would also provide cooled water during the summer, replacing the need for chillers in the base case. Under the proposal, the two 140kW boilers and two 35kW chillers would be replaced with one 140kW boiler and one 100kW GSHP. Additional savings that could be achieved by installing advanced control technology to optimise operation of the boiler were also investigated.

For each proposed change, the capital investment cost and annual savings in heat and/or electricity consumption were first estimated, in order to allow the simple payback period for the measure to be calculated. Savings in CO₂ emissions associated with the design change were estimated, and a lifecycle cost analysis also completed.



COSTS & SAVINGS

Measure	Annual Savings	Investment Cost
Heating System		
Advanced Boiler Control (per boiler)	20,500kW _{th}	€5,500
Ground Source Heat Pump	118,000kW _{th}	€123,500
Building Fabric Upgrades		
Improved insulation	10,700kW _{th}	€12,500
Low emissivity glazing	36,200kW _{th}	€15,100
Lighting		
Electronic Ballasts	19,900kW _e	€4,600
Occupancy Detection	3,300kW _e	€1,800
T 16 Lamps	8,800kW _e	€5,800
Lux Control	1,600kW _e	€1,100





ACHILL ISLAND FIRE STATION AND MARINE COASTAL RESCUE CENTRE

Public Body: Mayo County Council & RNLI

Completed by: Mayo County Council

Project Reference Number: DS/021/01

Completion Date: December 2002

OVERVIEW

This study was initiated during the design stage of the new Fire Station and Coast Guard Facility on Achill Island, to investigate the opportunity for energy efficient design and operation of the new building. The two storey development, with a gross floor area of 625 m², is a joint project between Mayo County Council and the RNLI. The building incorporates both office space and workshop/bay areas, with shared occupancy between the two organisations of some common areas, including the canteen and changing area.

The building fabric has been specified to meet current Irish building regulations. The offices and canteen, with the majority of glazing in the building, have been located on the east side of the building to benefit from morning sunlight. T5 high efficiency lamps have been specified for the offices areas – proximity and lux level automatic switching were discounted due to low occupancy levels in the building, which would make the payback for these measures very long.

The building is naturally ventilated with the exception of areas such as changing and kitchen areas where odour or humidity are of concern; heat gains from the office and kitchen areas were considered when assessing the ventilation needs for the building.

The heating system in the building is required to meet a number of specific needs. Firstly, the different areas of the building will have varying occupancy levels. Therefore, a number of separate heating circuits with individual time control is desirable, to allow separate heating control of the different areas and hence minimise unnecessary heating hours.

Secondly, in general, a rapid heating pick up time is required in low occupancy areas to avoid heating being left on longer than necessary. This is particularly important for the Fire Station and Rescue Centre Bay areas, which in general will be kept at approximately 12°C, but must be capable of being rapidly boosted to 18-20°C when occupied. A 1/2 hour boost time was specified in the design study.

The study investigated the feasibility of installing a hybrid heating system incorporating a Ground Source Heat Pump (GSHP) together with conventional oil or gas fired boiler, supplying convector heaters in the Bay areas, and radiators elsewhere in the building.

This type of hybrid system is particularly well suited for this type of building, where the GSHP can meet the 24-hour low temperature requirement of heating the Bay areas, while the conventional boiler is available to meet higher heat demands. Estimated installation cost, including additional builders work, was €18,500, with predicted annual savings of €3,600, giving a simple payback of 5 years.



The study also assessed the feasibility of using solar water evacuated tubes to meet hot water requirements in the building (toilets and shower). It was found that the payback period was relatively long (16-20 years) due to the low volumes and relatively sporadic nature of the hot water requirement.

A stand-alone BMS is not economic for a building of this size and occupancy levels. However, the report recommends that a building management outstation be installed, thus allowing the control of the heating plant via a centralised BMS and enabling improved monitoring and control of energy consumption in the building.

COSTS & SAVINGS

Measure	Payback
Hybrid GSHP & conventional boiler heating system	5-7 years
Six Circuit heating system with motorised controls	3-5 years
Modulating boilers	3-5 years
Humidity control of fans in drying room	3-5 years
Lighting proximity sensors & lux level control	10-15 years
Weather compensators for heating system	3-5 years





UCC INFORMATION TECHNOLOGY BUILDING

Public Body: University College Cork

Completed by: Project Management

Project Reference Number: DS/2002/034

OVERVIEW

This study relates to the proposed IT building at University College Cork, to be located on the site of the old greyhound track located on the Western Road in Cork City. The 15,871 m² three storey building will serve both the Department of Computer Science and the Department of Microelectronics, in addition to providing space for a number of commercial operations. Architectural features include an atrium, courtyard that runs the length of the building, and extensive glazing. As part of the design brief, UCC asked that a sustainable approach be used when designing the building's mechanical and electrical services.

Typically, for a building of this type with high IT loading, the target for HVAC and lighting energy consumption would be in the range 150-200kWh/m²/y. Current best practice as applied to similar buildings in the UK aims to achieve a target of 100kWh/m²/y, although it is unclear whether these targets are actually being met. The target adopted for this design study was therefore in the range 100-150kWh/m²/y.

The initial building concept design incorporated the following passive design techniques to minimise energy consumption:

- ▶ High heat gain spaces such as computer laboratories located in the northern section of building, away from direct solar gain, with low heat gain spaces such as offices located on the southern side;
- ▶ Maximise solar heating by designing main glazed facades southeast and northwest;
- ▶ Atrium used as a solar collector and thermal buffer in winter, and a natural stack in summer;

- ▶ Maximise natural ventilation and direct sunlight throughout the building;
- ▶ Use exposed ceiling slabs to facilitate thermal mass cooling.

Potential energy saving solutions were analysed and compared using IES, a sophisticated thermal simulation software package which is capable of modelling a wide range of HVAC systems in conjunction with modelling the building's thermal performance. It uses dynamic simulation techniques to trace the thermal state of the building through a series of hourly snapshots, providing a detailed picture of the way the building would perform throughout the year.

The model was used to evaluate energy requirements for the building, enabling the following energy saving options to be assessed:

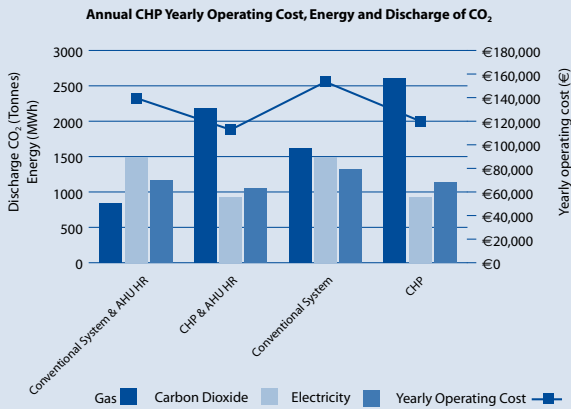
- ▶ Benefits of improving building fabric U values above those required by Irish Building Regulations;
- ▶ Comparison of a number of combinations of high efficiency and condensing boilers to meet building heat requirements;
- ▶ Installation of CHP;
- ▶ Installation of ground source cooling to the IT and Comms rooms.

The model was also used to assess the scope for naturally ventilating the building. Based on the results, it was concluded that mechanical displacement ventilation should be used in areas of high heat gain such as teaching auditoria and computer lab areas, while natural ventilation methods are suitable for the cellular and open plan office block areas on the south side of the building.



The design study estimates that, as a result of the proposed measures, the HVAC and lighting loads in the building would be 98kWh/m²/y, well below the design target of 100-150kWh/m²/y, and representing a 20% reduction compared to a typical naturally ventilated building and a 53% reduction compared to a typical air-conditioned building.

COSTS & SAVINGS



Measure	Payback
Heating System (Base case – 3 high efficiency boilers) Option 1 – 1 condensing lead boiler, 2 high efficiency boilers Option 2 – 1 condensing lead boiler, 1 condensing boiler, 1 high efficiency boiler	4 years 6 years
CHP Option 1 – CHP, no heat recovery Option 2 – CHP with heat recovery	5 years 6 years
Ground Source Cooling AHU cooling IT & Comms Room Cooling Toilet flushing	9 years 1 year 1 year





WICKLOW COUNTY COUNCIL OFFICES

Public Body: Wicklow County Council

Completed by: Building Design Partnership

Project Reference Number: DS/2002/038

OVERVIEW

The Wicklow County Council Offices building, located on Station Road, Wicklow, is a three storey building covering an area of some 4,000m². The original building is quite old, with an extension added during the 1990s. All offices in the building are naturally ventilated, with radiator heating throughout provided by means of an oil-fired system.

