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 European Commission DG for Energy and Transport initiates, coordinates and manages energy saving policy actions focusing on energy efficiency, maintaining and enhancing security of energy supply and international co-operation. A central policy instrument is the support and promotion of energy Research, Technological Development and Demonstration (RTD), principally through the ENERGIE sub-programme under the European Union's Fifth Framework Programme for RTD. This includes the HOSPITALS project.

The HOSPITALS project aims to demonstrate the significant reductions that can be achieved in the total energy demand of the European health care building sector. These energy demand reductions will contribute to significant reductions in CO_2 emissions.

ENERGY CONSCIOUS EUROPEAN HOSPITALS AND HEALTH CARE BUILDINGS

– INTRODUCTION

This brochure outlines strategies to save energy in buildings, with a focus on hospital and health care buildings. It has been prepared by the HOSPITALS project (EU Project No. NNE5-2001-00295 supported by the European Commission).
The brochure aims to illustrate innovative elements that may be included at the first stage of building design and can deliver significant energy savings. The amount of energy saved and the resulting reduction in CO_2 emissions are quantified.

The primary target groups of the HOSPITALS project are administrators, facilities managers, designers and contractors of health care buildings. 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.

List of Contents:


Aabenraa Hospital, Denmark


Fachkrankenhaus Nordfriesland, Germany


Meyer Children's Hospital, Italy


Torun City Hospital, Poland


Deventer Hospital,
The Netherlands

Innovative elements used in the buildings include:

- Double skin facades
- High performance low-e double glazing
- Transparent insulation
- Environmentally friendly insulation materials
- New energy efficient heating, ventilating and air-conditioning (HVAC) systems reducing the installed capacities & minimising circulation losses
- Optimised control systems for heating, cooling, ventilation & lighting
- Local CHP (Combined Heat and Power) plants
- Minimised use of adsorptive & absorptive building materials, lowering the risk of infection
- Light ducts for increased daylight utilisation & improved visual comfort
- Active solar heating for domestic hot water (DHW)
- Multi-functional photovoltaic (PV) systems, e.g. for electricity production & control of solar gain
- Hybrid ventilation (fan assisted natural ventilation)
- Large aquifers for seasonal storage of heating & cooling

Work packages:

The HOSPITALS project includes five core work packages:

WP1: Integrated Design Process: Implementation and integration of renewable energy elements
WP2: European Design Workshops & Design Review at European level
WP3: Monitoring and Evaluation
WP4: Hospital Facilities Management & Psychical Working Conditions
WP5: Dissemination

And five site specific work packages:

WP6: Planning and Design
WP7: Construction & Erection
WP8: Commissioning
WP9: Monitoring
WP10: Reporting

Funding is being provided by the EU for a proportion (35%) of the eligible capital costs of the five participating sites. Eligible costs include planning, construction, commissioning, monitoring, evaluation and dissemination with respect to the implementation of the innovative elements in the 5 hospitals.

Aim:

The HOSPITALS initiative aims to demonstrate innovative but practical methods for significantly reducing the total energy demand of the European health care building sector.

The specific objectives are:

- to introduce the use of an **integrated energy design process** when renovating or constructing health care buildings.
- to increase the use of **innovative renewable energy technologies and energy efficiency** in the health care building sector.
- to obtain significant **reductions in primary energy use, CO_2 emissions and peak electricity demand**.
- to ensure **large improvements in thermal comfort and lighting conditions** for patients and employees, thereby achieving a **more comfortable indoor climate, faster recovery of the patients and increased efficiency of the employees**.
- to carry out comprehensive and careful **monitoring and evaluation of five hospital sites**.
- to **disseminate the experiences and results achieved** to key decision-makers, hospital managers, consultants and manufacturers, leading to wide spread knowledge and **adoption of the successful techniques** used.
- to move the European health care building sector forward to the point where the **use of energy efficient technologies becomes standard practice for future building programmes**.

