Paper presented at the ISES-Europe Conference EUROSUN 2000, Copenhagen, Denmark, June 19-23, 2000

TOWARD SUSTAINABLE CITIES: CASE EKOVIIKKI IN HELSINKI AND ITS SOLAR PROJECT

Heidrun Faninger-Lund
SOLPROS AY, Oltermannintie 13 A 4, FIN-00620 Helsinki, Finland,
Tel. +3538-9-777 49 57, Fax:+358-9-777 49 58,email:solpros@kolumbus.fi

Peter Lund
Helsinki University of Technology, Advanced Energy Systems Laboratory,
P.O.Box 2200, FIN-02015 HUT (Espoo), Finland
fax:+358-9-451 3195, email:peter.lund@hut.fi

Abstract – Ekoviikki in Helsinki is the largest sustainable building site in Finland. It has a strong experimental character and it includes a range of environmental and energy concepts for demonstration but also introduces new planning approaches for sustainable suburbs. Various criteria has been introduced covering the different aspects of sustainability (e.g. energy, resource use, water, CO_2, waste) in the city, site, and building planning (the original site was a large field). A special feature of Ekoviikki is that sustainability is considered as a whole. Due to the cold climate in Helsinki, the energy aspects have received much attention – e.g. the solar access of the whole site is good, renewable energy and energy efficiency is promoted. Concerning the solar energy utilization, the largest solar energy project in Finland is realized at Ekoviikki within the EU Thermie frame. Nine highly building integrated solar heating systems with a total area of 1,246 m^2 will produce 15% of the total heating demand of the area. In addition, profound analyses have been made to assess the sustainability improvements in Ekoviikki. These show that Ekoviikki and its solar project represents a 50% improvement compared to standard practices in Finland.

1. INTRODUCTION

1.1 General about Ekoviikki
Helsinki (60 ^{o}N) is the northernmost capital of the EU countries. The city has a strong commitment to improve the environment and to enhance sustainability. As an example of this is the Ekoviikki project which is a unique ecological building site. Ekoviikki is a part of the Viikki area which is the new science suburb of Helsinki and the largest bioscience campus in Europe. The Ekoviikki site will house some 2,000 inhabitants and the construction takes place during 1999 and 2001.

Fig.1. Ecological building site Ekoviikki in Helsinki.

The Ekoviikki site has been subject to extensive sustainable planning accounting for energy and environmental improvements enabling integration of solar energy from the earliest moment and ideas. The solar project described in this paper was also integrated into the planning and construction process.

The whole Ekoviikki housing area will have a built area of 64,000 m^2. Almost half of this is subject to solar heating design within this solar project. As such this large scale solar integration scheme would be largest ever realized in Finland and among the ten largest in Europe.

1.2 Ecological considerations at Ekoviikki
In Ekoviikki, special consideration has been given to ecological and sustainable planning principles using the PIMWAG approach. This method is a multi-criteria evaluation and decision-making method in which five major factors effecting the building's environmental performance are considered including health and sustainability. Health issues are accounted for through IAQ, humidity, noise, access to sun, and living diversity. Table 1 gives the requirements for the criteria

Interfacing, system boundaries and integration have in Ekoviikki a special role as extensive energy and material savings technologies will be introduced to the houses. The minimum heat energy conservation required in the buildings to be constructed is -34% from present standard of 160 kWh/m^2,a (space heat and dhw). For tap water, a -22% level is compulsory, or maximum dhw of 40-50 l/person,day. The dhw savings approaches may have an influence on the solar heating design and have therefore been carefully considered here. The level of conservation may be even stricter varying from house to house. The different energy conservation approaches in the buildings will reduce the basic heat demand which makes the use of solar heat more effective.

Table 1. The ecocriteria used in Ekoviikki.

CATEGORY	Criteria	Reference	Min required	Max. values
POLLUTION	CO_2 Waste water Construction waste Waste Ecolabels	4 tons/m^2 160 l/p/day 20 kg/m^2 200 kg/p/day -	3.2 125 18 160 -	2.2 85 10 120 paints, glues
NATURAL RESOURCES	Heating energy Electricity Primary energy Design flexibility	160 kWh/m^2,a 45 kWh/m^2,a 37 GJ/m^2,50a -	105 45 30 15%	65 35 20 15%+
HEALTH	IAQ Construction work Surface materials Moisture management Noise Sunny, windless site Living diversity	 Present norms Normal	Class 2 Class 1 Class 2 Good New norms Good Normal	Class 1 Class 1 Class 1 Very good >New norms Excellent 30%
BIODIVERSITY	Flora Rainwater		Site-specific plants Normal	Increased biodiversity Rainwater utilized
FOOD	Plantations Ground material		Normal On-site use	Cultivation On-site use

2. DESCRIPTION OF THE SOLAR SITES

2.1 Housing area with solar heating

The solar demonstration project at Ekoviikki consists of nine (9) separate solar heating systems between 80-250 m^2 each integrated into the building roofs or overhangs. The total collector area is 1,246 m^2 and as such largest ever realized in Finland. Each system has been optimized for its integration to the building in question. As the building planning did not start before the solar project, the siting, placing and sizing (predesign) of the solar heating systems have been possible. Also, the building planning process could better account for the solar aspects and requirements.