Under the design study, a full energy evaluation of the building was completed, and the following energy saving measures considered:

- ▶ Replace glazing in the old section of the building with a modern double-glazed system;
- ▶ Conversion of heating system to gas, including local controls and optimum start control of boilers;
- ▶ Replacement of individual electric water heaters in toilets with centralised gas-fired hot water heater;
- ▶ Replacement of light fittings with energy efficient alternative and installation of automatic lighting controls.

A 3-D dynamic simulation model was used to assess impact of all proposed changes.

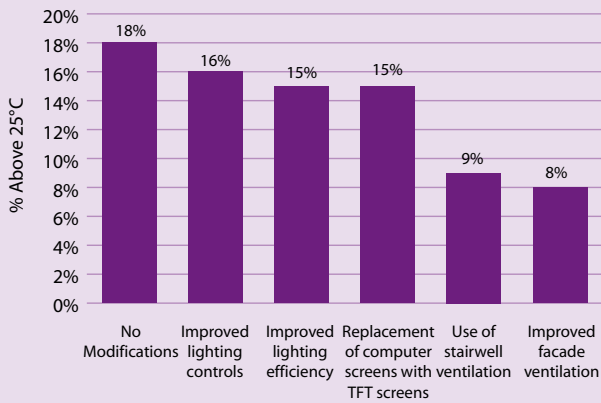
Occupant comfort and energy use are often closely related. In the case of the Wicklow County Council Offices building, occupants had reported experiencing discomfort related to overheating in many of the office areas. An initial study commissioned by the Council suggested that air conditioning would be required throughout the building in order to control air temperature. While this measure would reduce internal

temperatures, the Council was concerned about its many drawbacks, including significant energy consumption and associated environmental effects. It was therefore keen to find an environmentally responsible solution to the overheating problem. The design study therefore also considered alternative energy efficient options for improving occupant comfort.

It was found that overheating in the old part of the building is related to two factors – the small area of openable sections in the existing windows, and the positioning of those sections. Although the windows in the new part of the building have reasonable openable window areas, it was found that the position of the openings does not support effective natural ventilation, resulting in overheating. Therefore, while glazing replacement might be difficult to justify purely on the grounds of energy savings achieved, the fact that it also has the potential to overcome problems with local overheating must be taken into consideration.

A number of other approaches were examined in detail with a view to both reducing internal heat gains (from lighting and computers) and improving the natural ventilation provided, thereby improving occupant comfort. The effects of each of the measures considered are shown in the following graphs.

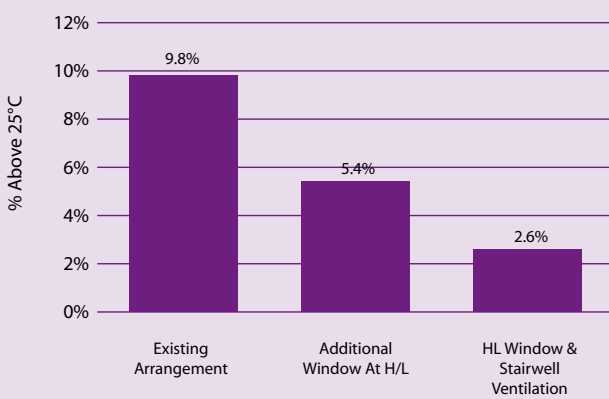
A figure close to 5% is considered to be ideal for natural ventilation; a slight increase above 5% would be acceptable for an existing building. It should be noted that the graphs show the impact of individual measures, rather than the cumulative effect of a combined of measures. The simulations show that acceptable temperatures may be obtained in both sections of the building by using a combination of two temperature control measures.



COSTS & SAVINGS

Measure	Payback
Conversion from oil fired boiler to gas boiler	<1 year
Replace electric immersion heaters with gas fired water heater	8 years
Energy efficient lighting & automatic controls (original building)	7 years
Energy efficient lighting & automatic controls (extension)	6 years

Original building



Building extension





KILLARNEY SPORTS AND LEISURE CENTRE

Public Body: Killarney Town Council

Completed by: Arup Consulting Engineers

Project Reference Number: DS/2003/009

Completion Date: December 2004

OVERVIEW

The Killarney Sports and Leisure Centre is a state-of-the-art facility comprising a swimming pool, multi-purpose sports hall, gymnasium/aerobics studio, wet and dry changing areas, offices, treatment rooms, crèche and spectator viewing facilities. The two storey complex has a gross floor area of approximately 4,235 m². The combination of full-height glazing and roof lights in the pool hall maximises daytime light and solar heat gain.

This design study was completed as an integral part of the design process, to meet the requirement in the design brief that sustainability and energy efficiency be addressed fully in the completed facility. In conjunction with Kerry County Council's energy manager, the following energy measures were proposed:

- ▶ Use of optimum quality building insulation materials;
- ▶ Use of a special heat loss prevention coating on glazing;
- ▶ Installation of energy-efficient lighting, incorporating the use of T16 fluorescent lamps (as opposed to T26 lamps in the conventional design) and presence detection throughout the building;
- ▶ Installation of LPG-fired boilers in preference to oil-fired boilers;
- ▶ Use of heat recovery technology, including run-around coils, in all ventilation systems throughout the building, and the use of mixing boxes in all ventilation systems with the exception of the swimming pool;

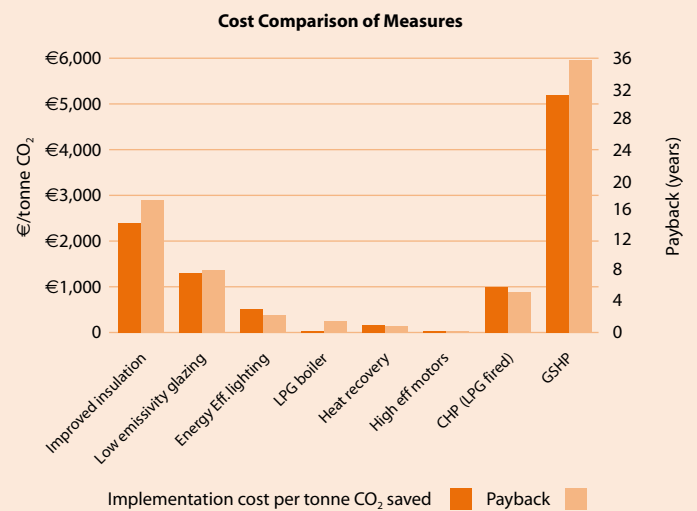
- ▶ Use of high-efficiency electric motors;
- ▶ Installation of a microturbine CHP unit to meet the base thermal demand during the summer months;
- ▶ Installation of a ground source heat pump (GSHP) to supply the underfloor heating system in the lower ground floor changing areas;
- ▶ A preheating system for supplying domestic hot water, low temperature hot water heating coils in the changing facilities air handling unit and the heat exchanger used to maintain swimming pool water temperature;
- ▶ The GSHP would also provide free cooling for the swimming pool, changing facilities AHU and gym/aerobics studio AHU.

The feasibility of each of the proposed measures was assessed by calculating the projected payback period, based on a capital cost comparison (compared to conventional technologies), and an estimation of the annual energy savings that would be generated as a result of the energy saving measure. Savings in carbon dioxide emissions as a result of each measure were also calculated.



