# ENERGY EFFICIENCY AND ENVIRONMENTAL AWARENESS INTEGRATED IN THE EVERY DAY LIVING – AWARDED IN THE ENVIRONMENT 2000 COMPETITION, NEW BUILDINGS CLASS

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**Topic area:** Panel 4, Sustainable energy use in buildings

## 1. SYNOPSIS

SBC is building the future's housing where consideration to the environment is integrated into daily life. These award-winning, new environmentally friendly buildings are being built in Hammarby Sjöstad, Sweden.

## 2. ABSTRACT

SBC, a Swedish housing company mostly providing multifamily co-operative housing (tenant-owned individual flats in multifamily buildings), has a well-established reputation of high quality buildings. SBC now has deepened their environmental-engagement commitment even further by integrating energy-efficiency measures and environmental awareness from the very start of the building design process. The energy consumption in these new, high standard buildings is calculated to be less than 90 kWh/m$^2$ compared to a Swedish standard that is often more than three times higher. Environmental assessments carried out during the design process also show remarkable results.

An overall life-cycle cost approach is used when creating the SBC homes of the future. Four specific energy-efficiency and environmentally friendly areas have been given particular attention in the design process. These are:

- Lighting: Increased use of daylight, unique solutions in the residential sector, energy-efficient luminaires almost everywhere in the building, and lighting control sensors
- IT: individual metering of energy and water, car-fleet bookings, security and maintenance alarm features
- Comfort: High-performance windows, low-temperature heating system (floor distributed), energy-efficient appliances, and efficient and environmentally friendly waste handling system
- Building components: Hybrid PV cells and solar collectors, cables combined for TV, telecommunication and IT. All building components will be well insulated.

The first SBC multi-family building following this new strategy has been competing successfully in the Environment 2000 Competition[1)], where the concept won a silver medal. The first new building following this concept will be erected in Stockholm (the new city district Hammarby Sjöstad). The construction phase will start in February 2001, and the inhabitants will be moving in beginning June 2002.

## 3. BACKGROUND - QUALITY OF LIFE

### 3.1 SBC's philosophy

SBC's guiding light is quality and quality of life. From a technical viewpoint, this philosophy can be summarized as: everything they build will be a cut above average. In an effort to steadily improve its policy, it now empathizes the importance of energy-use efficiency and reducing environmental damage.

SBC offers help in establishing saving accounts for housing purchases for its 11 000 members. In order to buy a flat from SBC, you need to be a member.

### 3.2 Hammarby Sjöstad: a whole new city district in Stockholm's city centre

Hammarby Sjöstad is an entirely new city district in Stockholm's city centre. Construction has been underway for a couple of years, and is planned to go on until 2010. Once finished, the district will hold 8 000 flats (approximately 15 000 inhabitants) and an estimated 10 000 workplaces. Using various forms of grants of enjoyment for tenant's rights and tenant-owners rights, and even saving accounts for housing from the majority of builders, there are real opportunities for young and old to live in the new city district.

The City of Stockholm has very high ambitions for the new city district and has an overarching goal that energy consumption and environmental impact shall be less than half of that in corresponding buildings from the beginning of the 1990s.

As a part of this striving, the city launched a competition, *Miljötävling (i.e., "Environmental Contest") 2000*— the awarding of prizes to new construction within the Hammarby Sjöstad, Östberga and Skärholmen city

districts. The competition, which was open to all actors in the construction industry in the above-named city districts, designed far-reaching requirements with the goal of reducing environmental impact in the new city districts.

**3.3 Thoughts and reflections prior to creating the Kobben city block**
SBC accepted the challenge of *Miljötävling 2000*, and used the contest's documentation as an opportunity to devise a corporate strategy for building the future's residencies.

Using their own staff and a team of outside consultants specializing in environmental design and energy consumption, SBC developed the concept now serving as the basis for its construction in the Hammarby Sjöstad contest. Beginning with a systems perspective and life-cycle costing as the economic base, a variety of measures were analyzed and adopted that now serve as the building stones of the new concept.

In its effort to evaluate and compare these various measures, and in addition to LCC calculations, new software (referred to as the "environmental impact profile") was developed by the City of Stockholm and applied.

**3.4 The new concept is being tested in the Kobben city block in Hammarby Sjöstad**
As already mentioned SBC's basic philosophy focuses on people; ethical values, mixed with energy conservation, are built into daily life. There are many concrete examples of this in the new concept first tested in SBC's block in Hammarby Sjöstad.

The building's core is a glassed-in central room. It is here that all communications come together, it is here that all residents will meet. People get to know each other and create feelings of community, with all the good that entails - security, safety, happiness, friendship and creativity.

In order to further the idea of "focusing on people", a unique solution using light itself has been created employing everything from daylight (heliostats), many and large energy-efficient windows, and carefully selected low-energy lighting.

Quite a few other measures, large and small, lead the residents to participate in a resource-conserving system - environmental conservation built into daily-life. These include everything from a combination of underfloor heating and FTX-ventilation, IT-solutions, to discounts on new saucepans or kettles as a moving-in present.

The mix of esthesics, comfort and environmental conservation creates the opportunity of reaching a higher quality of life. This comes from focusing on people such that everyone can actively influence their living environment and life style, where behavioural patterns are modified due to the design of the residence.

**3.5 Additional cost for environmentally friendly construction?**
The purpose of the developmental effort that SBC has invested in Hammarby Sjöstad is to be able to duplicate these measures in future projects, and that the costs being expended now will pave the way for future standard solutions that are better and more environmentally friendly the today's methods.

