LOW ENERGY URBAN HOUSING
SIX EUROPEAN UNION DEMONSTRATION PROJECTS

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ABSTRACT The SUNH and SHINE European Commission THERMIE 1996 Targeted Projects aim to demonstrate for European urban housing sector the relevance of a serie of innovative technologies (applied on 10 new constructions within SUNH and 6 retrofitting projects within SHINE) to reduce CO_2 emissions through the implementation of different RUE & RES techniques. After the general presentation of SUNH and SHINE made during the PLEA conference of Lisbon, this paper aims to give a detailed presentation of the most advanced projects using slides and video.

1 Introduction

The **SUNH** (Solar Urban New Housing) THERMIE 96 Targeted Project, supported by the European Commission DG XVII, involves a consortium of 10 organizations in the procurement of making an energy saving of 50 % compared to national standards, in each building to be erected in different European cities and playing with architectural integration. The consortium's commitment is to demonstrate the relevance of a serie of innovative technical measures to reduce CO_2 emissions through the implementation of different RUE (Rational Use of Energy) & RES (Renewable Energy Source) techniques. It is also expected to use clean friendly building materials.

The **SHINE** (Solar Housing through Innovation for the Natural Environment) THERMIE 96 Targeted Project, also supported by the European Commission DG XVII, brings together 6 social housing organisations in 5 European countries to demonstrate solar and bioclimatic concepts, and perform architectural energy efficient refurbishment. Each project is located in an urban area and has developed at least one original innovative energy saving solution, with a target of 60 % overall reduction in energy consumption compared with the present. The SHINE project also aims to demonstrate solutions which bring more comfort and improve environment for low income people in poor urban areas found throughout Europe.

2 Presentation of 3 SUNH Projects

2.1 Reading UK

2.1.1 general description

The site is located on the edge of the densely built up area of Reading, an inland town of 140 000 people, some fifty miles from the coastline of Britain. All of 50 THERMIE houses in this larger development of 190 houses are built to a very high standard of energy efficiency and environmental performance. Active, solar water heating, passive ventilation systems, condensing boilers and recycled newspaper insulation are included in the houses. It is predicted that there will be a 30 % reduction in energy consumption compared to UK building regulations standard housing. Erection is completed, the project is now evaluated, and results will be available at the end of 1999.

2.1.2 ecological improvement

The homes were built to achieve the BRE Environmental Standard which includes issues that minimise the environmental impact of the dwellings. In this way there will be environmental benefits on three scales :

Global, by reduced energy use minimising carbon dioxide emissions and other pollutants. Using insulants with no ozone depletion potential and by specifying timber which comes only from sustainable sources. Recycling of household waste has been encourages by providing separate storage facilities for recyclable waste.

Local, conservation of local water resources by using low volume flush WCs and providing water storage butts for garden use.

Indoor, The release of volatile organic compounds has been minimised by specification of materials. No lead-based paints have been used and no asbestos products have been allowed.

2.1.3 building envelope improvement

Standard wall construction has been used but with 100 mm cavity fully filled with expanded polystyrene in the construction. This gives a cost saving over the conventional building methods, usually have a gap between insulation bats and internal wall facing. Recycled cellulose insulation is used in the roof void in place of mineral fibre which would be conventionally used in the UK. This material uses waste paper which would otherwise be incinerated or buried in a landfill site.

2.1.4 solar heating and DHW system

An active solar system was used to provide heating and hot water for the dwelling. The unit was chosen as it is combined with a high efficiency gas burner to provide top-up heating when necessary. This minimises space requirements in the dwellings and greatly simplifies the installation process. Standard central heating programmers are installed which allow residents to choose the optimum hot water and heating times for their home. A simple heating control system has been chosen to ensure that they will be easy to use. A number of monitoring systems are installed as part of the construction process to allow ongoing monitoring of the energy used in the scheme and to advise residents as well as the building owner of the most cost effective use of the of the buildings.

2.1.5 passive stack ventilation

A passive stack ventilation system runs from kitchens on the ground floor and from the bathrooms on the first floors. Where the ducts run through the roof void, they are insulated. The stacks terminate at the roof ridge with a ridge tile terminal. The use of passive stack ventilation has eliminated the use of electrical energy for ventilation purposes.