Benchmarks/target figures

The table below shows the energy demand for space heating and domestic hot water and the total electricity demand for each site.

Site	Benchmark kWh/m²/year		Target kWh/m²/year	
	Thermal	Electricity	Thermal	Electricity
Site 1, DK	168*1	72*1	112	103
Site 2, DE	185	60	81	26
Site 3, IT	112	99	73	63
Site 4, PL renovation	640*2	29*2	448	29
Site 4, PL new	180	-	83	34*3
Site 5, NL	208	81	118	68

*1 Average figures; *2 Before renovation; *3 More equipment has been installed in the new part compared to the existing hospital.

Site	CO_2	SOx	NOx
Site 1, DK*1	974	0,18	1,59
Site 2, DE*1	262	0,23	0,002
Site 3, IT*2	899	0,77	7,91
Site 4, PL*1	3.537	116,0	9,0
Site 5, NL*2	1.943	8,71	3,35

Expected emissions reduction [tonnes/year]

*1 Compared to existing levels
*2 Compared to benchmark

Innovative elements:

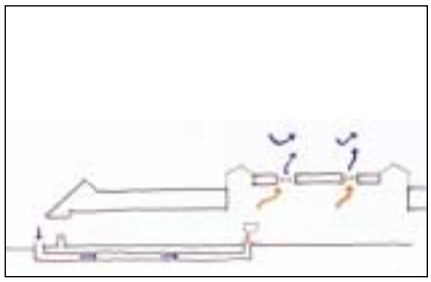
- **Building integrated solar energy**
- **Double skin facades**
- **Natural fan assisted ventilation controlled by a computerised building management system (BMS)**
- **Active solar heating for domestic hot water**
- **New water based heating system**

Aabenraa Hospital

Courtyard before renovation

Glazed courtyard after renovation

Roof lights for courtyard



Ventilation principle for hybrid ventilation

Aims & Expectations (Aabenraa):

Energy savings: The energy demand for space heating, ventilation and domestic hot water is expected to be reduced by 2.700 MWh/year and the electricity demand is expected to be reduced by 200 MWh/year. These figures are compared to existing conditions for the renovated building and a building meeting current Danish building codes for the new building.

Financial savings: The annual saving is estimated at 139.719 Euro/ year. It is anticipated that the total maintenance costs will be similar to those before the renovation. The total eligible investment cost is 1.759.783 Euro. This gives a simple payback time of 12,6 years, including EU-support (615.924 Euro) the payback time will be 8,2 years.

Emissions savings: The energy savings will lead to a total reduction of polluting emissions per year of: 974 tonnes CO_2, 0,18 tonnes SOx and 1,6 tonnes NOx.

Location of solar collectors and glazed courtyard

Haderslev Hospital

Site 1:

Aabenraa (& Haderslev) Hospital, Denmark

Gross area: 28.600 m² (& 76.700 m²)

The wind cowls for natural ventilation

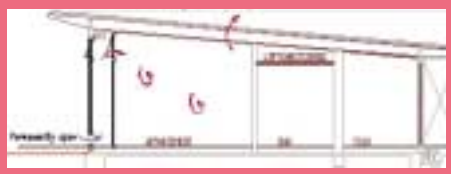
Solar collectors on the roof

Aabenraa Hospital is located in the southern part of Denmark. It is a medium sized hospital with 104 beds, but space for 145. It was built between 1987 and 1992. The floor area is 37.000 m². There are 3 buildings with bed wards (A, B and C), each consisting of 3 floors including a basement. All operations are conducted in a separate building connected to the wards, which are also connected to each other. In 2002, the health committee of the County of South Jutland made a decision to renovate (phase I) and enlarge (phase II) the existing hospital by about 10.000 m².
Detailed studies of double skin facades and hybrid ventilation were originally carried out by the HOSPITALS project for Haderslev Hospital. However, for political reasons Haderslev will not be renovated and it has been replaced by Aabenraa Hospital in the HOSPITALS project. The results from Haderslev have been transferred to Aabenraa hospital.