COSTS & SAVINGS

Measure	Annual Savings	Investment Cost
Improved Insulation	27,400kW _{th}	€16,250
Low emissivity glazing	20,700kW _{th}	€5,800
Energy efficient lighting	22,250kW _e	€5,600
LPG boiler (versus oil fired)	141,818kW _{th}	€9,700
Heat recovery measures	1,170,900kW _{th}	€39,250
High efficiency motors	26,000kW _e	€450
CHP (LPG fired)	60,600kW _e -1,275,400kW _{th}	€132,300
GSHP	-84,900kW _e 528,600kW _{th}	€264,800





UCD, THE URBAN INSTITUTE

Public Body: University College Dublin

Project Reference Number: MS/2001/01

Cost of Project: €2 million

Estimated Cost of Energy Saving Interventions: €289,500

OVERVIEW

This project comprises a new low energy research building at University College Dublin. The building includes research offices, a library, meeting rooms and a laboratory, with a floor area of 840 m² over two floors. The building was occupied in September 2003.

Natural light is maximized in the building, with skylights covering the central part of the building. Artificial lighting in the building is daylight linked, and controlled by a self contained Philips lighting control system.

The skylights are fitted with motorized windows that are controlled by the BMS, and are raised above the prevailing flat roof area to facilitate the stack effect and wind driven circulation. By this means, natural ventilation is brought deep into the building. Low power consumption fans in the main foyer and below skylights, again controlled by the BMS, circulate hot stratified air down into building during the heating season. The fans can be reversed to pump heat up towards open windows when the building is too hot. Inlet louvres are fitted above ground floor windows; BMS controlled motorised dampers control air flow through them.

The features discussed above are controlled by the BMS to optimise the building for natural ventilation. Both temperature and CO₂ level control are implemented; however, analysis of actual operating data indicates that in reality, the units are controlled on temperature alone, and suggests that sufficient

air leakage paths exist in the building so that CO₂ set point levels are never reached. In retrospect, it was felt that the lighting could also have been controlled more economically by the extensive college BMS system. An information screen in the main lobby displays a rolling slide show showing various aspects of building performance. This is used as a training aid, to raise energy awareness, as a marketing tool and as a signifier of commitment to sustainable development.

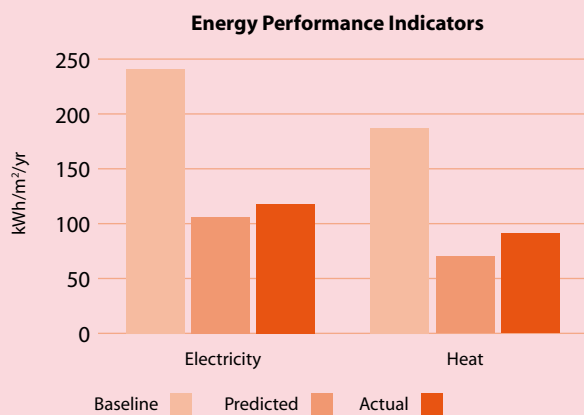
The building fabric incorporates improved insulation in walls, roof and windows. Excessive solar gain to office areas is avoided by specially designed fins & overhangs to office windows. A pressure test of the building gave air permeability at 50kPa of just over 10m³/h/m². Current UK Building Regulation technical guidelines suggest that a figure of 10m³/h/m² or lower should be achieved. While the result achieved in the Urban Institute is reasonable, there is the potential to achieve a lower infiltration rate, which would result in reduced fuel consumption. In particular, thermal imaging identified air leakage paths between window frames and walls, through louvres (when dampers are closed) and next to rooflight window mullions. Reducing building infiltration losses can be as important as improving building fabric in minimising heat loss from the building.

Space heating requirements in the building are met by gas fired boiler plant, which is located in an adjacent building. Hot water demand in the building is low, and is met by local electric immersion heaters to eliminate distribution losses.



PERFORMANCE

The chart below shows actual energy performance in the building compared to the baseline case and predicted performance. Electrical energy performance is close to that predicted, while thermal energy usage is slightly higher, due in part to the infiltration losses as discussed above. Significant savings relative to the baseline have been achieved in terms of both thermal and electrical performance.



Actual energy cost savings for the project were as follows:

	Savings	Simple Payback
Reduction in Gas Consumption	€8,410	
Reduction in Electricity Consumption	€6,540	
Total	€14,950	19 years





LIMERICK COUNTY COUNCIL NEW HEADQUARTERS

Public Body: Limerick County Council

Project Reference Number: MS/2002/02

Building Cost: €32 million

Predicted Cost of Energy Saving Interventions: €854,700

OVERVIEW

This project comprises a new low energy County Council headquarters building in the suburbs of Limerick City. The building includes offices, the council chamber, meeting rooms, and a canteen, and totals 7,900 m² spread over four floors.

The heart of the building is four-storey high linear atrium running southeast northwest along the main spine of the building. The southwest elevation is highly glazed, while the northeast side is bounded by four floors of offices. The atrium main façade is double glazed, with external shading to reduce excess solar gain and glare. Glass on the ends of the atrium, which are fully glazed, is fritted to reduce solar gain from early morning and late evening sun, thereby reducing overheating.

The office space in the main building benefits from natural light from both the atrium and northeast facing façade. As a result of the building layout, most desks are within 5m of a source of natural light. It is estimated that approximately 30% of the atrium glazing provides useful daylight for the offices. Initial problems with glare on sunny days have been solved by the retrofit of manually adjustable linen shading panels, which are translucent to give soft daylight while allowing free air from the atrium to be maintained. For offices that do not overlook the atrium, daylighting is provided by a band of northeast facing windows.

Daylight penetration is increased by an exterior concrete light shelf below the window and an interior fritted glass light shelf-cum-light fitting below the upper section of glass. Lichen growth on the concrete light shelf has reduced reflectivity somewhat – plans to clean the shelves and subsequently treat with chemical should to inhibit growth in future, thus maintaining the benefits to high reflectivity. The council chamber is day lit by roof lights.

Artificial lighting is provided via high frequency lighting with dimmable fluorescent tubes, controlled by a Philips central lighting control system. Lighting sensors throughout building control dimming of local luminaires. While lighting controls in offices can use motion detection, the system has been set up to require users to enable lights manually, thus ensuring that lighting is only switched on if the occupant feels it necessary. Daylight and artificial light penetration is increased by painting the concrete soffit slab white.

The building is primarily naturally ventilated, with limited areas of mechanical ventilation, including the council chamber and meeting rooms. Open plan offices are used where possible to allow double sided through ventilation to be used, with the atrium forming one of the air paths. Motorised ventilation openings 3m above the atrium floor, coupled with motorised windows at the top of the atrium are controlled by the BMS.

Offices are ventilated through a combination of manual and automatic controls. Purpose-designed ventilation boxes, including sound attenuator and outside louvers to avoid rain ingress, are manually controlled to provide ventilation during the day. Motorised openable window sections above the manual vents are opened at night during the summer, along with atrium opening, to purge the building and cool down the building fabric, in particular the precast waffle slab which is used to increase the building thermal mass. BMS logic takes into account day, season, wind speed, rain, indoor temperature and external temperature.

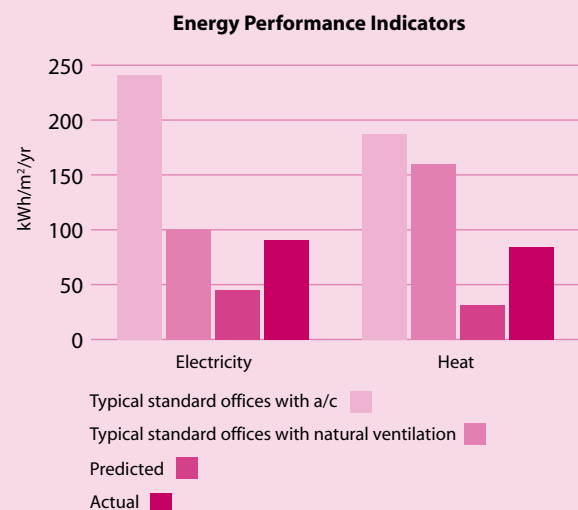


The building was specifically designed to reduce infiltration losses, with specified leakage rate and air permeability test being written into contract documents. The completed building met the specified air permeability of $5 \text{ m}^3/\text{h}/\text{m}^2$ at 50kPa internal pressure.

