BUILDING 2000

Commission of the European Communities

- Renovation of Caneton indoor public swimming pool
- New roof with increased thermal insulation and solar collecting surface
- Preheat of fresh air by passage through solar roof
- Reduction of ventilation heat losses
- Addition of solar water heating system

INDOOR PUBLIC SWIMMING POOL

CESSON/FRANCE

Building 2000 is a series of design studies illustrating passive solar architecture in buildings in the European Community.

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PROJECT DESCRIPTION

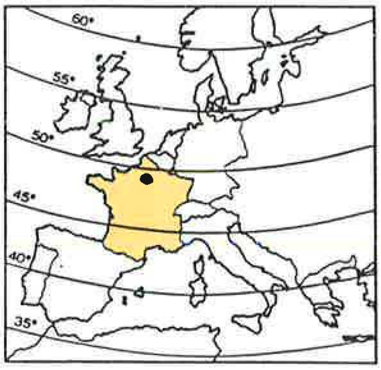


Figure 1. Location

Degree days (base 25° C) over	
whole year	5000
Sunshine hours over	
whole year	1793
Oct-Apr	701
Global irradiation on a horizontal plane	
Jan-Dec in kWh/m²	1103
(Jan-Dec in MJ/m²	3970)
Oct-Apr in kWh/m²	383
(Oct-Apr in MJ/m²	1380)

Table 1. Some key climate data

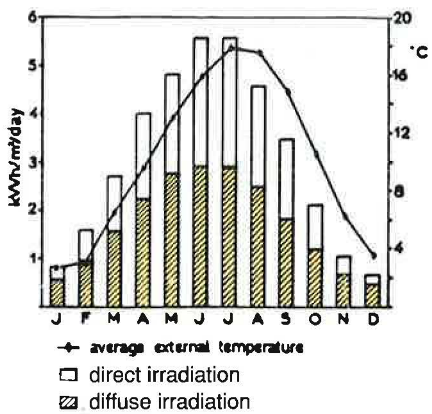
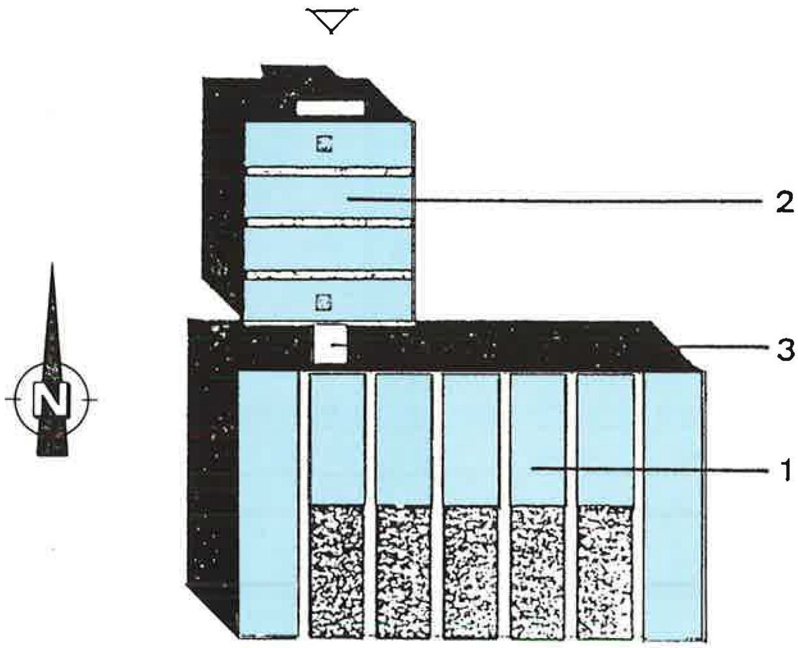


Figure 2. Average ambient temperatures and solar irradiation data

Building Type

This project concerns the renovation of a Caneton-type indoor public swimming pool which had fallen into disrepair. The original pool (see Figure 3) was typical of the 200-250 Caneton pools built throughout France over the past fifteen years as part of a French government programme aimed at encouraging people to take up swimming. In all, around a thousand indoor pools were built in this programme using a total of five designs chosen through a design competition held in 1969.

A large number of the pools are now in a state of considerable degradation and the aim of this project is to demonstrate on one pool a system of renovation which is capable of easy replication in the other Caneton pools. It involves replacement of the roof and installation of a new solar heating system.



Key:
1. Swimming pool hall
2. Building containing entrance hall and changing rooms
3. Passage with footbaths

Figure 3. A Caneton indoor swimming pool

Location

The demonstration pool is located in the Cesson region of Paris (Figure 1) at a latitude of 48° 33' and an altitude of 77 m.

Site Microclimate

The site is not overshadowed by other buildings. Some climate data are given in Table 1 and Figure 2.