2.2 Oslo, Norway

2.2.1 general description

The site is situated close to the city center of Oslo. During the last 20-30 years the area has had lots of well known urban problems, like heavy traffic, increasing railway traffic close to living areas, increasing number of immigrants, etc. Therefore a renewal programme was launched 15 years ago to renovate old buildings, or to rebuild and reduce traffic and pollution. This project, being an important part of this program, consists of 57 flats. The triple glazing system on the south facade will preheat ventilation air and the solar collectors on the roof will heat DHW. Predicted yearly energy consumption per house is expected to give a saving of 40% over the reference case. Erection phase started in October 1998. The building will be completed in June 1999.

2.2.2 ecological improvement

The design process focused in every step on ecological features such as water saving and local purification devices, reduced amount of both garbage and building waste, focus on building materials from an ecological point of view, and indoor climate.

2.2.3 building envelope improvement

The building has well insulated North, East and West facades - 200 mm mineral wool. This is above normal standards. The south facade is designed as a double-glazed construction for preheating of ventilation air. The outfacing glass is one-layer with metal layer on the outside Piklington Kappa energy Float or equivalent (for higher glass temperature/less condensation problems). U-value for this layer is 4.9. One layer glass on the outside means simplified and cost effective constructions. The wall facing indoors is a two-layer panel - Piklington IPA, U-value of 1.1, with 66 % light transmission. The quality of this wall prevents overheating and reduces the need for outdoor shading (in addition to blinds in the double glazed space). Its also prevents unwanted cold air streams on the inside. Construction U-value without taking solar into account is 0.9. The distance between the glass walls is 600 mm, enough space for plants, sitting etc., but not large enough for living (no solar balcony). This is done to take benefit of the energy produced, and to avoid unwanted heating of the space.

2.2.4 active / passive solar systems

The building is south facing (19° off South), and ideal for active solar energy. A building integrated water based solar system is part of the building's energy system. Solar energy is used for both space heating and DHW. The collector area is 270 m^2, and 3 storage tanks are placed under the collector area. The main space heating system is low-temperature floor heating, plastic tubes in concrete floors. System temperature varies between 28°C and 35°C. As mentioned above, the passive solar system is the double-glazed south facade, with concrete floors for short time heat storage. The South facade is also used for cooling. The space between the tow glass layers can be ventilated when necessary, and cold air to the apartments is delivered from east/west. A heat pump is connected to the mechanical ventilation system and supplies the heat storage (solar) with heat.

2.3 Barcelona Sitges Spain

2.3.1 general description

The 58 THERMIE dwellings are spread over two buildings located in Sitges town (35 km far away from Barcelona) and use a ventilation system known as Solar Acoustic Ventilation (SAV) system. Erection of the first building is now completed, evaluation programme is on going till the end of 1999.

2.3.2 SAV system description

This consists of the space occupied by the windows, conduits, ventilators and domotic system and the main component are the windows. These consist of two panes of glass which are separated by 4 cm with a venetian blind between. Air is allowed to pass between them via small holes at the top and bottom. The combined effect of the double glazing and the internal storage space produces an accumulation of heat between the two panes of glass. According to the time of year it may be necessary to either introduce this heat energy in to the inside of the dwelling (winter) or expulse it to the outside (summer). The ventilation/extraction system (both with twin speed) consists of a compact box located on the north facade which is connected to the central zones by conduit. The operation modes are : in **winter**, the extractor produces a slight lowering of pressure inside the dwelling which causes the warm air within the window to enter the dwellings volume. This heat produces a pre-heating which implies a significant heating economy (an increase of 3 to 4°C).

In **summer**, however, the ventilator forces fresh air into the north zone and then circulates it via the gratings. This produces a double ventilation effect : the introduction of fresh air in the north zone and the expulsion of the accumulated heat within the windows, preventing it from entering the dwelling. Experience has demonstrated a difference of 2 to 3°C. There is a well-controlled air renovation both in summer and in winter which provides an improved quality of life inside.