Central heating is provided by 3 gas fired forced draught boilers with primary header pumps. These mainly provide heat to secondary zone pumps and weather compensated mixing valves for radiators, convectors and underfloor heating. The secondary weather compensated circuits further are split into tertiary subzones with local control valves. In addition, radiators are fitted with thermostatic radiator valves. It is estimated that heating required to overcome glazing heat losses in the atrium accounts for as much as 35-40% of total heat energy. The energy costs for such a design are therefore considerable, emphasising the necessity of considering energy requirements and costs in any overall assessment of building design proposals.

PERFORMANCE

The chart below shows actual energy performance in the building compared to typical standard office consumption and predicted performance. Savings relative to a baseline case incorporating air conditioning are considerable. Electrical consumption is close to that expected in a typical office with natural ventilation. While this may appear to be a disappointing result, analysis of consumption data indicates a very high base load in the building, associated with office equipment being left on overnight and at weekends. Measures to tackle building occupant behaviour in this regard are expected to result in a significant improvement in electrical EPI. Thermal EPI, although higher than predicted, is considerably lower than both baseline cases.



Actual energy cost savings for the project were as follows:

	Savings	Simple Payback
Reduction in Gas Consumption	€3,190	
Reduction in Electricity Consumption	€38,380	
Total	€41,570	20 years



PLANT RESEARCH LABORATORY, TEAGASC OAK PARK

Public Body: Teagasc

Project Reference Number: MS/2002/014

Cost of project: €3 million

Predicted Cost of Energy Saving Interventions: €152,300

OVERVIEW

The project consists of a laboratory and office building for Teagasc at Oak Park, Carlow, with a total floor area of 1,400m² over two floors. The building was occupied gradually from May to September 2004. Whilst generally occupied normal office hours, the building is at times partially occupied at unsocial hours, due to the work habits of research workers.

The main bulk of the energy saving investment was targeted at removing the need for air conditioning in typical spaces. Approximately 50% of the ground floor space is air conditioned due to the need for a clean room laboratory environment. The windows are sealed closed in this area. Remaining areas are naturally ventilated.

7 m deep laboratories are located either side of the central corridor, with full height walls separating them from the circulation corridor for security and other reasons. The laboratories are therefore naturally ventilated from one side only. This 7 m depth would be considered marginal for single sided natural ventilation, necessitating careful design of the façade to avoid overheating. Measures include open louvered panels to provide shading to windows.

Ultra low U-value glass was specified throughout, aimed at both removing the need for air conditioning and reducing heating costs. The insulation in the roof was also improved to further reduce heat loss from the building. A large proportion (approximately 35%) of the building glazing is associated with the main atrium. It is unlikely that the large areas of glass could be justified in energy terms since circulation areas

require comparatively lower levels of lighting than occupied spaces, and passive solar gains would not justify the large glazed areas facing north and north west. Since glazing is more costly than insulated wall, a more economic and lower energy consumption solution may have been to reduce the glass area in the atrium. However, the glazing performs both aesthetic and psychological functions in making circulation spaces bright and creating a corporate identity and identifying the main entrance, illustrating the sometimes conflicting requirements faced by design teams.

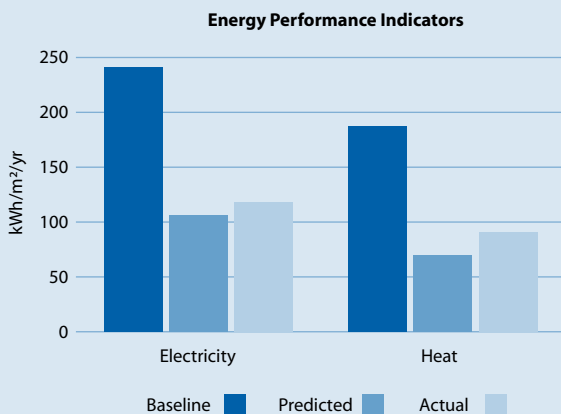
A BMS is installed to control plant instead of conventional control methods, with estimated savings of some 15% of fuel energy consumption attributable to the accurate control of plant and the use of optimum start stop algorithms. A subsequent analysis of operating data suggests that while the optimum stop routines are working well, there may be some initial problems with the implementation of the optimum start routines, indicating that there may be scope for further energy savings in the future. This type of fault can be difficult to identify, and can only be found by detailed monitoring of performance over a prolonged period.

The speed of the heating pumps is controlled electronically to satisfy system requirements. These pumps have other advantages as well as energy savings, including an LCD screen which, with pump curve data, can be used to determine flow rates which can be used in the commissioning of buildings. Laboratories are heated by radiators, with thermostatic radiator valves fitted throughout.



PERFORMANCE

The chart below shows actual energy performance in the building compared to the baseline case and predicted performance. Performance is close to predictions, with significant savings relative to the baseline being achieved in terms of both thermal and electrical performance. It is expected that the thermal EPI will be further reduced when issues associated with the boiler optimum start routines are resolved.



Actual energy cost savings for the project were as follows:

	Savings	Simple Payback
Reduction in Gas Consumption	€3,800	
Reduction in Electricity Consumption	€13,440	
Total	€17,240	8.8 years





SCIENCE LECTURE BUILDING LOW ENERGY THEATRE VENTILATION SYSTEM

Public Body: University College Dublin

Project Reference Number: MS/2003/022

Cost of project: €78,200

Predicted Cost of Energy Saving Interventions: €47,300

OVERVIEW

This project comprises the replacement of a 40 year old constant volume belt driven ventilation system with a new air handling unit (AHU) incorporating demand based control of heating and ventilation to a 400 seat 580 m² lecture theatre at University College, Dublin. The lecture theatre is one of six theatres within the 8,000 m² Science Complex, which also houses offices, a 200 seat restaurant and central concourse. The project also addresses demand based lighting controls in the theatre.

The old constant volume ventilation system supplied 17 l/s of heated fresh air to the space for each of the 400 possible occupants based on a timeclock, which was set to satisfy the lecture schedule. This resulted in 6.8 m³/s of air being delivered to the room during the daytime regardless of the occupancy of the room, with heat being added in winter as necessary.

With occupancy patterns varying frequently, especially during revision and examination times and holiday periods, the system often operated when the room was empty. The large air volume was necessary because at the time of design smoking was permitted in the room. Recommended fresh air levels are now less than half the old levels, at 8 l/s/person. The old lighting system was mainly controlled by occupants using wall mounted switches.

The new AHU is a packaged full fresh air unit with built-in controls. The unit has been integrated with the college Building Management System to ensure the system operates in response to demand rather than a time schedule. Lighting is likewise controlled. The whole control strategy is designed to maintain a comfortable healthy working environment whilst minimising energy use.

The new AHU includes:

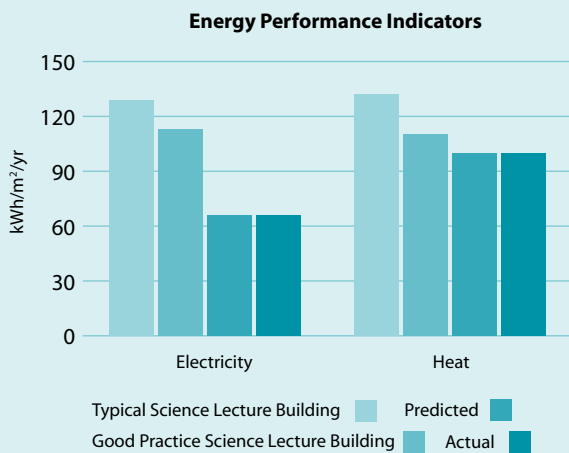
- ▶ motorised fresh air and exhaust air dampers to ensure that outside operating hours infiltration into the building is reduced;
- ▶ direct drive supply and exhaust fans with inverter driven variable speed motors which reduces air flow to the minimum required, thus reducing fan motor electrical energy consumption and heating requirements;
- ▶ a heat recovery wheel which captures heat from the vitiated air being exhausted from the building and passes this heat to the incoming cooler supply air;
- ▶ bag filters to prevent dust build up on the heat wheel and to deliver clean air to the room;
- ▶ factory installed microprocessor controls which monitor intake and discharge temperatures on the supply and return side, and control both fan speeds, damper motors, and heat recovery wheel.

The BMS controls are carefully optimised to maximise savings.