The basic building data is given in Table 2 for the buildings in this project. The name of the site refers to the building constructor or contractor of this project.

2.2 Solar heating systems

The solar heating systems will mainly supply the DHW load of the houses. The predesign parameters of the individual optimized system configurations are shown in Table 3. These systems may supply in average 46% but up to 53% of the DHW load. The numbers where obtained by numerical hour-by-hour simulations. The solar radiation on horizontal surface is 950 kWh/m^2,yr and mean ambient temperature 6 ^{o}C. These systems may provide a clear increase compared to a standard solar dhw system with a 35-40% solar share.

Table 2 Building data of the solar sites

site	nr of buil-dings	floor area m^2	nr of flats	dhw MWh/a	total heat MWh/a
ATT (1)	4	2600	38	94	435
ATT (2)	3	5000	88	216	798
Skanska (1a)	1	2250	27	65	313
Skanska (1b)	1	2250	28	65	314
Skanska (2)	5	2400	20	65	340
Skanska (3P)	1	3800	60	148	705
VVO	2	4500	60	148	680
HELAS	3	2050	25	61	302
ESY	3	2000	25	61	302
Total	23	26,850	371	923	4,189

Table 3. Solar heating system data

Site	collector $\{m^2\}$	store $\{m^3\}$	solar fraction {%} of dhw	solar fraction {%} of total
ATT (1)	120	6	43	13
ATT (2)	250	12.5	44	13
Skanska (1a)	115	10	53	15
Skanska (1b)	115	20	53	15
Skanska (2)	96	4	47	12
Skanska (3P)	220	12.5	49	13
VVO	170	8.5	42	12
HELAS	80	4	45	12
ESY	80	4	45	12
total	1,246	71.5	46	13

The individual systems will differ also in building integration approach and concepts. For example, the storage units will have to cope with the height of the buildings (H/D-ratio varying) and also the size (collector area/storage volume) need to fit with the expected dhw load/profile. One Skanska site is especially interesting where dhw savings methods will be incorported and therefore the storage is larger than usually to provide more buffering.

The collector orientations and inclinations will also vary, etc.. An inclination angle between 30-60 ^{o} and azimuth south ± 30^o is the optimum range strived for collector mounting in Ekoviikki. For each site, special solar building integration aspects / design are included shown in Table 4. The feasibility study contains more info on these. Through the basic building planning and consideration of solar systems, the architectural integration and esthetics will be optimized.

Table 4. Solar integration aspects

site	comments
ATT (1)	house roofs very suitable for solar integration 4 x 30 or 2 x 60 m^2 collector arrangement possible
ATT (2)	collectors will be integrated as shading elements two different orientations (SW and S)
Skanska (1)	2 high-rise buildings, collectors integrated to the roofs buildings planned already for solar use
Skanska (2)	5 row houses, collector integrated to the roofs collectors may replace winter garden roofing
Skanska (3P)	collectors may be part of balcony roofing storage will be placed in the ground floor
VVO	collector integration to roof roof inclination may be increased
HELAS	the insulated water storage unit will be place outside and integrated in outer wall openings the roof inclination and structure can be changed
ESY	roof integration roof structure

An interesting feature is also the influence of the ownership of the houses. The Ekoviikki builders will not own the houses, but functions as building constructors. There will be four (4) different organizational approaches: rental buildings, occupancy rights, full ownership and occupancy influenced designs. The influence of the behavioural patterns from these on solar performance may be important and included in the evaluation part of the project.

3. TECHINCAL SOLUTIONS

3.1 Basic solar heating concept

The solar heating system consists of the collectors, storage and required HVAC components. The storage will operate with high stratification accomplished through a low-flow scheme and veritical passivly opening stratifiers. This fits well with the basic heating system which is district heating with very low return temperatures (25-35 ^{o}C). Thus, the solar heating system can operate at relatively low temperatures and consequently reach higher solar yields. Following, the collector gross yield is will be much higher than in standard systems. Here in average 400 kWh/m^2,yr is expected. The system layout of the solar heating systems is illustrated in diagrams in Fig.2.