Site 2:
Fachkrankenhaus Nordfriesland, Germany

Gross area: 5.800 m²

Double skin facades - ventilation principle



Principle for winter ventilation,

Principle for summer ventilation

Principle for summer ventilation
- with high solar gains

The Fachkrankenhaus Nordfriesland (FNF) was founded in 1975 as a non-profit public hospital. It is owned by a private foundation and is situated in the city of Bredstedt near the North Sea.

The hospital specializes in psychiatry, and psychosomatic and environmental medicine. It has 120 beds. The new building will double the capacity of the hospital and will make it possible to offer totally different structures for patients and employees. Furthermore, it will allow more advanced research projects to be carried out.

Innovative elements:

- **Improved insulation levels**
- **Double skin facades**
- **Multifunctional PV-system integrated into glass roof**
- **Transparent insulation**
- **Low-emission building materials**
- **New local CHP plant**

The atrium from inside

The courtyard

The atrium seen from the outside

Perspective view of the hospital

Aims & Expectations:

Energy savings: The annual energy demand for heating (space heating, heating of ventilation air and domestic hot water) is expected to be reduced by 56%. This reduction is due to an increased insulation level, transparent insulation and passive solar utilisation.

The heat demand for ventilation is increased by the use of natural ventilation without heat recovery, but this is compensated for by a large reduction in electricity use for fans.

The annual electricity demand (artificial lighting, fans and equipment) is expected to be reduced by 57%. This reduction is due to the hybrid ventilation system, the utilisation of daylight and the use of energy efficient lighting equipment.

Financial savings: The annual saving is estimated at 76.500 Euro/year with an annual maintenance cost of 6.500 Euro. The total eligible investment cost is 1.467.518 Euro. This gives a simple payback time of 13,7 years, including EU-support (336.587 Euro) the payback time will be 8,9 years.

Emissions savings: The energy saving will mean an annual reductions in emissions of 262 tonnes CO_2, 0,23 tonnes SOx and 0,002 tonnes NOx. This is a reduction in total emissions of 46%.

Innovative elements:

- **Buffer space**
- **Energy efficient hybrid ventilation system**
- **Light ducts**
- **Environmentally friendly surface paints**
- **BEMS (Building Energy Management System)**

External view of the greenhouse

View of the building site

Aims & Expectations:

Energy savings: The annual energy demand for heating and cooling is expected to be reduced by 35% and the use of electricity is expected to be reduced by 36% compared to a standard new built Italian hospital.

Financial savings: The annual saving is estimated at 92.000 Euro/year with an annual maintenance cost of 9.000 Euro. The total eligible investment cost is estimated to 1.467.518 Euro. This gives a simple payback time of 17,7 years and including EU-support (513.631 Euro) the payback time will be 11,5 years.

Emissions savings: A substantial reduction in emissions of 899 tonnes CO_2 per year, 0,77 tonnes SOx and 7,91 tonnes NOx is expected compared to the emission levels before renovation.

Bioclimatic section

View of the buffer space

Site 3:
Meyer Children's Hospital, Italy

Gross area: 31.000 m²

The architectural integration of energy saving strategies has been a main aim in the design of the Meyer Children's Hospital in Florence. The building, now under construction, will have 150 beds and will be important in the paediatric field in Italy and in Europe. Its exemplary construction has great potential for dissemination and advancing the design of hospitals within Europe. The project has focused on the detailed planning and design of the health care environment and, particularly, the psychological effects of the environment. This approach has been considered essential for the neonatal intensive care environment which has a significant effect on babies, their families and caretakers.

Sun light in halls

Special attention was paid to interior rooms and the surrounding view in order to obtain a better confinement period and to stimulate beneficial effects on patient health.

