



# SUNDIAL OFFICES, LIVINGSTON

## CASE STUDY



**SUST.**  
THE LIGHTHOUSE ON SUSTAINABILITY

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Client  
Architect  
Consultants

Scottish Enterprise Edinburgh and Lothian  
HLM Architects, Glasgow  
ARUP Scotland (Structural and Environmental Consultants)  
Davis Langdon & Everest/ Mott Green Wall (Cost Consultants)

## **INTRODUCTION**

**There are a number of examples of sustainable offices recently designed for specific UK clients, including the Centrica Building in Granton, Edinburgh and the Wessex Water offices in Bath. However, the majority of office developments are constructed for speculative letting, and do not exhibit sustainable design features.**

**Scottish Enterprise Edinburgh and Lothian (SEEL), is a forward-thinking client, keen to promote the benefits of sustainably designed offices with an emphasis on the commercial, environmental, and social benefits of this approach. The impetus for the project was consideration of how government agencies such as Scottish Enterprise might achieve reduced carbon emissions consistent with the Kyoto Agreement. HLM Architects were commissioned to develop a sustainable office design for speculative letting, and within the usual economic constraints affecting conventional building design. Potential tenants for the building, to be sited on the Alba Campus in Livingston, could range from call-centre operators to financial-services companies.**

**Throughout the project, HLM took an holistic, 'triple bottom line' approach to the design development. The main considerations were:**

- environmental sustainability or 'green' construction methods**
- economy in terms of construction, energy, and operational costs**
- social factors including user comfort, user-control and democracy of space**

**A study tour was organised to visit similar developments that displayed sustainable design principles. This allowed the design team to anticipate possible issues that might arise and to explore best practice methods. These included optimisation of investment value, flexibility of use, aesthetic qualities, durability, occupier-appeal, quality of finish, use of environmentally- friendly technologies, plus**

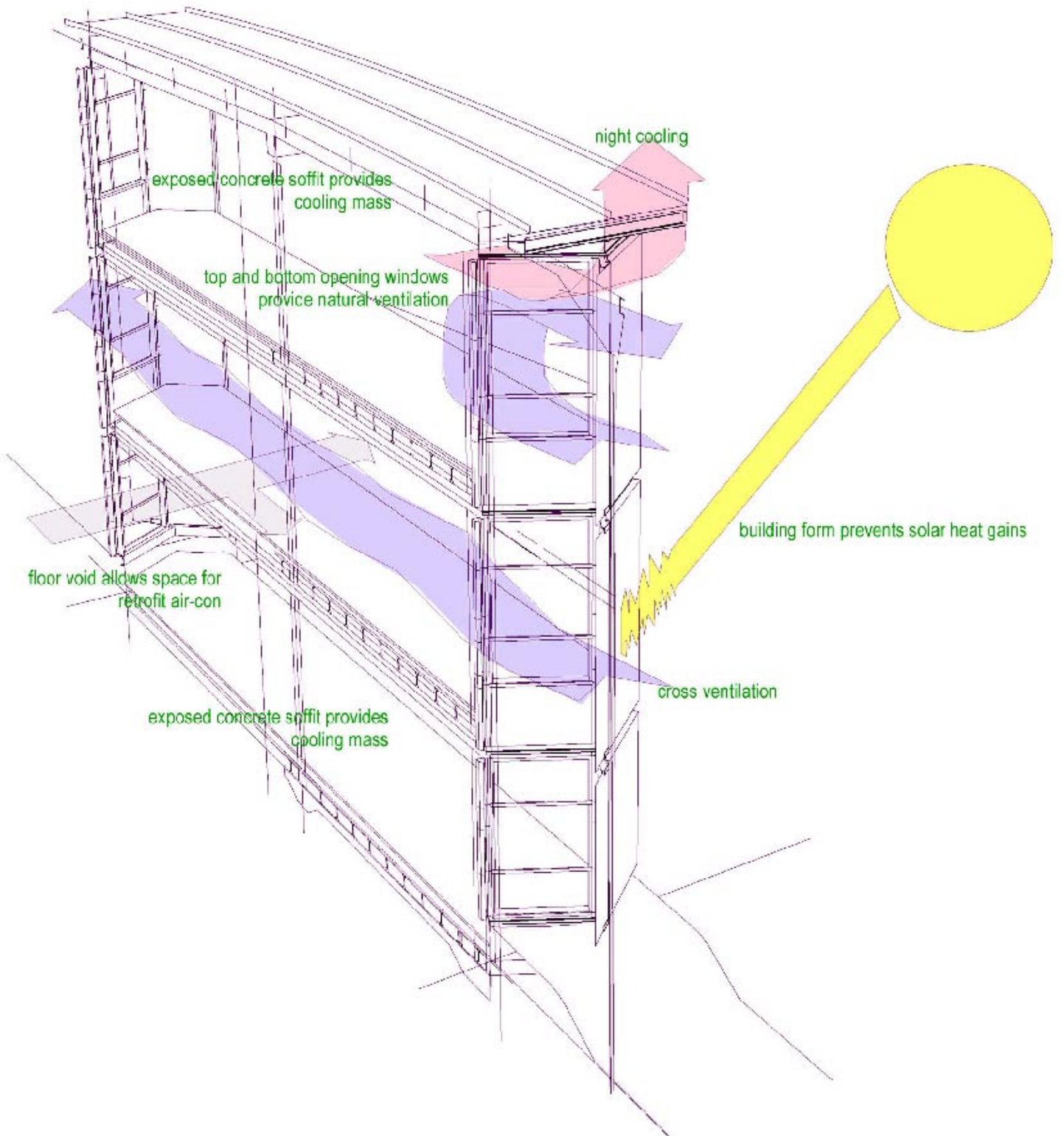
**servicing strategies and running costs.**