Design and Construction Details

The original facility at Cesson had an area of 925 m^2 and a volume of 3475 m^3. It consisted of a well-insulated swimming pool hall (34 m x 19.5 m) containing a 25 m x 10 m pool and a reception building (12.3 m x 14.7 m) with entrance hall and changing rooms.

The building frame was made of six self-supporting post-and-beam structures of triangular cross-section.

The renovated system was developed using the results of studies carried out through the Building 2000 programme. A scheme of the final design is shown in Figure 4. To achieve it the existing roof, apart from the support structure, is dismantled and a new roof constructed. This has been designed to:

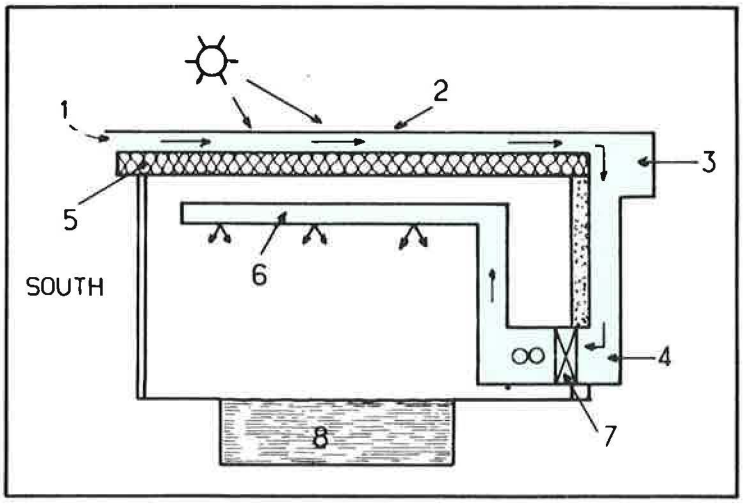
- capture solar radiation;
- have good thermal insulation properties (see Table 2);
- allow good natural lighting of the pool;
- be comfortable acoustically.

In addition, solar water heaters are installed.

The approximate cost of the renovation is FF 1.5 million (250,000 ECU).

U-values in W/m^2 K	
of triple-glazed surface	2.60
of opaque surface	0.35

Table 2. U-values of the new roof



Key:
1. Fresh air
2. Aluminium panels
3. Inlet duct
4. Heated fresh air
5. Insulation
6. Air supply duct
7. Heating coil
8. Pool

Figure 4. The renovated Caneton swimming pool system

DESCRIPTION OF PASSIVE SOLAR FEATURES/COMPONENTS

Design Principles

The renovated system was designed to take into account the fact that nearly 40% of the energy used to run the original building was taken up in conditioning the ventilation air. A further 5% was used to provide hot water. Hot water consumption is highest in summer because it is a function of pool occupancy.

New Roof Structure

Part of the new roof structure is triple glazed. In the remainder, insulating sandwich panels consisting of 80 mm polyisocyanurate foam with a waterproofing surface on top and a ribbed galvanized steel sheet on the under-side are fixed to detachable cross girders. The under-side serves as a vapour barrier. Aluminium alloy or steel roof panels (black on top) are mounted above the sandwich panels in such a way that air can circulate through a 50 mm space between the two. These panels cover an area of approximately 500 m^2, providing additional waterproofing of the roof and serving as a solar collecting system which warms the air passing beneath. A profile of the roof surface is shown in Figure 6.

Figure 6. Profile of the roof surface

Figure 5. Photograph of a solar tube

Solar Water Heaters

The system is completed with a solar water heating system using solar tubes in sufficient quantity to obviate the need for storage tanks. In all, the system contains 50 tubes. Photographs of an individual tube and an array are given in Figures 5 and 7.

Figure 7. Photograph of solar water heating system

ENERGY CALCULATIONS PERFORMED AND DESIGN TOOLS USED

Aim of Energy Calculations

The details of the renovated system were developed with the help of thermal performance calculations. The aim was to create a design which was not only energy-efficient but also had appropriate values of those parameters which determine thermal comfort conditions in an indoor pool building. Examples of the latter are relative humidity, air temperature and temperature of surfaces inside the building - parameters which are very different from those which create comfort in the home.

Computer Model

The thermal performance calculations were carried out using the PISCOV computer model of a covered swimming pool.

Input of Meteorological Data

In carrying out the studies, meteorological data for the city of Trappes was used.

Building Parameters

To conduct the simulation studies, values of certain parameters had to be input into the model to describe the building before and after renovation. The parameters for the original building are given in Table 3.

