The Handbook of Sustainable Refurbishment

Non-Domestic Buildings

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Nick V. Baker

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Preface

In most European cities there is a vast stock of existing buildings, many of which are getting to the end of their useful life. To replace the stock would take several decades and incur an unrealistic financial burden. It would also create a large contribution to CO_2 emissions, as a result of the energy associated with the production of materials and the construction of replacement buildings.

It is therefore essential that we develop strategies and techniques to improve the energy performance of our existing stock. It is commonly understood that the heating, cooling, lighting and ventilation of buildings accounts for nearly half of global energy consumption, with the consequent CO_2 emissions having an effect on global warming. The reduction of day-to-day consumption of fossil fuels for heating, cooling, lighting and ventilation must be the main objective in any attempt to refurbish a building sustainably.

This guide is a product of the European Union (EU) funded REVIVAL project, which set out to demonstrate some of these principles by incorporating them in five refurbishment projects of large non-domestic buildings. Wherever possible it draws from the experience of the REVIVAL project, but includes other examples and illustrations when necessary.

This guide is aimed at the architect, engineer, surveyor and project manager. It sets out the case for sustainable refurbishment and the principle measures that can be adopted. It presents principles in a concise technical language, but follows with an explanation of practical implications. It does not attempt to be a source book of manufacturer's information and technical data, or to deal with construction detail.

REVIVAL Team
July 2009

13 The Meyer Hospital, Florence

Refurbishment and addition of large greenhouse to historic building in warm climate

The building dates from the 1930s when it was a hospital for tuberculosis patients. It consists of a long three-storey terrace running east–west, of traditional construction with very thick walls and a tiled roof. A central corridor serves rooms on the north and south side (Figures 13.1 and 13.2). The total area is 10,480m². The building had been semi-derelict for some years. A new paediatric hospital has been built on the site adjacent and the refurbished building forms the administrative and reception centre.

Refurbishment strategy

Being of traditional construction the building was non-insulated and single glazed. The first consideration was how to insulate the envelope. The roof presented no problem, since during reconstruction insulation material was included, in this case mineral fibre quilt. The windows were also replaced giving the opportunity to incorporate low-e double glazing in timber frames, giving a U-value of 2.85W/°Cm². This also reduced uncontrolled infiltration.

Figure 13.1 South elevation of the Villa Ognissanti, the original Meyer Hospital

The solid walls presented some problems. External insulation would have disturbed traditional detailing of this historic building, whilst internal insulation would have reduced thermal inertia.

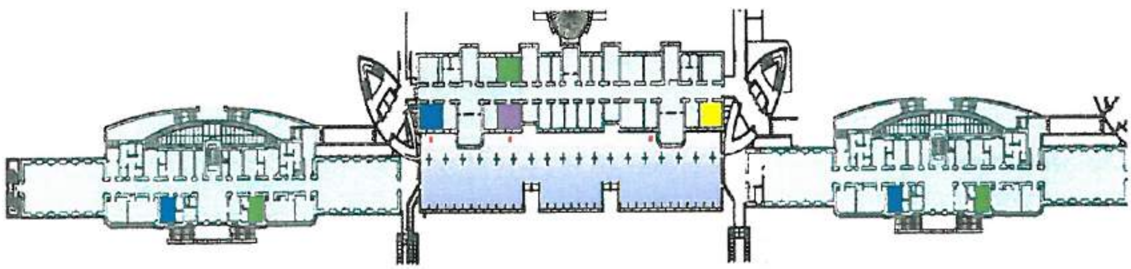


Figure 13.2 Plan of the east–west running terrace showing the additional greenhouse (centre)

Figure 13.3 Replacement timber windows with low-e glazing

Figure 13.4 Refurbished traditional louvre shutters on south elevation

In the end, bearing in mind the nature of the climate (mild Mediterranean) it was decided to leave the walls non-insulated other than a small improvement brought by new external render containing a natural lightweight volcanic aggregate. The resultant U-value is calculated to be 2.0W/°Cm².

A new building energy management system (BEMS) was also installed. This not only managed the conventional heating and cooling, but also the night cooling.

Originally, the renewed south-facing windows were to have included an interpane shading system, magnetically controlled from outside the sealed unit. These were finally rejected on the grounds that since the external louvred casement shutters (Figure 13.4) had to be kept for historic reasons, the expense of the additional integral shading was not justified.