PERFORMANCE

The chart below shows actual energy performance in the building compared to the CIBSE good practice and typical EPIs for a Science Lecture Theatre. Electricity consumption is significantly lower than the baseline cases, while thermal performance is also better than the base cases. The chart shows EPIs for the building as a whole. It must be remembered that the lecture theatre is one of six theatres; savings in the building would be significantly higher, with correspondingly lower EPIs, if all theatres were to be retrofitted with new AHUs as outlined above. Actual performance was in line with predictions.



Actual energy cost savings for the project were as follows:

	Savings	Simple Payback
Reduction in Gas Consumption	€4,290	
Reduction in Electricity Consumption	€3,375	
Total	€7,665	6.2 years



GAELSCOIL AN EISCIR RIADA, TULLAMORE

Public Body: Department of Education & Science

Project Reference Number: MS/004/01

Cost of project: €2.8 million

Predicted Cost of sustainable design features: €870,000

OVERVIEW

This project comprises a new eight classroom low energy national school in the suburbs of Tullamore. The building includes a general purpose hall and ancillary spaces such as library, staff room and office, and has a total area of approximately 1,700 m².

The building fabric is insulated to levels exceeding building regulations, including a green roof (planted with sedum). Since the school operates for comparatively short hours each day, a lightweight structure was chosen so that the school could be heated up quickly. Timber frame construction was used.

Configuration of windows was subject to a detailed multidisciplinary study, taking into account useful passive solar gain, avoidance of overheating, avoidance of glare, promotion of natural ventilation, comfort, ease of use, buildability, maintainability, air tightness and cost. Classrooms are occupied for longer hours in morning than in the afternoon; they were therefore orientated to optimise benefit of morning winter sun. No carpets are fitted, to allow heat from sunlight to be absorbed more efficiently by the floor and to help even out temperature fluctuations due to passive solar gain.

Artificial lighting in classrooms is controlled by occupancy detection and is daylight linked to minimise unnecessary electricity consumption. Motion detectors control lighting in toilets, stores & other spaces. Light pipes are used to illuminate interior corridors and some interior rooms.

The school uses natural ventilation via single sided openable windows which are manually controlled. The size and distribution of the openings was determined by bulk airflow modelling and computational fluid dynamics. The risk of overheating when the building is occupied is reduced because the school is not open in the peak summer months.

The building was specifically designed to reduce infiltration losses, with a design air infiltration rate of 0.2 air changes per hour when the building is unoccupied and all windows & doors closed. This may be compared to a more usual assumption of 1 air change per hour. Leakage rate was written into contract documents, and an air permeability test included in the contract. The completed building met the specified air permeability of 5 m³/h/m² at 50kPa internal pressure.

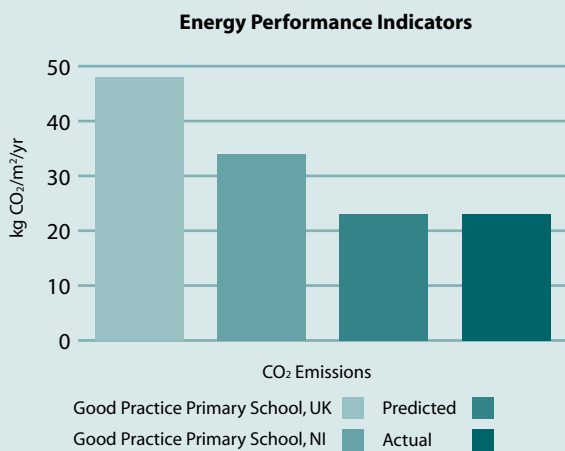
The building is heated via underfloor heating coils, supplied by Ground Source Heat Pump. The system mainly operates at night, using night rate electricity tariffs, and stores heat in the thermally massive concrete floor which then emits heat throughout the day. Each classroom has its own temperature sensor & modulating valve. There have been some concerns regarding the relative lack of responsiveness of the system, specifically relating to rapid changes in solar gain, which may lead to overheating. This is not an issue in offices and other spaces which are not subject to high solar gain. Local electric immersion heaters meet domestic hot water demand, thereby avoiding distribution losses, and are controlled by time clock. A rainwater collection system collects rainwater from roof for toilet flushing.



The school is controlled by BMS, and monitored from the consultant’s office. The BMS is linked to a touch screen in the main corridor, which allows students to access information about the building energy use. The principal has a PC in her office allowing her to adjust temperature settings and change occupancy times.

PERFORMANCE

The chart below shows actual energy performance in the building compared to good practice EPIs for primary schools in Northern Ireland and the UK. The thermal and electrical EPIs have been combined and expressed in terms of CO₂ saved per unit area, since the GSHP at the school, which results in increased electricity consumption but avoidance of fuel consumption, makes it difficult to draw conclusions from a comparison with electrical and thermal EPIs from more conventional applications. Energy performance at the school is in line with predictions, and is significantly lower than the good practice base cases shown.



Actual energy cost savings for the project were as follows:

	Savings	Simple Payback
Avoidance of Oil Consumption	€14,100	
Reduction in Electricity Consumption	€400	
Total	€14,500	42 years*

* 13 years excluding cost of green roof and timber frame construction





LIMERICK INSTITUTE OF TECHNOLOGY, CHP

Limerick Institute of Technology

Public Body: Limerick Institute of Technology

Project Reference Number: MS/2002/22

Cost of project: €139,280

Predicted Cost of sustainable design features: €139,280

OVERVIEW

The project comprises a gas fired combined heat and power (CHP) unit using a micro-turbine. The unit, commissioned in December 2002, produces 110 kW electrical energy and 185 kW of thermal energy.

A well-designed and operated scheme provides better energy efficiency than conventional plant, leading to energy, cost and environmental savings. Although the profitability of CHP generally results from its cheap electricity, its success depends on using recovered heat productively, so the prime criterion is a suitable heat requirement.

The CHP is capable of supplying 20% of the maximum electrical load and 15% of the maximum thermal load depending on operating conditions. The CHP is installed in parallel with two existing boilers which each have a capacity of 610kW. The CHP satisfies the base heat load during mild weather and when the building is occupied. At this time the boilers are rarely used. The heat output from the CHP unit is not metered separately. The unit has produced 455,000 kWh of electrical energy in its first two years of operation.

Given the efficiency of the CHP plant, the electrical load profile, the electrical tariff structure and cost of gas, it is always economic to run the unit at full load from 8 am to 11pm even if there is little demand for heat. Although the building's night time electricity demand is in excess of the CHP output, it is not economic to run the unit at night due to the low unit cost of night time electricity.

The unit was supplied as a turnkey project and is maintained by the installer. The unit is linked to the installer's office by phone line. It reports any faults directly to the installer such that no intervention is required by on-site maintenance staff.

PERFORMANCE

Provided the CHP unit is optimised according to the heat demand, the following benefits arise:

- ▶ Increased efficiency of energy conversion and use;
- ▶ Lower CO₂ emissions;
- ▶ Energy and cost savings.

Significantly lower CO₂ emissions result from the operation of appropriately sized CHP. The table below compares the CO₂ emissions before and after the installation of the CHP plant. The net CO₂ savings resulting from this project is 115 tonnes per year.

Description	CO ₂ emissions CHP	CO ₂ emissions Boilers and purchased electricity
CO ₂ emissions for gas CHP plant	144 tonnes	
CO ₂ emissions for electricity displaced per year based on average emissions of power generators		150 tonnes
CO ₂ emissions for useful heat displaced per year		109 tonnes
Total CO ₂ emissions	144 tonnes	259 tonnes
Net CO₂ savings		115 tonnes



The economics of cogeneration are sensitive to energy prices, and the differential between the price of the fuel used, and the value of the electricity and heat which is generated. The following table presents the costs and savings associated with the CHP installation.