Input of various parameters for the renovated building showed the following:

- increasing the insulation of the roof and the glass walls of the hall had the effect of:
  - increasing the mean radiant temperature (raising inside surface temperature);
  - increasing the inside wall temperature (reducing risks of inside condensation);
  - making it possible to increase internal relative humidity (improving comfort of the swimmers when they are wet and saving energy by reducing the flow of fresh air and evaporation).
- reducing the area of roof glazing in order to compensate for the increased area of glazing in the south wall had the effect of:
  - improving the winter heat balance (solar gains from a south- facing vertical wall are greater than those through a horizontal wall);
  - reducing overheating in summer and warm weather.
- dehumidifying with fresh air at a flow rate which takes into account the relative humidity inside the building had the effect of:
  - increasing comfort by increasing relative humidity in winter;
  - saving energy by reducing amount of heated air and pool evaporation.

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U-values in W/m^2 K	
fixed roof	0.86
translucent mobile roof	3.5
doors on south side	
opaque section	1.0
translucent section	5.6

Dehumidification by fresh air was at fixed flow rate of 14,000 kg/hour (approximately 12,000 m^3 /hour)

There was no pool cover

Temperature was regulated by ambient air sensor

Coefficient of heat loss through walls, roof and floor as ratio of internal volume (G1) was 0.83 W/m^3 K

Table 3. Some parameters for the original building

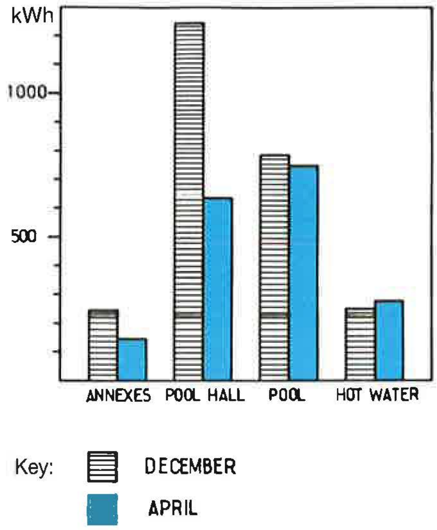

Figure 8. Daily heat losses (kWh) in December and April after renovation

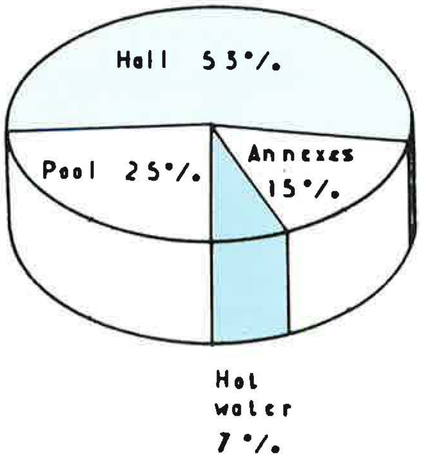

Figure 9. Breakdown of energy savings after renovation. (Total savings: 545,400 kWh a year.)

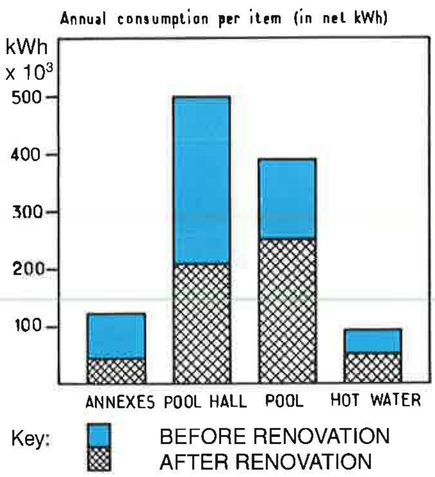

Figure 10. Annual energy consumption (net kWh x 10^3) before and after renovation

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- allowing settings of inside temperature and relative humidity to vary as function of ambient temperature had the effect of:
  - saving energy by reducing the temperature difference between the hall and the outside air, reducing the fresh air flow and evaporation during warm weather;
  - maintaining comfort conditions (raising humidity when the inside temperature falls);
  - preventing condensation on inside of the cold exterior walls (lowering relative humidity of air inside the building and raising the indoor temperature during cold weather).
- using a pool cover at night saved energy.
- maximum fresh air flow was 14,000 kg/hour (approximately 12,000 m/hour).
- the coefficient of heat loss through walls, roof and floor as a ratio of internal volume (G1) was 0.55 W/m^3 K.

Results of Thermal Performance Calculations

Some results of the energy calculations are given in Table 4 and Figures 8, 9 and 10.

Figure 8 shows the daily heat losses of the different parts of the building - pool hall, annexes (i.e. the reception building), the pool itself and the hot water system - after renovation.

Table 4 and Figures 9 and 10 show energy consumption before and after renovation. The total energy requirements of the original building amounted to 1.1 x 10^6 kWh a year. Renovation reduced this by nearly 50% to just over 0.5 x 10^6 kWh a year. Over half the savings were made in the pool hall, 15% in the annexes, 25% in the pool itself and 7% in the hot water system.