Fig.1 Completed building in Sitges. Photo: BCN

3 Presentation of three SHINE projects

3.1 Goteborg Sweden

3.1.1 gneral description

This project is located in the north-eastern part of Goteborg city, called Angered, which was built during the 1960-70's. The area is typical of urban housing districts built during this period not only in Sweden, but all over Europe. The project comprises renovation of 10 buildings including 255 apartments. A prefabricated roof with an integrated modular solar collector will be used to preheat DHW. The innovative roof integrates solar air collectors which will distribute solar heat to the north wall via the insulated double envelope wall. The wall will have the benefit of protecting deteriorated structural joints from rain and wind and giving additional thermal insulation. Buildings with exhaust air ventilation will utilise preheated air from glazed balconies. Whilst those with whole house ventilation will be equipped with air to air heat exchangers. Heating energy saving compared to the existing situation is expected to be 50 %. Design process is now completed, erection phase started in February 1999, for one year.

3.1.2 ecological improvement

Integrated community greenhouses with growing lots under glass for the dwellers will be erected. The courtyards between houses will give room for outdoor growing lots. Non energy food storage facilities will be installed. Recycled materials will be used when possible and available, as well as healthy materials and paints, while considering life cycle costs.

Fig.2 Building in Goteborg. Illustration: Christer Nordström

3.1.3 building envelope improvement

Thermal losses will be reduced and existing cold bridges will be avoided by using semi-prefabricated externally mounted insulation elements as well as glazed balconies and galleries.

3.1.4 active / passive solar systems

Solar preheating of DHW : A new type of prefabricated innovative roof module collectors, mounted directly on the roof trusses, will be used to preheat DHW. The design is based on a common roof module complemented with the basic components in a solar collector, i.e. insulation, absorber and cover (hardened glass) using a new absorber (water/glycol) with an innovative environment friendly selective surface showing increased performance and an interesting cost perspective.

Double envelope solar air system: The solar heated air is distributed from the collector to innovative double envelope wall units by a number of small fans (low air speed, low pressure losses). The heated air is led downwards through the units, delivering and storing heat to the old concrete wall element joints (cold bridges). Stored heat is passively distributed to the indoor space through the walls. The air is returned upwards through the outer parts of the wall units to the collector to regain new heat. The system is closed in order to avoid vapour and dust problems. The system is divided into sections, each one covering one building section. Each section is independent and includes a fully functional system unit, leading to a high degree of generality, as well as low installation and maintenance costs; the solar air collectors are semi-prefabricated, site built and glass covered, with a selective coated aluminium plate absorber.

The double envelope wall units are designed to cover the elements joints (cold bridges) on the Northern facade, resulting in several important positive effects, e.g. the efficiency of the solar air system is increased, transmission losses are reduced and the concrete element joints are protected from penetration of rain and wind. Furthermore, the solar system operation will result in " warm walls ", which has a positive effect on the thermal comfort (increased operative temperature). The design of the double envelope solar air system is based on encouraging experiences from experimental buildings, i.e. the "Solar House Järnbrott", in operation since 1986.

Solar preheating of ventilation air: Buildings with exhaust air ventilation will utilise preheated air from glazed balconies and galleries (buffer zones).

3.2 Amsterdam The Netherlands

3.2.1 general description

This project concerns the energy renovation of the 'Brandaris' in Zaandam near Amsterdam, a 14 storey multifamily building with 384 apartments. Objectives of the project are to save up 57% on primary energy, to reduce emission of CO_2 by 41 %, to improve indoor comfort (related to exhaust gases and airtightness), to integrate renovation and energy saving with an improvement of building attractiveness, and finally to act as an example for the large stock of similar buildings, having similar problems. The building which was constructed in 1968, has long facades facing east and west . The new communal heating system, which has been extended to meet the requirements for DHW, is fed by a solar boiler with 760 m^2 of collector area mounted on the flat roof. It is the largest solar system on one building in Europe. The solar boiler will provide at least 15 % of the total energy demand for both DHW and space heating. New glazed balconies will improve both the appearance of the building and indoor comfort as well as providing valuable extra space. Low E glazing will replace the existing single glazing. The lighting on the roof top pavilion which looks out over the array of solar panels, will be powered by photovoltaic cells. Erection phase is now completed. Energy saving will be evaluated during the monitoring phase which is now starting.

3.2.2 building envelope improvement

The energetic and building physical quality of the building envelope is improved by low E glazing, insulation of cavities, floor insulation, improved airtightness and glazed balconies. Facade will remain a it is in dwellings that received glazed balcony to save use of materials.

