Energy saving strategies for the new design Meyer Hospital in Florence

Energy Saving Strategies for the New Design Meyer Children Hospital in Florence

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Abstract

The article is referring to an ongoing Research under the European Union's Fifth Framework Programme for RTD, entitled " HOSPITALS - EXEMPLAR ENERGY COUNSCIOUS EUROPEAN HOSPITAL AND HEALTHCARE BUILDINGS" (EU Contract NO: NNE5-2001-00295), with a five Hospital buildings selected as demonstrative case studies.

The implementation of sustainable energy systems is an objective of the European Union's energy policy. This policy aims to support and promote secure energy supplies with a high quality of service at competitive prices and in an environmentally compatible manner.

The HOSPITALS initiative aims to demonstrate that renewable energy technologies may be used with very positive results within the European health care building sector and in this way encourage the exploitation of renewable energy.

This paper aims to illustrate methods of obtaining large energy savings using bioclimatic design strategies from the first stage of building design. The amount of energy saved and the resulting reduction in CO_2 emissions are quantified.

Bioclimatic Design Concept

Bioclimatic Design approach covers a range of strategies to save energy in buildings, and this article contains general information, guidelines and strategies with a focus on hospital buildings from the first stage of building design.

Building orientation and form

It is important to consider the local climate during the first stage of building design. An energy conscious design which results in an energy efficient building has to be based on the local climate. In a new hospital, the form and the orientation of the building should be first defined considering the climate of the area, the wind, the temperature and the solar radiation. The aim is the reduction of the annual energy demand balancing the various requirements: Patient comfort is clearly of paramount importance.

Objectives:
- the reduction and control of solar radiation;
- the provision of natural ventilation and natural cooling of the external buildingsurfaces by evaporative cooling.

Figure 1 *View of Deventer Hospital*

Actions:
- minimize the surface area of the south facing façade;
- at the same time provide for natural lighting and shading;
- avoid excessive solar gain during the cooling season;
- use the roof as an active skin.

Building envelope and materials: Glazing and Double Skin Facade

To guarantee a thermally comfortable indoor environment it is necessary reduce the energy losses through the building envelope. A Double Skin Facade is an additional external skin for a building that optimize the indoor climate and reduce the energy demand of the building.Building materials has to be carefully selected, based on criteria for: emissions, adsorption, surface roughness and cleaning, in order not to affect the indoor air quality.

Wall insulation

Energy losses are normally stated in terms of heat flow through a square meter of wall per unit of time. The losses depend mainly on the temperature difference between the inside and outside face of the wall and the thermal resistance of the material, or combination of materials, of the the wall. Main way to reduce losses is to prevent heat conduction by adding thermal insulation to the building envelope.

Figure 2 *The building envelope of the new hospital uilding at Fachkrankenhaus Nordfriesland has been designed with high insulation levels and a double skin façade. Windows are optimized for additional ventilation, daylighting and visual comfort.*

Cavity insulation: Is the cheapest way of insulating, but can only be used when a cavity wall is present. Retrospective insulation of a cavity wall can be done by injecting expanded clay granules, mineral wool flakes or polys-

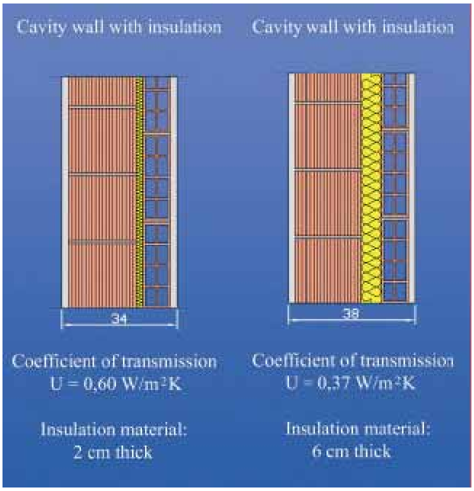

Figure 3 *Two options for insulating the walls of wards at the Meyer Hospital have been studied. The two drawings above show the options with different thicknesses of cavity wall insulation.*

External insulation changes considerably the appearance of the exterior. A single, thick insulation layer can be applied, which makes it possible to achieve desired insulation value. The main advantage is to remove and prevent cold bridges.