The greenhouse

The boldest intervention is the installation of a large greenhouse on the south side of the central pavilion abutting the lower two of the three storeys (Figures 13.5, 13.6 and 13.7). As an energy conserving measure, this strategy may be a little surprising for a warm climate. However, there were two mitigating circumstances – firstly much of the lower glazing is shaded by vegetation, and being in contact with the massive non-insulated wall provides stabilizing thermal mass. However, considerable interest has been

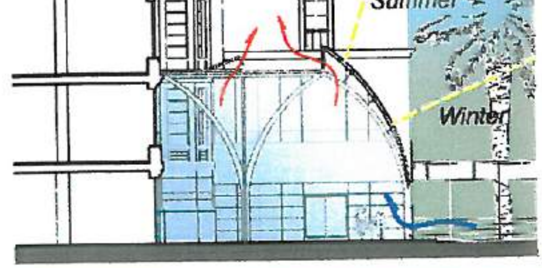


Figure 13.5 Section of greenhouse showing shading and ventilation openings

focused on the risk of overheating in the greenhouse itself, and in the adjacent offices.

The structure is made from laminated timber columns and is a striking addition to the architecture. Its spatial function is as the arrivals foyer and reception area for the whole hospital complex.

Figure 13.6 Interior view of greenhouse showing semi-transparent PV shading

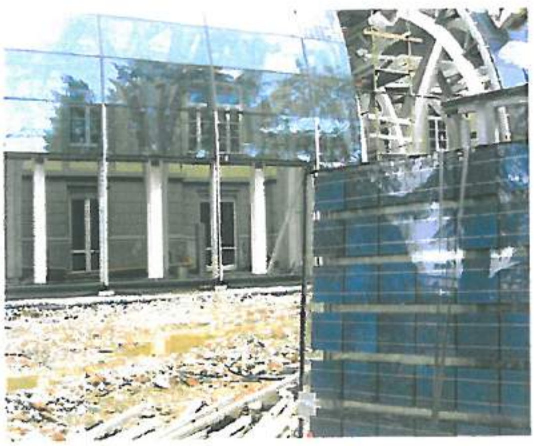
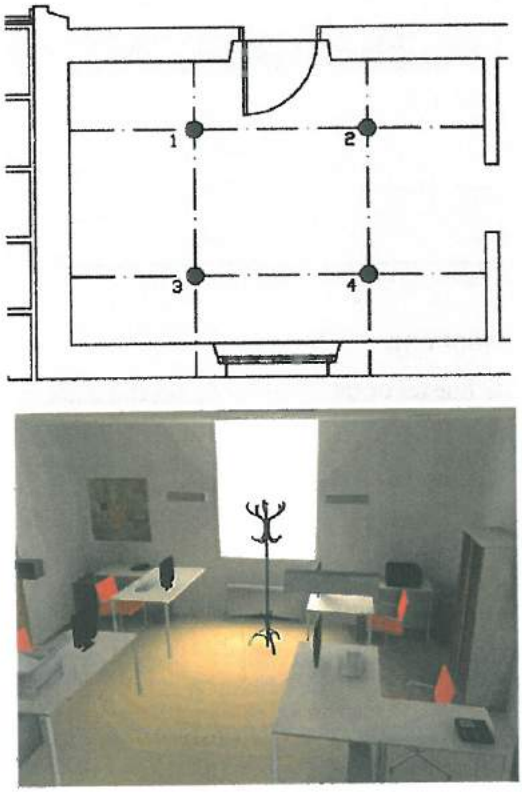


Figure 13.7 Exterior view of greenhouse during construction

Recognizing the potential risk of overheating, the design demonstrates the sound principle of shading and ventilation. In this case, the shading is provided by semi-transparent photovoltaic panels. This, and the ventilation provision, are shown in Figure 13.5. The ventilation openings at the top and bottom of the greenhouse are controlled by the BEMS. A further open area can be obtained by leaving the main doors open.



Position	Daylight Factor %
1	1.71
2	1.37
3	2.57
4	2.02
Average	1.91

Figure 13.8 Simulated daylight results for office facing greenhouse

Table 13.1 CO_2 emissions for corrected measured Meyer 2007 data compared with reference case

	kWh	kWh/m²	CO_2 factor	CO_2
Gas reference	1,257,600	120	0.19	238,944
Meyer	876,652	83.7	0.19	166,563
Electricity reference	1,194,720	114	0.44	525,676
Meyer	880,320	84	0.44	387,340

Note: Total CO_2 kg – Reference 764,620; Meyer 553,903.

Daylighting

The impact of the greenhouse on the daylighting of the adjacent office rooms had been tested by simulation (Figure 13.8). The result shows a mean value of 1.91 per cent.