**The use of simulation and design tools facilitated the appraisal of the proposed design and allowed accurate environmental benchmarking. The principal tool applied was HLM-esp, a dynamic building simulation tool developed within HLM and based on the simulation software esp-r developed by ESRU at The University of Strathclyde. The tool was central to determining two main design features of the project.**

**Firstly, HLM-esp was used to assess the energy performance of an existing, air-conditioned building of similar specification that had been recently completed on the Alba Campus and this became the primary benchmark.**

**Secondly, the software was then used to assess the performance of the design proposals with respect to energy consumption and thermal comfort. In addition to HLM-esp another tool that was also developed in-house, WIN-DES, was used for assessing average daylight factors and annual solar gain within the spaces. This analysis was expanded through the use of RADIANCE software to assess visual comfort (glare and specific daylight factor distribution) throughout the space.**

**The Building Research Establishment's Environmental Assessment Methodology (BREEAM) was also used to assess the environmental performance and the proposed design achieved a preliminary rating of 'excellent'.**



# SUSTAINABLE DESIGN FEATURES

## Assembling the design team

Once the brief had been developed by SEEL and HLM Architects, the design team was assembled at the Inception of the project. Specialists were chosen to join the design team on the basis of experience and sustainable development objectives of the development. Enthusiasm for the project was also an important consideration. Great importance was placed on interviewing the individuals who would work on the project and not relying solely on the reputation or profile of the consultancy organisation. The advantage of including the engineer and cost consultant at such an early stage was that their expertise could be incorporated into the design process as opposed to being added on at a later stage. Such benefits are demonstrated through the innovative design strategies embodied within the design, including the use of passive cooling, thermal mass, and façade design that reduce the requirement for air-conditioning and lighting.

## Sustainable features

- Natural ventilation – cross-flow or single-sided depending on chosen fit-out configuration, avoiding the need for air-conditioning
- Use of timber frame windows with easy-to-open top and bottom lights
- Floor slab used as thermal mass to absorb heat gains throughout occupied periods, while stabilising internal temperatures
- Passive cooling – the floor slab is cooled down at night by leaving windows open, enabling accumulated heat gain to dissipate, and so ‘resetting’ the floor slab for next-day occupancy
- High levels of flexibility within the letting units
- High ratio of useable floor space with net-to-gross area efficiency of 89%
- Orientation and façade: the building is situated six degrees east of north and incorporates a ‘saw tooth’ façade that allows a ‘democratic’ spatial quality, reduction of solar gain and maximisation of natural daylight
- Flexibility – a 300mm free-raised floor slab allows space for retrofit of air-conditioning and other services, which individual users with energy generating equipment may require
- Plant minimisation throughout the building

## Maintenance of comfortable working conditions

A prominent feature of the design is the projecting façade ‘fins’ that provide shade within the space. The windows are designed to open at the top and bottom to provide natural ventilation. This might be cross-flow if the full floor-plate is used by one tenant, or single-sided ventilation if the spine of the office is sealed by the use of an access corridor separating individual tenants. The undulating nature of the façade also facilitates localised positive and negative air pressures, further aiding the ventilation strategy.