Fig.3 :Glazed Balconies erection in Amsterdam

3.2.3 active / passive solar systems

760 m^2 of solar collectors at the roof contributes to heat the collective system. In the design process the efficiency and economy of the system have been optimized using advanced simulation techniques (EMGP3). Return water is as cool as possible to achieve maximum solar contribution. Related measures are low temperature heating and improved heat exchangers for DHW. Passive solar contribution is improved by the use of glazed balconies. The glazed balconies have been produced according to guidelines given in IEA task 20 : 'Solar energy in building renovation'. Both the solar collector system and the glazed balconies act as an international example for optimized renovation using solar energy.

3.3 Grenoble France

3.3.1 general description

This THERMIE project targets one social housing site near the old city centre of Grenoble, with 120 apartments contained within 3 five storey blocks which were constructed in the early 1970's. A highly insulated double envelope will be added to reduce thermal bridging. An air to air heat recovery system will preheat ventilation air introduced to the main rooms through the facade double envelope (dynamic insulation). New conservatories will create an additional living area. Thin metal structures with planting along the facades will provide solar protection and improve the overall appearance. The anticipated energy saving compared to existing consumption is 53 %. The project is now under the design phase, erection is expected to start in 1999.

3.3.2 ecological improvement

The aim concerning environment, is to try to change the image of the site to demonstrate solutions for better well fare for the inhabitants. For this we work on the building itself (decreasing cost of heat, electricity and water, using ecological materials, improving indoor air quality, abolishing existing asbestos materials), on the façades by using thin metal structures and annual or permanent Green climbing plants. New water saving system for flush in toilets and bathrooms will be installed allowing to save 17 m^3/dwelling/year of drinkable water corresponding to 20% of saving compared to the exiting situation.

3.3.3 building envelope improvement

The façades will receive new conservatories for the living rooms (additional space of 7 m^2). During summer, these glazed conservatories will be widely opened and shaded. All the buildings will receive a total new double envelop made of FIBRAROC panels (wood fiber

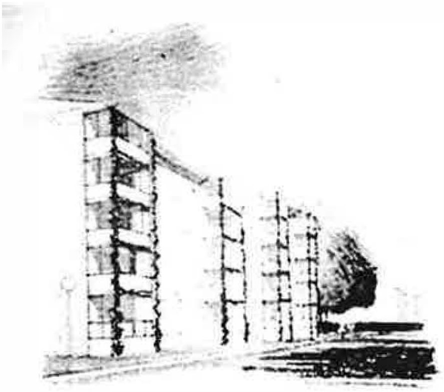

Fig.4 :SHINE Project in Grenoble – Illustration ArchiMEDES

material) plus extra thermal insulation (about 10 cm of mineral wool) fixed on the existing facade thanks to a wood structure in order to create an air gap between the insulation and the existing facade. The double envelop will act both as thermal insulation and as a duct channel for the preheated fresh air. Moreover the existing thermal bridges (very important) will be abolished. Airtightness of existing double glass windows as well as roof insulation will be. The traditional insulation for these type of façade is internal insulation, which take a lot of place, external insulation, which is very expansive and difficult to set in place, specially to join the windows. The solution we propose, gives for similar cost very interesting heating gains. These solution may be applied to the very large number of dwellings built in Europe between 1960 and 1980, and more in Eastern Europe.

3.3.4 active and passive systems

New radiators allowing a better distribution of the building heating needs will replace the existing convectors systems. Moreover new radiators will allow the user to have room individual control for heating. The existing collective heating distribution will be kept and optimized by installation of valves to control heating flows. General control and distribution of heat supply will be individualized per building. A new double flow controlled mechanical ventilation will replace the existing static inefficient ventilation system. An heat recovery system from exhaust air will be installed in the building attic. It will be constituted of a heat exchanger and thin filtration plus 2 ventilators. The pre-heated high quality clean fresh air will be introduced to the main rooms of the flat through the façade double envelope.

4 Conclusion: main benefit for a building owner

The benefit should be a better quality and comfort of buildings, but most of these housing sites are social, so the first ones to benefit from it are tenants.

For the building owner the benefit is less global maintenance because the construction is of better quality, with outside insulation (better for the preservation of the building structure), a stronger design orientation on passive gains/no maintenance, and most of these projects don't have sophisticated BEMS or technologies.

The second interest for a building owner is to adopt the image and design of green modernity, which is a strong will within both projects SUNH and SHINE (Ecological housing).

5 References

All the information included within this article is derived from the different partners involved within SUNH and SHINE.

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