The 500 m solar collecting roof surface was calculated to recover 65,000 kWh energy a year - about 12% of the total savings made.

	Annual consumption (kWh) before renovation	after renovation	Net savings (kWh)	% savings
Annexes	121,000	40,700	80,300	66.36
Pool hall	499,400	208,100	291,300	58.32
Pool	389,400	250,600	138,800	35.64
Hot water	91,000	56,000	35,000	38.46
Total	1,100,800	555,400	545,400	49.54

Table 4. Energy consumption before and after renovation

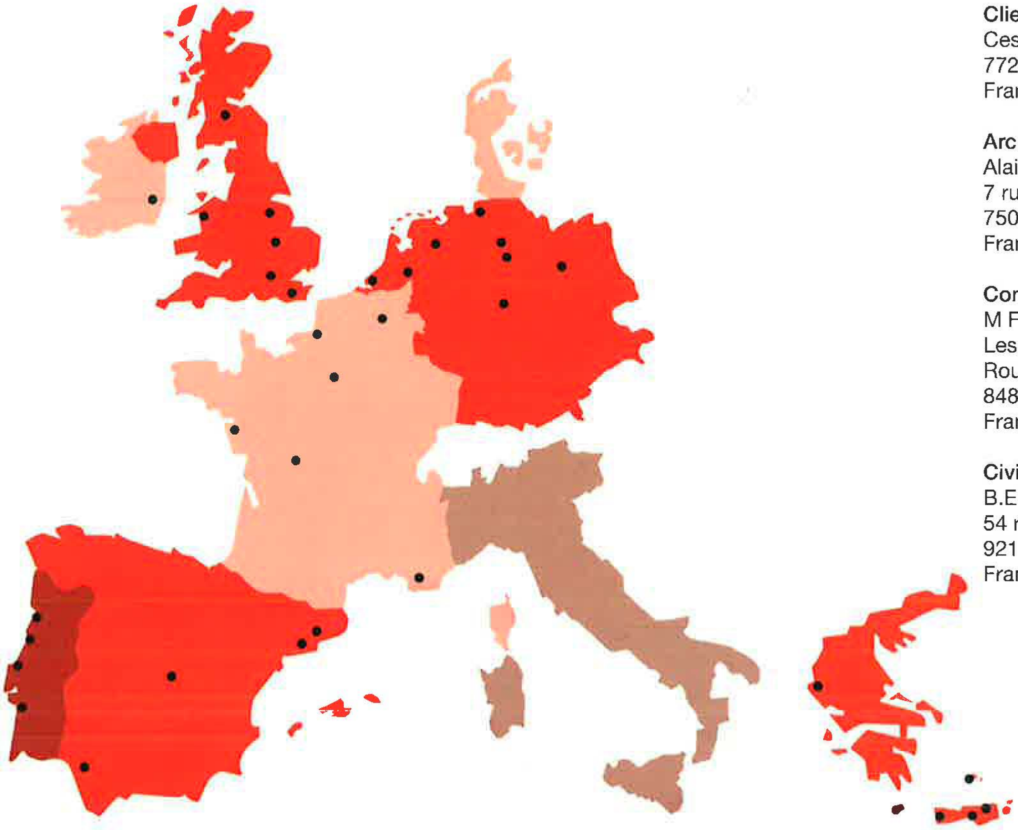
GENERAL DESIGN GUIDELINES/POINTS OF INTEREST RESULTING FROM THIS PROJECT

The recent interest in saving energy has led to the development of some complex techniques which require considerable capital outlay. Design and construction of systems using these techniques are often poor because the technology is not always fully understood. Further, the completed systems are often incorrectly run by unqualified operators, with bad results.

To avoid this, simple passive solar techniques have been chosen for renovation of the Caneton pool at Cesson which are reliable to operate and produce consistent results. The lessons learned through the Building 2000 studies enabled systems to be specified which make effective use of solar energy in the form of heat and light. It is expected that, as these techniques are used in pools in the future, the problems encountered in the old covered pools will be avoided and there will be improved user comfort and reduced energy consumption.

BUILDING 2000 Building 2000 brochures are published by Directorate General XII of the Commission of the European Communities to show how design studies can help architects and other building designers use passive solar principles to the best effect to produce attractive energy efficient buildings. Each brochure describes studies carried out with the support of the Commission during the design phase of one of thirty-six non-domestic buildings in the EC Member States. The studies were on such topics as daylighting, heating, cooling, ventilation, comfort, control systems and urban design. They were carried out with the help of acknowledged European experts in these fields and drew heavily on lessons learned and techniques developed through the Commission's research and development programme on solar energy applications to buildings.

Commission of the European Communities/Directorate-General for Science, Research and Development



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This set of **Building 2000** brochures illustrates how architects and other building designers can successfully apply passive solar principles to produce energy-efficient buildings.

BUILDING 2000
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