Concrete floor slabs at each level absorb heat gain generated during the day by occupants, equipment, and the sun, resulting in comfortable working temperatures. At night the space and slab are ‘purged’ to ‘reset’ thermal mass for the next day. There is space within the floor construction to allow for the retrofit of cooling

equipment. This may be required by individual tenants where there is considerable use of heat-generating equipment.

A relatively high (3.25 metre) ceiling provides extensive daylight penetration and allows natural light to penetrate the middle of the room, resulting in a reduced need for artificial lighting.

The next stage of the design work will consider the integration of solar collectors, waste and water strategies and the use of a sedum roof.

### **Site layout**

The architects were aware that typical north-south orientation of a building led to high solar gain and uncomfortable working conditions in south-facing offices, while north-facing facades tended to be dull. An east-west orientation was thus considered with an undulating facade that allowed windows to face northeast and northwest. This provides maximum diffused light, while minimising glare and excessive heat gained from direct sunlight.

### **Costs**

Commercial considerations of the design were of prime importance. No design can be truly sustainable without due consideration to economic issues. Indeed, buildings that cost too much to build or to maintain are unlikely to be built, or may be difficult to let and are therefore inherently unsustainable. A key element of the design strategy was that the building should be economically viable both in build costs and maintenance as similar, conventional constructions. Capital costs are expected to be in the region of £110 per square metre, with running costs projected at least 30% lower than other benchmark buildings. Total life-cycle costs are expected to be lower still, mainly due to the absence of plant associated with air-conditioning and mechanical ventilation and, consequently, maintenance requirements.

### **Social aspects**

Consistent with the 'triple bottom line' approach to sustainable construction, social aspects including user-

comfort, were prime considerations.

A democratic approach to user-occupancy resulted in the floor plate being designed to afford a dual aspect, offering optimal daylight distribution and with each level overlooking an existing water feature. Occupant control of the working environment was also a feature in the overall design.

The floor plate can be flexibly divided, allowing for a number of occupancy types. This also serves to make the building a more attractive proposition to commercial developers.

Using simulation tools, both thermal and visual comfort factors were predicted. The results indicated that the proposed design is at least as effective as a comparable air-conditioned facility.

### **Consultation**

Early within the design process, workshops were held involving a range of associated professionals, including property agents and contractors. They tested design assumptions and suggested further considerations to the design team. The workshops revealed that clients expect air-conditioned offices as standard. There is a level of education required to inform clients that comfortable working conditions can be achieved through alternative approaches, which bring additional benefits in terms of health and maintenance.

The contractor who attended the workshops suggested a number of ways that waste might be reduced in construction. Sorting waste can reduce volume and skip usage. Specifying fully assembled lighting units, meanwhile, can reduce the amount of packaging and breakage during assembly, usual when the components are supplied separately.

# EXPERIENCE OF SUSTAINABLE DESIGN

Throughout the past three years, HLM Architects have developed in-house software tools to facilitate improvements to design process outcomes, particularly in the area of sustainability.

## **The tools that have been developed include**

- HLM-esp - a dynamic building simulation tool
- RADIANCE - a lighting simulation tool
- WIN-DES - a calculator for levels of daylight and solar gain-levels
- HLM-LCC - a life cycle cost comparator
- HLM-Area - an area analysis tool

These tools are now routinely used on all projects within the practice and offer a 'window' into the performance of sustainably designed buildings.

In addition to the use of simulation and design tools, a knowledge base of expert information has been accumulated, providing a valuable resource for designers, and helping to inform the design process.

HLM Architects have won a variety of prizes for sustainable design competitions including Lochend Butterfly Competition; and Falkirk Town Centre redevelopment. The practice is working toward ISO14001 accreditation and is a licensed BREEAM assessment organisation.

## **Implementation of sustainable development policy within the client organisation**

Scottish Enterprise encourages innovation and forward thinking in its economic development agenda that is allied to the Scottish Executive's sustainable development policy. This project seeks to bring some of these issues together by proving that the commercial property market can contribute towards the adoption and implementation of these policies. They can do this without compromising profits, expected from conventional speculative office design, construction and sale of fully occupied buildings.