Description	Cost	Savings
Cost of gas per year to run CHP unit	€15,100	
Cost of maintenance per year	€2,900	
Value of electrical energy per year		€14,330
Value of avoided demand related charges		€4,960
Value of useful heat displaced per year		€11,500
Total running costs and savings	€18,000	€30,775
Net savings excluding VAT		€12,775





E3 ENERGY MANAGEMENT BUREAU

Universities: UCD, DIT, TCD, DCU

Consultants: PowerTherm Solutions, White Young Green

Project Reference Number: EMB/2003/02

Completion Date: 31 December 2006

OVERVIEW

UCD, DIT, TCD and DCU are cooperating in the development and implementation of a programme to reduce energy use. Their energy management bureau, e3, seeks to implement a strategy to reduce energy use so as to reduce energy costs and the emission of greenhouse gas into the earth's atmosphere. Work commenced in 2003, with the goal being to achieve a 10% reduction in the energy requirement of 30 buildings over three years against a background trend of increasing energy usage year on year.

The strategy to achieve this goal involves a number of steps:

- ▶ Complete a project commencement study to establish a performance benchmark;
- ▶ Prioritise buildings in terms of energy efficiency per m² and develop an action plan;
- ▶ Undertake an energy survey of each building to identify opportunities for energy savings – these may be categorized as savings associated with good facilities management practices (switching off lights, scheduling of plant), and savings achieved by the implementation of specific measures. In the latter case it may be necessary to evaluate the cost-benefit in detail.

To achieve savings associated with facilities management practices, energy survey findings are discussed with key staff via a series of meetings and presentations. Regular building and monthly energy reports are emailed to staff, providing them with feedback of the impact on energy use. The message is communicated with wider audiences by presentations, posters and stickers. All printed materials provide the website address www.e3.ie as a source of further information. The colleges have

an internet-based system which monitors the performance of individual buildings, can be accessed by anybody, and is updated realtime (every 15 minutes). One benefit of realtime data is that staff closing a building at night get immediate feedback of the impact of their activities.

To achieve savings associated with the implementation of specific measures, the measure is discussed with buildings office staff who then either implement the change directly, or engage contractors to undertake the work.

If achieved, the goal will result in *annual* cost savings of the order of €800,000 and carbon dioxide savings of 3,000 tonnes at the end of year 3. Energy costs are also saved by the regular procurement of electricity and gas.

ORGANISATION AND MANAGEMENT

The execution of the above strategy requires undertaking energy surveys; producing monthly and annual building reports, delivering a number of energy services which are undertaken by a bureau service provider, consisting of White Young Green and PowerTherm Solutions. There are two service categories: routine services which are undertaken for a fixed annual fee, and commissioned services which are undertaken as required based on a pre-agreed schedule of rates.

Routine services include operating the Monitoring & Targeting System, undertaking energy surveys, producing monthly and annual building reports, delivering energy presentations to key groups, planning activities and maintaining action lists, holding regular progress meetings with each college to track the implementation of measures, annual procurement of electricity and gas, coordinating and taking minutes of steering committee meetings, and general coordination.



Commissioned surveys include feasibility studies, comprehensive energy surveys, design and printing of awareness materials, etc.

To execute the above services the bureau service provider has appointed an account manager, who is the point of contact for each college and undertakes most of the energy surveys. Benefits of this approach are that they become familiar with the buildings and controls, the people involved, and are accountable for ensuring progress in the college. There is also a project manager, who is responsible for general coordination of activities and provides technical direction.

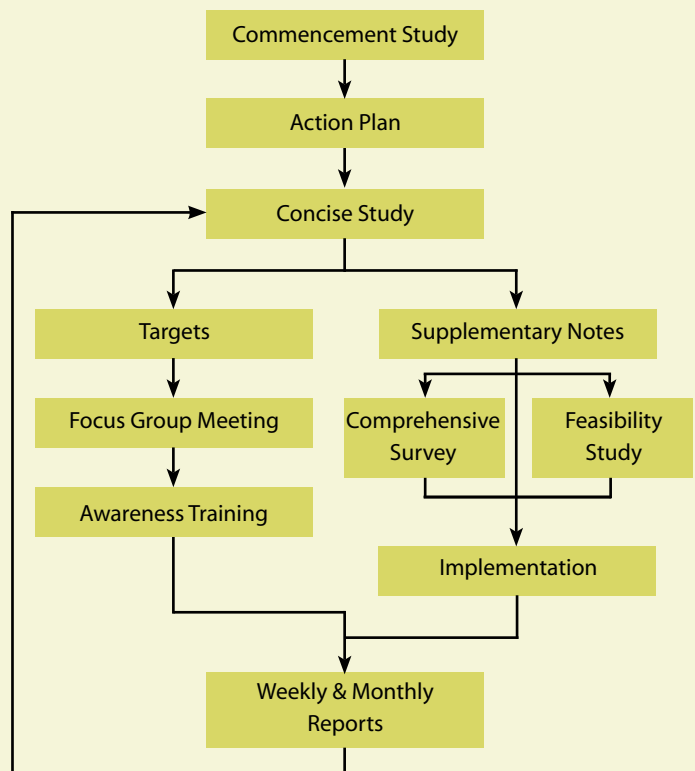
The bureau direction is managed by a steering committee consisting of a representative from each of the four colleges, Sustainable Energy Ireland, and the bureau service provider. The committee meets every 4-6 weeks.

PROGRESS SO FAR

In 2003 the colleges agreed to form an energy bureau and developed a detailed strategy for the bureau. The colleges received approval for 50% funding from Sustainable Energy Ireland and went through a public procurement process to select a bureau service provider. Simultaneously, the colleges began a process of installing electricity and gas meters in each building, and connecting these to an M&T system.

In 2004 e3 was officially launched and the process of getting the programme – surveys, reports, presentations and implementation – underway began in earnest. Despite a slow start, at the end of 2004 the bureau had exceeded its Year 1 goal, achieving an overall energy saving of 3.3%. The reduction in primary energy requirement was 4,200MWh, the cost savings were €120,000 (at 2004 prices), and emissions savings were almost 1,000 tonnes.

In 2005 e3 was the public sector winner in the Energy Management Programme 2005 category at the annual Energy Awards. Despite difficulties associated with unavoidable increases energy use in a number of buildings, the bureau exceeded its Year 2 goal, achieving energy savings of 6.3%, albeit with a little help from the mild weather. The reduction in primary energy requirement was 7,500MWh, the cost savings were €428,000 (at 2005 prices; 45% of the financial savings were attributable to procurement activities), and emissions savings were almost 1,700 tonnes.





The main challenges have been:

- ▶ To tailor the strategy to meet the diverse needs of the different colleges;
- ▶ To identify the key staff – those who can effect change – and find a forum through which they can be reached in a time efficient manner;
- ▶ To permanently change the behaviour of those responsible for facilities management;
- ▶ The implementation of specific energy saving measures, largely due to human resource constraints within the colleges;
- ▶ A time delay between identifying measures, implementing change, and the 12 months required for this change to work its way through a full year of data;
- ▶ Unavoidable increases in energy use in a number of buildings.

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APPENDIX

SECTOR – LOCAL AUTHORITY

Ref. No.	Public Body	Project Title
DESIGN STUDY SUPPORT SCHEME		
DS/003/01	Cork County Council	Eco Industrial/Business Centre
DS/004/01	Fingal County Council	Fingal Offices and Library Baldoyle
DS/005/01	Monaghan County Council	New County Offices for Monaghan County Council
DS/010/01	Offaly County Council	Offaly County Council New Offices
DS/021/01	Mayo County Council	Fire Station and Coast Guard Facility
DS/011/02	Tipperary N.R. County Council	Tipperary (N.R.) County Council New Offices
DS/012/02	Limerick City Council	Heat recovery, Electricity Generation and reduction of Environmental Impact at Limerick Corporation Offices, and associated facilities at Dock Road, Limerick
DS/014/02	Kildare County Council	New Civic Offices
DS/017/02	Cork County Council	Cork County Hall
DS/2002/021	Cork County Council	Environmental Offices and Veterinary Laboratory
DS/2002/026	Drogheda Borough Council	Drogheda Fire and Emergency Centre
DS/2002/038	Wicklow County Council	County Buildings Refurbishment
DS/2003/002	Mayo County Council	Training Centre, workshops and extension to Aras an Chontae, Castlebar
DS/2003/008	Cavan County council	Central Cavan Library Headquarters and Council Offices
DS/2003/015	Wexford County Council	New Office Building for Wexford Co. Co.
DS/2003/019	Kerry County Council	Castleisland area service centre and public library
DS/2003/021	Cork City Council	Sustainable City Campus