Figure 5 *100 mm exterior insulation used for Torun Hospital*

Internal insulation: fitted on the inside of the walls of a building is an isiest intervent on existing buildings, but reduces the interior surfaces of the rooms and need carefully execution in order to prevent condensation by cold bridge.

Integration of Renewable Energies

Photovoltaic (PV) cells convert sunlight directly into electricity through semiconductor materials such as crystalline silicon. PV systems integrated into building façades allow energy production to be combined with other functions of the building envelope, such as shading, weather shielding or heat production.

Substantial cost savings can be made combining these functions, e.g. in expensive façade systems where the cladding costs may equal the costs of the PV modules. Building integration does not just mean mounting PV modules on a building.

Real integration can involve much more, including all steps of the design process.Solar water-heating systems use solar collectors, to heat either water that circulated from the collector to water storage tanks similar to those used in aconventional gas or electric water-heating system.

Figure 7 *At Aabenraa hospital three solar collector systems were implemented All the systems were roof mounted. For architectural reasons and in order to avoid glare, solar collectors were mounted so that they arent visible from outside the building. Special attention was given to the risk of legionella bacteria, by using electrical backup system to ensure that high water temperatures required for avoiding legionella growth were always achieved. Each system includes approximately 50 m² solar collec tors, which provides an annual energy yield of about 27 MWh per system. This provides about 60% of the annual energy requirement for water heating.*

Figure 6 *Fachkrankenhaus Nordfriesland Hospital The large ceiling surface has a shallow north facing slope; here a white curtain is used to reduce solar radiation. On the south facing steeply sloping roof section, polycrystalline PV modules are integrated into the glazing to act as solar shading while generating electricity.*

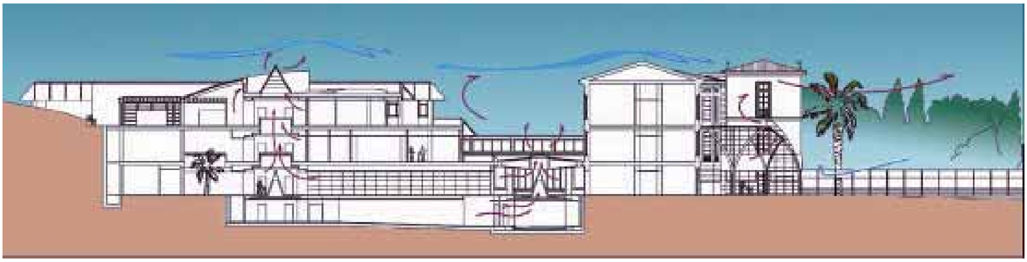

Figure 4 *The section view of the Meyer Hospital, partly sunk into the hill: This diminishes the impact of the building on the site and contributes to energy conservation by providing shelter*

Green Roofs

To reduce heat losses it is necessary to insulate all opaque elements in a building, including the roof. A greenroof can insulate a roof and at the same time help to protect the environment by diminishing the environmental impact of the building. Green roofs can provide a fresh architectural approach with visually appealing organic architecture. It is assumed that a good environment has a positive influence on the recovery of patients. Hospital buildings should therefore be considered as a part of the treatment of patients. Selecting building materials with low levels of emissions such as green roofs can lead to an improved indoor climate, which will benefit the patients.