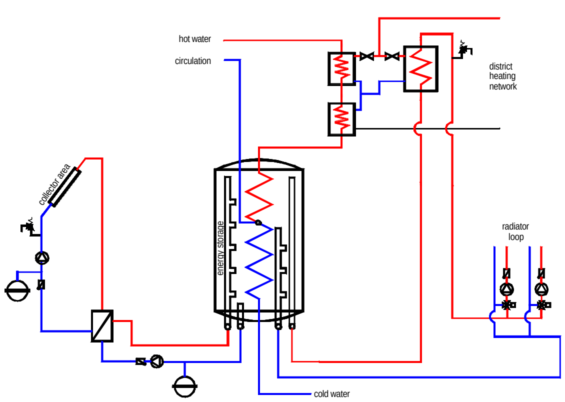

Fig.2. Basic solar heating concept used in Ekoviikki in connection with district heating.

3.2 Roof-integrated collector

One of the innovative elements of the proposal is the solar collector. The module is especially designed for building integration (Fig.3). The whole collector array will provide weather proofing. The absorber manufacturing is unique in Europe and based on high throughput ultrasound welding. The modules are large size 10 m^2 units which will reduce the mounting costs and risks for bad connections. The heat loss factor for the solar collector is 3.9 W/m^2K

The collector flow is of low-flow type with 8-18 kg/m^2h. The collector temperature range is up to 90 ^oC and some 2300-2500 operational hours per year are estimated. The collector loop is filled with a 50% antifreeze and connected to storage with an outside heat exchanger and 2 pumps.

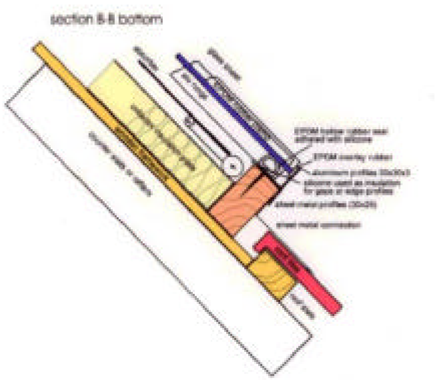

Fig.3. Roof-integrated large-unit solar collector used in Ekoviikki.

4. SITUATION IN SPRING 2000

The construction of the Ekoviikki as a whole and the solar demonstration project are underway. By early autumn 2000 all solar systems will be in operation. In summer 2000, 2/3 of the solar have been installed and will provide heat.

Fig.4. Construction site at Ekoviikki in late 1999. Upper picture shows the ATT(2) site in which 250 m2 of collectors have been integrated into the house roof. The lower picture shows ATT(1) site and the collector support structure.

5. EXAMPLE OF SUSTAINABILITY

As an example of various analysis performed for the Ekoviikki we have illustrated in Fig.5 a path toward improved sustainability and healthiness of one building (HELAS site).

By considering advanced strategies, we are able to demonstrate in Fig.5 concepts that increase the visual comfort, thermal quality and IAQ but at the same time a drop by one third the life-time CO_2 emissions and energy use compared to the Ekoviikki case.

ACKNOWLEDGEMENTS

The European Commission (DGXVII REB71/98/FI) and the Technology Development Centre of Finland (TEKES) are greatly acknowledged for providing financial support to the solar demonstration at Ekoviikki.

Helsinki City officials are thanked for their help and support throughout the project.

The nine partners of the EU-Thermie A project REB71/98/FI are also gratefully acknowledged for their contributions in the solar project.

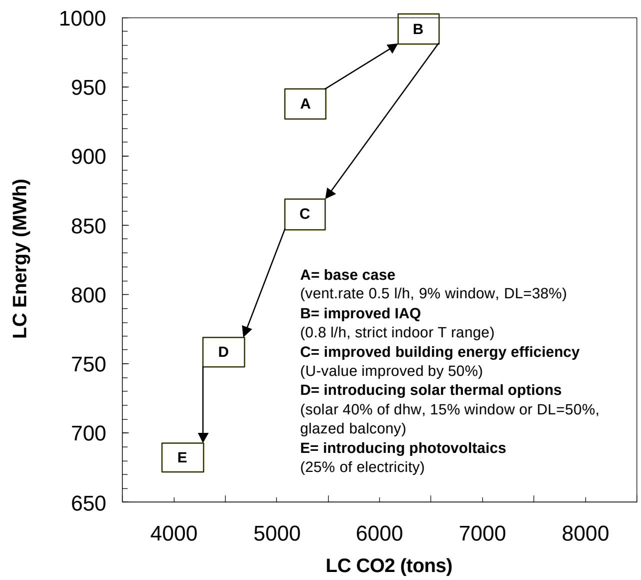

Fig. 5. An example of a strategy in which different measures are added.