SECTOR – LOCAL AUTHORITY

Ref. No.	Public Body	Project Title
MODEL SOLUTIONS INVESTMENT SUPPORT SCHEME		
MS/002/02	Limerick County Council	Limerick County Council New Headquarters
MS/2002/002a	Limerick County Council	Limerick County Council New Headquarters
MS/003/02	Waterford City Council	Waterford Regional Community Sports Complex
MS/004/02	Fingal County Council	Fingal Offices and Library, Baldoyle
MS/2002/010	Offaly County Council	Offaly County Council New Headquarters
MS/2002/017	Sligo Corporation	Commercially Viable Renewable Energy System
MS/2002/018	Cork County Council	Environmental Industrial Estate
MS/2002/021	Cork County Council	Environmental Offices, Inniscarra
MS/2002/024	Cork County Council	Extension and refurbishment of Cork County Hall
MS/2002/029	Limerick City Fire Brigade	Energy Conservation Project, Limerick Fire Brigade
MS/2002/031	Monaghan County Council	New County Offices - Monaghan County Council
MS/2002/034	Waterford County Council	Civic Offices, Tramore
MS/2003/015	Kildare Co Council	Kildare County Council New Headquarters
MS/2003/019	Wicklow County Council	Wicklow County Council Energy Study
MS/2003/021	Laois County Council	Laois County Council Offices Extension
MS/2003/029	Mayo County Council	Aras an Chontae, Training Centre Extension
MS/2003/033	North Tipperary County Council	Energy Upgrade to Newport Fire Station
MS/2003/034	North Tipperary County Council	Energy Upgrade to Borrisokane Fire Station

SECTOR – DEFENCE

Ref. No.	Public Body	Project Title
DESIGN STUDY SUPPORT SCHEME		
DS/003/02	Defence Forces	Refurbishment of "Old" Billet Block
DS/004/02	Defence Forces	Refurbishment of Block 6
DS/2003/006	Department of Defence	Energy Study for school of Physical Culture
MODEL SOLUTIONS INVESTMENT SUPPORT SCHEME		
MS/2003/003	Department of Defence	Installation of LAN based BEMS in Curragh Camp



SECTOR – EDUCATION

Ref. No.	Public Body	Project Title
DESIGN STUDY SUPPORT SCHEME		
DS/012/01	Cork Institute of Technology	Energy and Environment Study of Atrium Areas
DS/013/01	University of Limerick	Engineering Research Building
DS/017/01	Department of Education and Science	Gaelscoil An Eiscir Riada, Tullamore
DS/022/01	Letterkenny Institute of Technology	Energy Improvement Works - Building Envelope and Heating Controls
DS/023/01	University College Cork	Art Gallery
DS/026/01	Department of Education and Science	Community School Millford, Co Donegal
DS/001/02	University College Cork	Boole Library
DS/007/02	University College Cork	Environmental Research Institute
DS/008/02	University College Dublin	Proposed Health Sciences Complex
DS/2002/018	Dublin Institute of Technology	Energy Efficient Technology Solutions
DS/2002/024	Waterford Institute of Technology	Waterford Institute of Technology, Tourism and Leisure Building
DS/2002/025	Dundalk Institute of Technology	Generation of DKIT's Electricity needs by using a wind turbine
DS/2002/027	Letterkenny Institute of Technology	Nursing Studies Accommodation
DS/2002/029	Mary Immaculate College	Mary Immaculate College Sports Building
DS/2002/030	Coolmine Community School and Sports Complex	Installation of Combined Heat and Power
DS/2002/031	Dundalk Institute of Technology	Nursing and Health Studies Building
DS/2002/033	National University of Ireland Galway	Marine Research Centre
DS/2002/034	University College Cork	Information Technology (IT) Building
DS/2002/036	National University of Ireland Galway	Martin Ryan Institute Expansion
DS/2002/037	University of Limerick	The Nursing Studies Building
DS/2002/039	County Laois VEC	Portlaoise Community College
DS/2002/040	Galway - Mayo Institute of Technology	Sustainable Energy Enterprise Building



SECTOR – EDUCATION

Ref. No.	Public Body	Project Title
DS/2002/041	National University of Ireland, Galway	Quadrangle Building Refurbishment
DS/2003/005	University College Cork	Good Energy Practices in UCC Sports Centre
DS/2003/010	South Tipperary VEC	Refurbishment of VEC Education Centre, Cahir
DS/2003/011	National University of Ireland	Nursing Therapies and Sociology and Politics Building
DS/2003/018	Department of Education and Science	Generic Repeat Schools
DS/2003/020	Waterford Institute of Technology	Waterford Institute of Technology, Nurses Education Building
GDS/2004/001	Department of Education and Science	Generic Repeat Design Primary Schools
MODEL SOLUTIONS INVESTMENT SUPPORT SCHEME		
MS/001/01	University College Dublin	The Urban Institute
MS/004/01	Department of Education and Science	Gaelscoil An Eiscir Riada, Tullamore
MS/2002/008	Letterkenny Institute of Technology	Enhancement of existing building envelope
MS/2002/009	University College Cork	Lewis Glucksman Art Gallery
MS/2002/015	University College Cork	Boole Library Chiller Retrofit
MS/2002/016	Dublin Institute of Technology	Energy Efficient Technology Solutions
MS/2002/022	Limerick Institute of Technology	Microturbine Combined Heat and Power at LIT
MS/2002/025	Waterford Institute of Technology	WIT IT Centre
MS/2002/026	Coolmine Community School and Sports Complex	Coolmine Community School and Sports Complex CHP
MS/2002/028	Dundalk Institute of Technology	Dundalk Institute of Technology Wind Turbine Generator
MS/2002/032	Dundalk Institute of Technology	School of Nursing
MS/2003/004	University College Dublin	Health Sciences Complex Phase 1
MS/2003/005	University College Cork	Environmental Research Institute
MS/2003/009	County Laois VEC	Portlaoise Community School
MS/2003/011	University of Limerick	Proposed Nursing Teaching Facility
MS/2003/012	Letterkenny Institute of Technology	Nursing Studies Accommodation
MS/2003/013	Letterkenny Institute of Technology	Multi purpose Centre



SECTOR – EDUCATION

Ref. No.	Public Body	Project Title
MS/2003/022	University College Dublin	Science Lecture building - low energy theatre ventilation system
MS/2003/023	University College Dublin	Energy Management Bureau Monitoring and Targeting System at UCD, TCD, DIT and DCU
MS/2003/025	Department of Education and Science	St Thomas's Community College, Bray
MS/2003/028	Trinity College Dublin	INS Building
MS/2003/041	Dublin City University	Henry Grattan Building-Heating Refurbishment
MS/2003/042	Letterkenny Institute of Technology	Energy Monitoring and Targeting

SECTOR – HEALTH

DESIGN STUDY SUPPORT SCHEME		
DS/011/01	Midland Health Board	Capital Project General Hospital Tullamore
DS/014/01	Midland Health Board	Regional Special Care Unit
DS/015/01	North Western Health Board	Sligo General Hospital Mental Health Unit
DS/019/01	North Western Health Board	Coolaney Primary Health Care Centre
DS/020/01	North Western Health Board	North Western Health Board Headquarters
DS/005/02	Mater Hospital and Children's Hospital Development Limited	Mater and Children's Hospital Development
DS/006/02	Southern Health Board	Tralee Healthcare Headquarters and Health Centre
DS/015/02	North Western Health Board	Boiler Replacements
DS/2002/020	St. Anne's Service	St. Anne's Energy Design Study
DS/2002/022	Western Health Board	Refurbishment of St. Therasas Unit
DS/2002/032	Mid Western Health Board	Energy Efficient Buildings and Services
DS/2002/035	University College Cork	UCC Medical, Nursing, Therapies and Crèche Complex
DS/2002/042	Brothers of Charity	Model Design Solutions for Brothers of Charity Services
DS/2002/043	Holles Street Maternity Hospital	Replacement of Central Heating Boilers
DS/2003/004	Mercy Hospital Cork	Mercy Hospital HVAC Systems and Window Upgrades
DS/2003/013	Western Health Board	Decentralisation of LPHU and DHW Services at Merlin Park Hospital
DS/2003/014	Western Health Board	Aras Attracta, Swinford, Mayo



