

SOLAR ENERGY AND SEASONAL STORAGE IN NEW HOSPITAL IN DEVENTER

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Deventer Hospital is part of the European R&D project HOSPITALS (2002 - 2005). The aim of this project is to carry out an innovative energy concept for the newly built Deventer Hospital, which shows a significantly higher efficiency than an average Dutch hospital, without compromising on aspects like comfort, adaptability and indoor climate. To increase the hospital's lifetime it is aimed to achieve a flexible building with an air-based climatic system allowing fast and cost efficient adaptation to new functions, free arrangement of rooms and individual regulation of local temperature.

The energy system is based on seasonal storage of surplus heat and cold in aquifers. 6000-m² solar collectors on the roof charge the heat storage. Using heat exchangers, the buffered warmth and cold is used for pre-warming during the winter and cooling during the summer. No extra energy for cooling is required. A heat pump upgrades the heat and covers 80% of the hospital's demand. These new insights open the way to new standards in building and construction from hospitals.

1. INTRODUCTION

The HOSPITALS initiative demonstrates the significant reduction potential of the total energy demand in the European health care building sector. The objective is to implement innovative energy efficient designs constructing 5 exemplary energy conscious health care buildings in Europe. On each site, an integrated energy design process and the use of innovative renewable energy technologies aim to significant decreases of energy use and CO₂ emissions and large improvements of the indoor climate for patients and employees.

In the Netherlands, the Dutch Care Federation (Nederlandse Zorgfederatie) signed an agreement with the Dutch Ministry of Economic Affairs to reduce the energy consumption of health care buildings in a 30% compared to the level of year 1988.

The new hospital building of Deventer offers an excellent opportunity to implement both ambitions at national and European level.

Besides the strong focus on energy efficiency, the new building's design is strongly dedicated to the comfort and well being of the patients as well as employees and other user-groups.

The Deventer Hospital (Deventer Ziekenhuis) appeared in 1985 out of a merge between two hospitals in the regional town Deventer in the Netherlands. The hospital covers 22 special areas and accommodates annually 15,000 patients, treats 7,000 patients in day-care and receives 230,000 outpatients.

Because the old building does not longer meet the requirements of modern health care, in 2006 Deventer Hospital will move to a new 60,000 m² building on the site of the Rielerenk, at the east side of Deventer.

Cees van Mil, technical coordinator from the new building of Deventer Ziekenhuis is assisted by Deerns

Raadgevende Ingenieurs and DHV for the EU demonstration projects HOSPITALS. Deerns Raadgevende Ingenieurs is responsible for the design and realization of the energy concept. DHV undertakes the international coordination, monitoring and dissemination for Deventer Ziekenhuis in the EU-project.

2. INNOVATIVE ENERGY SYSTEM

2.1 *Trias energetica*

The innovative energy system is based on the principle of Trias Energetica¹ to obtain sustainable energy systems. This strategy is based on the following three steps:

1. Reduction of energy demand
2. Maximal use of sustainable energy
3. Efficient use of energy resources

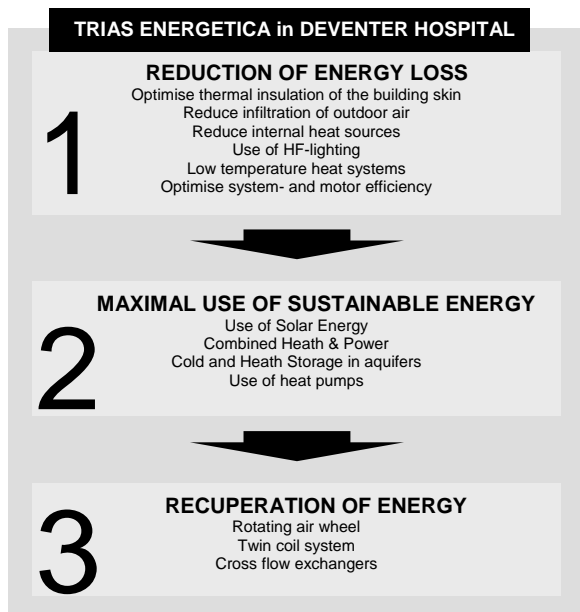
The application of each of the three steps during the design process of Deventer hospital has resulted in a whole range of measures.

Firstly, energy loss is reduced as much as possible in the new building, designing a building envelope with a good thermal insulation and optimizing the airtightness of the building skin.

Furthermore, a maximal use of sustainable energy is achieved by the heat and cold storage in aquifers, in combination with roof-integrated solar collectors and heat pumps to upgrade the heat. This system will be able to provide up to 80% of the heat demand.

The third step to achieve a sustainable energy system has resulted in designing efficient installations procuring that all necessary energy in the building is used in the most efficient way.

¹ The principle of Trias Energetica was developed at the Technical University of Delft as a strategy to obtain sustainable energy systems.



2.2 Low temperature system in combination with a high temperature system to prevent legionella

The standard demand for heating in the hospital is supplied by a low temperature system with an energy efficient heat pump, which covers about 80% of the total demand. Only for the peak loads (ca. 20% of the total capacity) high efficiency boilers are used.

In a low temperature system, the heat leakage is very low, resulting in significant energy savings. But in order to prevent legionella in the hospital, the low temperature system for the generation of heat will be combined with a high temperature system for the generation of hot tap water.

The legionella bacterium proliferates between 20°C and 45°C, but will die at temperatures above 60°C. This means that hot water supplies should be distributed above 55°C and the water should be stored at or above 60°C. In Deventer Hospital the hot water at high temperature will be provided by a combined heat and power plant eliminating every risk for legionella diseases.