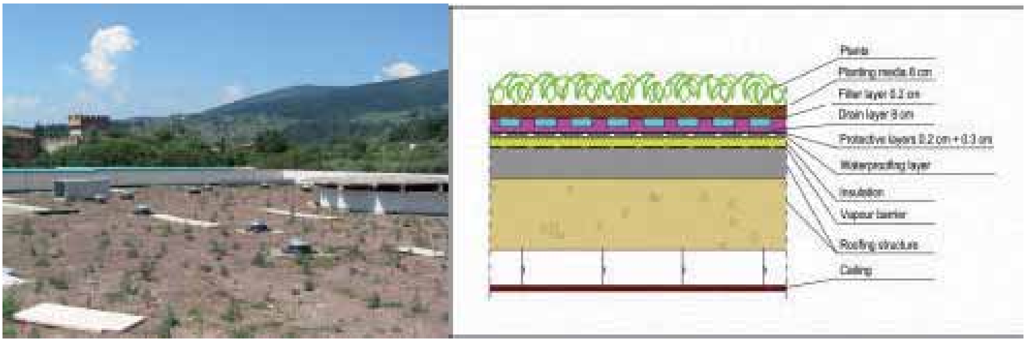

Figure 9 *A green terrace solution is planned for the Meyer Hospital. The final design, with increased amounts of insulation material in the cavity walls and a green roof - reduces the annual energy demand for heating by 36% per patient room.*

Water

The rational use of water is an important issue for saving water resources. It has to be taken into account from the first stage of the design.Collected rain water can contribute to maximizing the thermal comfort during the summer season when used in external spaces or atria to provide water to fountains, ponds and pools.

Figure 8 *Lake and pond in Fachkrankenhaus Nordfriesland Hospital*

These architectural elements are able to mitigate and influence microclimate and provide patients with a relaxing area and view. The evaporation of water from liquid to vapour is accompanied by the absorption of a large quantity of sensible heat from the air. The efficiency of the evaporation process depends on the temperatures of the air and water, the vapour content of the air and the rate of airflow past the water surface.

The main disadvantage of a pond or a fountain is the increased moisture content in the ventilation air supplied to the indoor spaces. Psychological aspects are very important for hospital patients. Patients need a friendly place to recover from sickness. Plants and water in the buildings and external areas give patients contact with nature, providing a relaxing hospital environment in which to recover.

Daylight Strategies

An energy conscious building aims to optimise the use of passive solar energy, natural ventilation and natural light to create a comfortable and energy efficient working environment.The use of daylight for interior illumination can reduce energy use within buildings and has a positive effect on visual comfort.

If considered at the design stage, the use of daylight allows for a significant reduction in electricity used for lighting and can reduce overall energy consumption. Daylighting depends on the availability of daylight, location, size and orientation of windows. Several strategies can be used to achive visual comfort when using daylight including: Rooflights, Atria, Glazing, Transparent Insulation, Lightpipes and Lightducts, Shading. The integration of rooflights is an effective daylighting strategy. The sky is generally brighter at its zenith than near the horizon: this is the reason why horizontal rooflights admit more daylight per square metre of glazed area than vertical windows (three times more than a vertical window).

Figure 5 *A Pictures of the sun pipes used at Meyer Hospital for daylighting. Sun pipes were installed to give good luminance levels in each patient's room. Each room accommodates two patients and has two windows, one looks outside and is day lit, the other is illuminated by sun pipes. At first sight the sun pipe installation gives the impression of being lamp lit.*

Sunpipes are among the more mechanically complex daylighting devices.

Sunlight is collected by heliostats (mirrors controlled by a tracking device), concentrated by mirrors or lenses, then directed inside the building through shafts or fibre optic cables.

Shading. Type, size and positioning of any shading device will depend on climate, building use, and the source of the light to be excluded (direct sunlight, diffuse sky light, or perhaps reflected light from outside).

Figure 5 *Shading devices at Aabenraa Hospital.*

Figure 5 *Shading system at Fachkrankenhaus Nordfriesland Hospital*

Figure 8 *Meyer Hospital. The surface of the sunspace will incorporate a semi-transparent PV system with a rated capacity of 31 kWp of renewable energy. The Meyer's sunspace is orientated to the south.. Design strategies consider not only energy and environmental aspects but also social impacts: the primary objective is to create a pleasant "socializing" space that can be used through much of the year without requiring any extra energy. This social space is integrated with the green park. PV installation was financed by the Ministry of Environment after a national competition on "PV High Architectural Integration".*

Conclusions

Demonstration with a pilot projects that energy efficient and sustainable hospital buildings can fully meet all the architectural, functional, comfort, control and safety features through the application of innovative and intelligent design and integrated design. This demonstration effect could contribute to a better acceptance of innovative and renewable technologies in public buildings.

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