Site 4:

Torun City Hospital, Poland

Gross area: 35.000 m²

Before renovation from the street

After renovation from the street

The hospital is situated in Torun – a city belonging to the European Network of Healthy Cities. Health promotion at local level is based on the pro-health strategies of the "Healthy Cities" Project of the World Health Organisation (WHO). The city authorities, when they made the decision to adopt the Project and join the existing Association of Healthy Polish Cities, made a commitment to change their policy – to a new approach to public health issues. The hospital has 249 beds. The Torun City Hospital project includes renovation as well as new buildings.

Innovative elements:

- **New room temperature controls**
- **Modern heaters**
- **Optimised ducting**
- **Advanced valves**
- **Fan assisted natural ventilation**
- **New high performance windows**
- **Significant increase of the insulation level**

Main entrance to the hospital

Main building after renovation

Main building is renovated

Roof of the main building with the natural ventilation ducts

Aims & Expectations:

Energy savings: Energy consumption of the existing buildings is expected to be reduced by 30% after insulation of the building envelope and implementation of thermostatic valves. The energy consumption of the new built part of the hospital is expected to be reduced by 54% compared to a standard new built hospital. Total annual expected savings of 73.935 Euro per year.

Financial savings: The annual saving is estimated at 73.935 Euro/year with an annual maintenance cost of 14.546 Euro per year. The total eligible investment cost is 900.604 Euro. This gives a simple payback time of 15,2 years, including EU-support (315.211 Euro) the payback time will be 9,9 years.

Emissions savings: The energy savings will deliver a total reduction per year of polluting emissions of: 3.537 tonnes CO_2, 116 tonnes SOx and 9 tonnes NOx.

Innovative elements:

- **Good building envelope insulation, low E-glazing and heat recovery from ventilation air**
- **Grouping of floors and areas with similar use periods**
- **Heat pump connected to seasonal storage of heat and cold in aquifers**
- **CHP for domestic hot water production**
- **Flexibility in energy management and building organisation through all-air heating system, and through BMS**

Hospital room - note that there are no radiators

Deventer Hospital seen from the north

Artists impression of the outpatient area

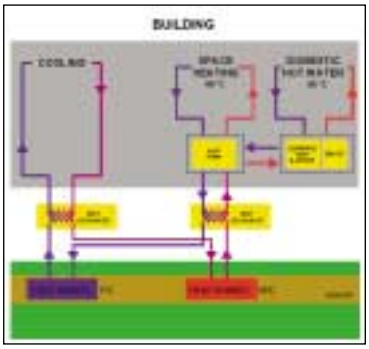
Artists impression of the reception area

Aims & Expectations:

Energy savings: Major savings in heat and cooling demand are expected. Compared to a conventional system the annual energy use for space heating is estimated to be reduced by 73% to 44 kWh/m^2, and the energy use for cooling is expected to be reduced by about 50%. Electricity consumption is estimated to be reduced by around 16% compared to a standard hospital.

Financial savings: The annual saving is estimated at 154.545 Euro. The total eligible investment cost is 2.039.548 Euro. This gives a simple payback time of 13,4 years, including EU-support (713.842 Euro) the payback time will be 8,7 years.

Emissions savings: Energy savings will result in annual emissions reductions of 1.943 tonnes CO_2, 8,71 tonnes SOx and 3,35 tonnes NOx. This is a reduction of 69% compared to a conventional system.



Schematic diagram of the seasonal storage of heat & cold

Site 5:
Deventer Hospital, The Netherlands

Gross area: 67.000 m^2

The Dutch Care Federation (Nederlandse Zorgfederatie) signed an agreement with the Dutch Department for Economy to reduce their energy consumption by 30% relative to the level of 1988. The newly built Deventer Hospital contributes to the implementation of this plan. In addition to the strong focus on energy efficiency, the new building design is strongly dedicated to the comfort and well-being of the patients as well as employees and other usergroups.

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Information about The Fifth Framework Programme is available at the following website: http://cordis/lu/fp5/home.html
Futher information on DG for Energy and Transport activities is available at the internet website address: http://europa.eu.int/comm/energy/res/index_en.htm

The HOSPITALS internet website address is **http://www.eu-hospitals.net**