# THE BUSINESS CASE

It is intended that the building be constructed and managed on a fully commercial basis with no additional subsidy outwith SEEL's initial support. The capital costs are expected to be consistent with equivalent benchmark buildings and energy costs are expected to be 30% lower than the benchmark. Life-cycle cost analysis is also expected to demonstrate potential savings for owners, mainly because there is no plant to maintain. Other projected commercial benefits include an 89% net-to-gross floor space efficiency, in comparison to a standard of 77%. Furthermore, quality finishes and subsequent replacement costs have been costed into the design on a typical replacement period basis.

## Lessons learned

The inclusion of specialists in the design process can be of great value for specific knowledge and input, although this may also result in a reassessment of fee structure. In the case of mechanical and electrical engineers, there is a direct conflict with regard to the provision of buildings with a low level of mechanical equipment, as their fee is based on the capital value of any plant specified.

In the current project, the design process benefited from a relatively lengthy time frame, not usually available to design teams. Without this development time, such a sophisticated design might not have been possible, nor such extensive savings estimated. However, having been through the process once, HLM now feel confident that they can implement future initiatives more efficiently.

Pragmatic decisions about the extent of sustainable features incorporated in the development had to be reached for the project to remain commercially viable. For instance, the use of 'green' technologies such as rainwater harvesting was considered, but the high costs in relation to benefits achieved in a low-water usage environment such as an office, would have jeopardised the economic sustainability of the project. Photovoltaics (PVs) were also considered as part of the façade, however the batteries required to store the energy produced on site have a short life expectancy, resulting

in waste-disposal issues. This, together with the high capital and installation costs, meant that the use of PVs could not be justified.

## Barriers encountered

The main barrier was in attitude to new ways of working. The architects made a conscious decision not to send out an organisational strategy or proposal for a floor-plate arrangement. Instead they wanted to initiate the design process by asking the other consultants for opinions on key issues that might shape the design. Thus, the floor-plate depth was constrained to 13.5 metres to ensure crossflow natural ventilation was achievable. Adopting this novel approach proved arduous at times, and resulted in various discussions, phone calls, meetings and team-building exercises before it became the accepted mode of working by all involved.

## Recommendations to others seeking to adopt a similar approach

Sir John Egan's report 'Rethinking Construction' advises the client to make full use of consultants' expertise by involving them early on in the development process. This was achieved in this project and, in addition, the architects also implemented a collaborative approach by involving other members of the design team at an earlier stage than usual. This was deemed beneficial to the overall design process, and led to a more holistic approach. The architects believe this way of working is the only real model for cross-disciplinary innovation to occur. This, they believe, also results in best value for the client.

The issues of sustainability enabled new and innovative possibilities for office design that may not have been considered previously, such as the directional façade design and the removal of air-conditioning.

## CONCLUSION

This holistic design approach, involving a wide range of stakeholders such as property managers, property agents, facilities managers, users, and developers, is very effective for delivering sustainable design. It considers a broad range of needs from the outset of the design process and increases the chances of developing buildings that are ecologically, socially and commercially viable.

In addition, such an approach can limit future risk for the client by providing an effective design that has considered alternative design factors to deliver an optimum solution for the client, the environment and the user.



**This proposed office design was developed using extensive computer modelling within a collaborative design process. The aim is to produce a speculative office design that can be built at a standard, commercially viable cost and provide a high level of rented floor-space suitable for multiple occupancy. Sustainable design features include reducing energy use by up to 40% through natural ventilation and daylight. Winner of the REASURE low-energy-design competition.**

Sustainable design features:

Natural ventilation

Floor slab used as thermal mass to stabilise internal temperatures

Passive cooling

High levels of flexibility within letting units

High ratio of useable floor space

Orientation and façade: enables reduction of solar gain and maximisation of natural daylight

Sust.: The Lighthouse on Sustainability aims to raise awareness of sustainable design in architecture. It was devised by The Lighthouse: Scotland's Centre for Architecture, Design and the City on behalf of the Scottish Executive and in support of the aims of the Policy on Architecture. It is funded by the Sustainable Action Fund.

[www.sust.org](http://www.sust.org)