2.3 Seasonal storage

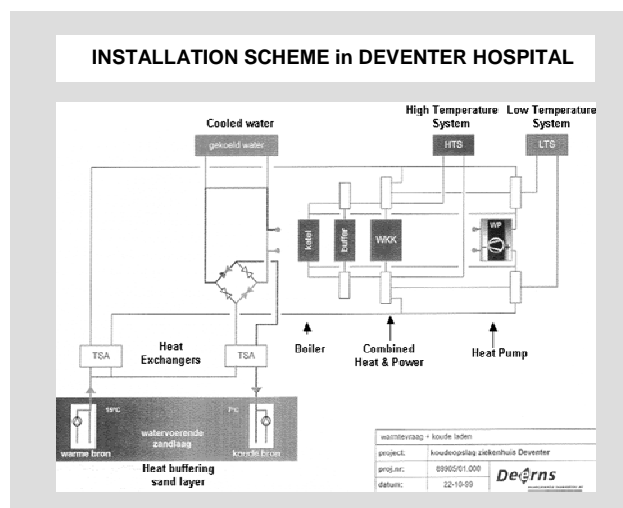
In Deventer Ziekenhuis, remaining heat and cold from the building is buffered in a heat-buffering layer of sand in the ground of the hospital. This seasonal storage system is realized by boring deep holes in the ground, placed in an optimal configuration to reduce the effects on the groundwater level.

With heat exchangers the buffered warmth and cold can be extracted from this sources when needed and used for pre-warming during the winter and cooling during the summer.

In Deventer hospital, the cold storage system is able to provide 100% from the necessary cooling energy. No

extra use of non-renewable energy resources will be required. During summer, the warm outdoors air will be cooled with the cold water from the cold source, which will have a temperature from about 8 to 10 degrees.

The heat storage is charged during summer season with surplus heat from the cooling process and by the collection of solar heat. Therefore, 6,000 m² of roof-integrated solar thermal collectors were included in the design. In this configuration, the solar collectors will function optimally and a very cost-effective use is being made from the collectors. During winter, the cold outdoors air will be preheated with the heat source, which will have a temperature from about 15 to 17 degrees. Less extra energy will be needed from the heat pumps to achieve a temperature of supply air from about 21 degrees. Moreover, heat pumps will gain efficiency, working with a smaller temperature difference.



2.4 All air concept

All necessary heat and cold is distributed via the ventilation air ("all air concept"). This means that there are no installation elements near the façade, to be preferred from the point of view of safety and hygiene and enabling free arrangement and adaptation of rooms.

The supply and exhaust ducts are situated in the ceiling and do not need extra space. Useful square meters become available. The installation elements will be situated preferably on the roof. On the other hand, main ducts will be preferably situated in corridors and places where no future changes are to be expected. If changes or further development will be necessary in the hospital building, the installation design won't have to be adapted.

The different floors of the hospital will be prepared for future changes in size, use and function, important aspects contributing significantly to the hospital building's lifetime, increasing their adaptability.

There is not only one central cooling and heating plant in Deventer Hospital. Decentralized systems for heating

and cooling in every plant make demand control possible; saving energy by avoiding energy loss in the distribution systems and provide again flexibility. The use of a demand control system for ventilation, cooling and heating enables that energy is efficiently used where and when needed.

To obtain a full energy efficient system, a rotating air wheel recovers heat from the exhaust air. Special attention will be drawn to the cleaning of heat exchangers and filters to avoid pollution in the all-air system.

The air-based energy system is therefore a highly efficient, flexible and healthy system.

2.6 Sustainable building

The sustainable choice of materials has been a key input for the design phase. Starting with an excellent thermal insulation and airtightness, the design of the façade has also been developed to yield an optimal utilization of daylight. This will also render ecological and architectural benefits. A sedum roof will cover half of the building, an element with well-known environmental and aesthetic advantages.

3. BENEFIT OF THE PATIENT

For Deventer hospital, the well being of the patient is a priority. The design of a comfortable building with a healthy indoors climate has been an important objective: demand control, healthy materials, low temperature systems, and optimal use of daylight have been the results of this consideration. The all-air system is not only good for the flexibility of the building, patients and personal also will benefit from it. By changing the air pressure in a room, it is very easy to isolate the air supply in particular patient rooms and avoid the entrance of contaminated air from other rooms. Special quarantine measures for risk patients won't be necessary anymore.

Before entering the rooms, the supply is filtered and patients and personal will always have a high quality indoor environment which very important in almost every area in a hospital: laboratories, treatment rooms, function rooms, patient rooms...

With an air system, it is also easier to change the temperature according to the comfort requirements of each individual user than if a traditional water based system with radiators is used. In very dry periods it is also possible to apply humidification, which reduces possible irritations to the mucous membranes.

A comfortable and healthy indoor environment with sufficient fresh air is always guaranteed.

4. RESULTS

The energy savings in the new hospital are 47% on heating and 13% on electricity compared to a standard hospital. This reduction of energy equals the reduction of 1 299 ton CO₂ per year, as well as an important reduction in related emissions, e.g. SO_x, NO_x.

These technologies used make Deventer Ziekenhuis a competitive example both in monetary terms and environmental terms.

Furthermore, the benefit for the health of patients, visitors and personnel and the longer lifetime of the construction due to adaptability of HVAC system are to consider as important results. A complete evaluation report will be available in 2004/2005

By gaining new insights in this demonstration project, future applications in other hospitals, but also other building types, e.g. commercial buildings, shall be motivated. The results and experiences will be disseminated to key decision makers, hospital managers, consultants and manufacturers and will stimulate that the use of energy efficient technologies will become standard measures for future building programs set up by the European health care sector.

PERSPECTIVE OF DEVENTER HOSPITAL