Occupants report a high level of satisfaction with the lighting, 4.0 on a 1–5 scale in the end pavilions, but slightly less, 3.5 in the central pavilion adjacent to the greenhouse (Figure 13.9).

Overall energy performance

The Meyer project is one of those where there has been major change in the function of the building, so there is no comparable data available for energy consumption before the refurbishment. Thus a reference office has been defined.

This shows a 28 per cent reduction in emissions, although it has to be said that the reference values for gas and electricity per m² are very high for a building in the climate of Florence.

Comfort

Questionnaires were issued to occupants in the central wing adjacent to the greenhouse, and in the two lateral wings. The results are shown in Figure 13.10. These are consistent, with the exception of a slightly lower satisfaction for lighting reported in the central wing, which could be due to the presence of the greenhouse. Unfortunately the question does not distinguish between artificial lighting and daylighting.

Comfort, which is probably strongly weighted towards thermal comfort, is a little on the positive side of neutral, which is typical where discomfort is not present, and should therefore be regarded as successful, although since all values are averaged, it is not possible to see if discomfort was reported by some respondents.

It is interesting to note that a positive response is recorded for the level of user control. This indicates that the temperature controllers in each room, providing a simple user-friendly adaptive opportunity, are appreciated.

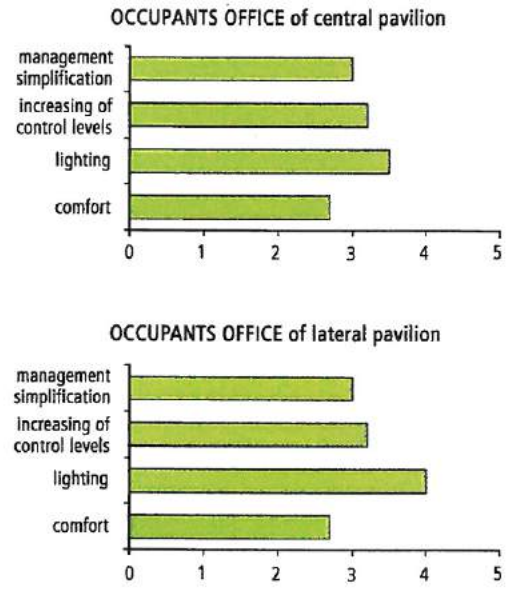


Figure 13.9 Results of user survey for office facing greenhouse (central pavilion) and office facing open air (lateral pavilion). Scale ranges from 0 – very dissatisfied to 5 – very satisfied.

'An incisive book that provides practical strategies and tactics for sustainable refurbishment, literally from the ground up. Richly illustrated with informative diagrams, supported by accessible quantitative analysis and reinforced by detailed case study examples, this book is a triumph.'

Koen Steemers PhD RIBA/ARB, Professor of Sustainable Design and Head of the Department of Architecture, University of Cambridge

'Nick Baker tackles head on what many eminent scientists in Cambridge regard as most pressing contemporary problems, the sustainable refurbishment of the existing building stock, much of which is going to be with us still in 2050. Dr Baker delivers his profound understanding of these difficult issues in a wholly intelligible and compelling way. I cannot commend this book to my profession and its patrons highly enough.'

Professor Alan Short, University of Cambridge and Short and Associates Architects

The refurbishment of existing buildings is a crucial yet often neglected subject within sustainable architecture – attention is usually focused on new buildings. Many old buildings waste large amounts of energy and provide poor internal conditions for occupants through poor lighting, poor ventilation, solar penetration and glare, and poor control of heating and cooling. Demolition is an option but the refurbishment alternative is increasingly seen as more sustainable in terms of architectural value, materials use, neighbourhood disruption and waste disposal. In addition, the potential impact of low energy refurbishment is much greater than that for new build since there are many more buildings already in existence than will be built in the next 10–20 years, the period over which many CO2 targets apply.

The Handbook of Sustainable Refurbishment: Non-Domestic Buildings offers architects, engineers and a wide range of building professionals practical advice, illustrated by real examples. It moves from principles of sustainable refurbishment to specific design and engineering guidance for a variety of circumstances. It emphasizes the need for an integrated approach by showing how refurbishment measures interact with one and other, and with the occupants, and how performance is ultimately influenced by this interaction.

Nick V. Baker is an independent consultant and technical expert on the energy efficient refurbishment and the development of LT software. He is affiliated to The Martin Centre, Department of Architecture, University of Cambridge.

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