SECTOR – HEALTH

MODEL SOLUTIONS INVESTMENT SUPPORT SCHEME

MS/003/01	South Eastern Health Board	St Josephs Hospital, Clonmel
MS/005/01	North Western Health Board	Building Energy Management System
MS/001/02	North Western Health Board	Coolaney Primary Care Centre
MS/006/02	South Eastern Health Board	CHP St. Dymphnas Hospital, Carlow
MS/007/02	North Western Health Board	Headquarters Building, Manorhamilton
MS/2002/012	North Western Health Board	St. Conal's Hospital, Letterkenny
MS/2002/020	Southern Health Board	Tralee Healthcare Headquarters and Health Centre
MS/2002/035	Mater Hospital	Mater and Children's Hospital Development
MS/2003/014	Dept of Western Health Board	Refurbishment of St Theresa's Unit, Castlebar
MS/2003/018	Mercy University Hospital Cork	HVAC systems and window upgrades
MS/2003/020	Holles St. Maternity Hospital	Replacement of Central Heating Boilers
MS/2003/024	Western Health Board	Refurbishment of 1960's buildings
MS/2003/031	North Western Health Board	Refurbishment of Various Boilerhouses and Controls Upgrade
MS/2003/032	Western Health Board	St. Mary's Hospital Castlebar
MS/2003/036	North Eastern Health Board	Boiler replacement, burner conversion and controls upgrade
MS/2003/040	Eastern Health Shared Services	Linking 4 sites back to central monitoring Station

SECTOR – GOVERNMENT BUILDINGS AND STATE AGENCIES

DESIGN STUDY SUPPORT SCHEME

DS/010/02	Teagasc	Teagasc Headquarters
DS/016/02	Bord Bia	Construction of a Food Centre of Excellence Facility
DS/2002/028	Teagasc, Kildalton College	Extension to Teagasc, Kildalton College, Piltown, Co. Kilkenny
DS/2003/012	Environmental Protection Agency	Environmental Offices and Laboratory
DS/2003/022	Forfás	IDA Headquarters

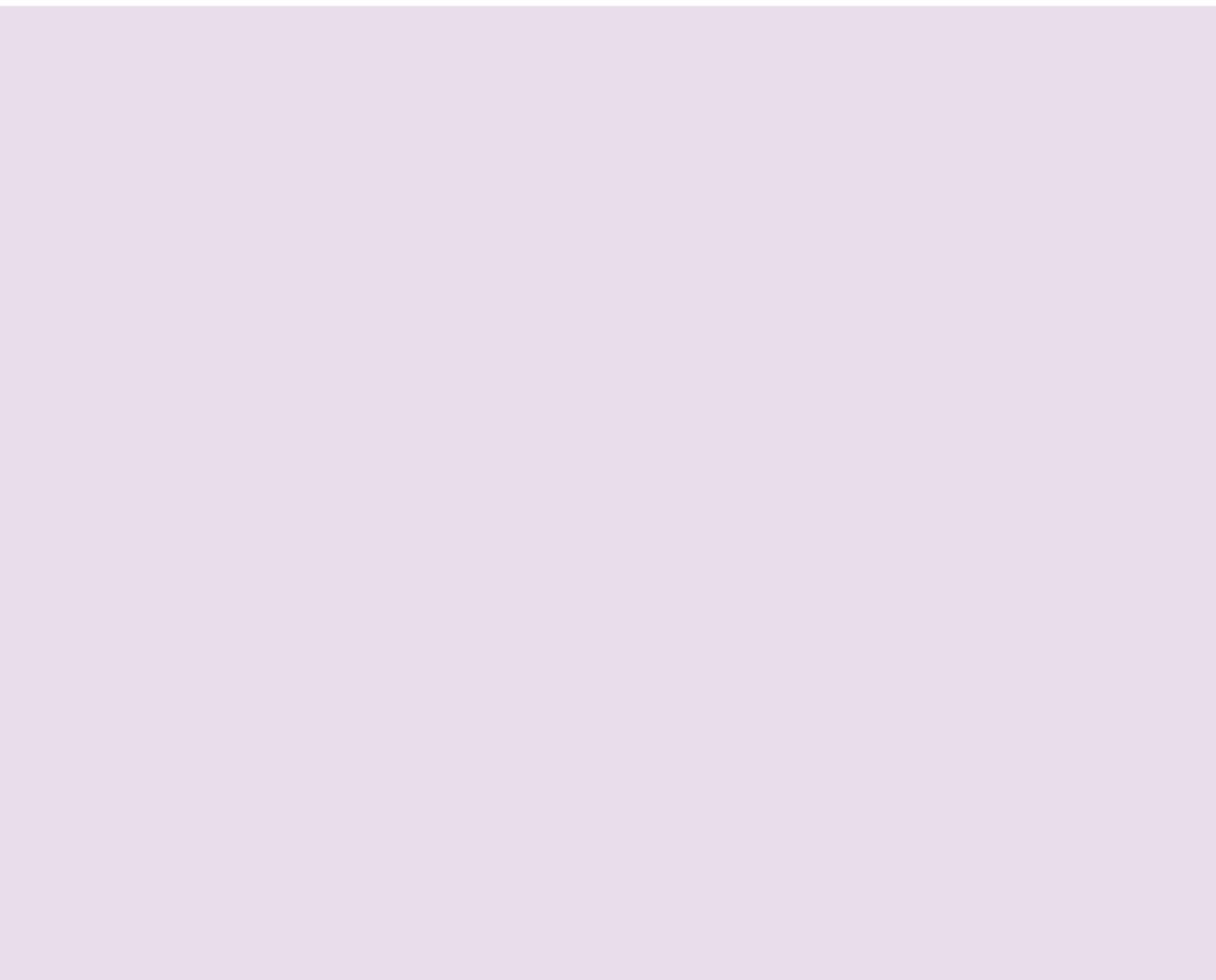


SECTOR – GOVERNMENT BUILDINGS AND STATE AGENCIES

MODEL SOLUTIONS SCHEME		
Ref. No.	Public Body	Project Title
MS/2002/011	Bord Bia	Ground Floor Accommodation Refurbishment
MS/2002/014	Teagasc - Oak Park	Plant Research Laboratory
MS/2002/023	Office of Public Works	Ballycroy Visitors Centre
MS/2003/007	Office of Public Works	Irish Architectural Archive
MS/2003/026	Office of Public Works	Stamping branch, Dublin Castle-heating system refurbishment
MS/2003/030	Revenue Commissioners	Sarsfield House, Limerick
MS/2003/035	Office of Public Works	Installation of BMS in 40 Buildings
MS/2003/043	Enterprise Ireland	Window Replacement and Panel Installation Materials Building, Glasnevin

SECTOR – SPORT/LEISURE

DESIGN STUDY SUPPORT SCHEME		
DS/001/01	Cork Corporation	Matt Talbot (Churchfield) Pool Reconstruction
DS/007/01	Waterford Corporation	Waterford Regional Sports Centre
DS/016/01	Mayo County Council	Refurbishment and extension of swimming pool, Claremorris
DS/024/01	Sligo Corporation	Renewable Energy for Sligo Regional Sports Centre
DS/013/02	Donegal County Council	Ballybofey/Stranorlar Leisure Centre
DS/2003/001	South Dublin County Council	Jobstown West Tallaght Swimming Pool
DS/2003/003	Office of Public Works	National Library of Ireland Phase 6 and 7
DS/2003/009	Killarney Town council	Killarney Sports and Leisure Centre
MODEL SOLUTIONS SCHEME		
Ref. No.	Public Body	Project Title
MS/003/02	Waterford City Council	Waterford Regional Community Sports Complex
MS/2002/019	Dublin City Council	Finglas Swimming Pool
MS/2003/002	South Tipperary County Council	CHP for Clonmel swimming pool
MS/2003/006	South Dublin County Council	Jobstown West Tallaght Swimming Pool
MS/2003/008	South Dublin County Council	Clondalkin Sports and Leisure Centre





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