In the Kobben block case, the additional costs for environmentally friendly measures are estimated at 10 million SEK (approx. 1.2 million €). This corresponds to approximately 5% of the total construction costs. However, the measures integrated into these new residencies lead to considerably lower maintenance costs, which makes the cost of living in the new flats less expensive than would be the case in "regular" newly built housing. A part of the initial extra costs that environmentally friendly construction generates today was won back, however, by participating in *Miljötävling 2000*. SBC was awarded a prize sum of 3.5 million kronor (approx 400 000 €) by the City of Stockholm for its contest entry "Kobben Block".

By beginning to change its standards in residential construction, SBC also sees a possibility that the extra costs for environmental measures will go down in the long run.

**3.6 Evaluation of the environmental investment in Hammarby Sjöstad**
Several different parties will be investigating the energy usage and environmental impact for the new buildings in Hammarby Sjöstad. SBC regularly follows up all their new buildings from a maintenance and energy viewpoint. The City of Stockholm of course has a vested interest in following these developments even after *Miljötävling 2000*, and in evaluating the new residencies in Hammarby Sjöstad. Certainly, even research institutes and universities in Sweden, as well as in other countries, will show an interest for how environmentally friendly Stockholm's new city district will be.

## 4. SITE PLAN FOR THE KOBBEN BLOCK

SBC's block, Kobben, consists of three buildings, two large and one small, with a total of 91 flats. The larger buildings are four and five storeys tall with 43 and 46 flats, respectively, while the small building (called "The Annex") is only two storeys tall and contains two apartments. The Kobben block is a large waterfront location, where the buildings' north façades faces Hammarby Lake. The south façades face a park.

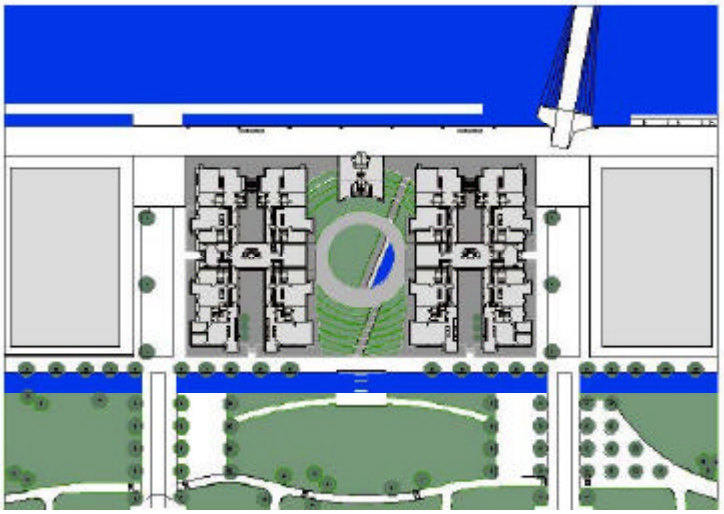

Figure 1: Site plan of SBC's Kobben block, Hammarby Sjöstad, Stockholm.

The flats vary in size from one-room efficiencies to 5 rooms with full kitchen. The smallest flats are 28 $m^2$ and the largest are 161 $m^2$. All flats have a lakefront view.

## 5. FIVE IMPORTANT ASPECTS ABOUT THE "KOBBEN" DISTRICT

### System aspects and life-cycle perspectives

SBC has a long-term life-cycle perspective for its construction projects, and uses life-cycle calculations. They view a building as an entity in which each component functions in its surroundings. In this way they avoid the risk for sub-optimization that occurs when the focus is narrowed to examining each component and detail in isolation. By using LCC calculations, lower operational costs arise and sometimes even lower total investment costs.

Environmental solutions will be integrated into the buildings, it must be easy to live in an environmentally friendly way in SBC's residencies. This is a necessity for achieving a sustainable result from applying efficiency measures. An environmentally friendly life-style must not consume extra time, otherwise it becomes merely temporary; instead it must be integrated as a natural part of daily life.

SBC's residencies in the Kobben block are built comprehensively on the five foundation stones of Lighting, Information Technology, Comfort, Building Components and Architecture.

### Lighting

- The buildings' lighting is very energy-efficient.
- The buildings' central communication rooms, with stairs and elevators, will extensively utilise natural lighting via heliostats and a holographic material in the banisters and railings to lead daylight into the building.
- Energy-efficient light luminaires will be installed throughout the building's common spaces.
- Lighting in common spaces will be directed using motion and sound detectors.
- SBC, together with Belid, manufacture of light luminaires, will offer the residents a new assortment of energy-efficient light luminaires.

### Information technology

- The buildings are prepared for e-shopping. The buildings' ground floors are designed to receive deliveries.
- The flats' will have individual measurement and debiting of heating, electricity, gas and water.
- The flats will be equipped with a "thin client", which provides the resident with the opportunity to a complete range of IT without having to have their own computer. By using these screens, the residents access SBC's portal, the Internet and statistics over their own energy consumption.

- The tenant-owners' society's job will be facilitated by giving the board members an external server. Sending paper communications to the members will become history - the information will appear on the screen in each residency.
- There will be an entry door telephone monitored by camera.
- Indoor and outdoor temperatures, wind and air pressure can be monitored.
- All wet rooms in the flats will be equipped with leakage alarms that automatically shut off electricity and water when the alarm sounds.
- Of course, the IT services also include fire and break-in alarms etc.

**Comfort**

- Large energy-efficiencies windows, in combination with underfloor heating in the flats, will provide an unbeatable residential comfort.
- The energy-efficiency windows produce a very comfortable indoor climate and can improve health via the large admission of daylight.
- Using a ventilation system with exhaust and supply air with heat recovery, energy can be returned to and air purity can be provided the flat after filtering. In addition, the supply air is pre-warmed, which eliminates draught.
- All flats will be equipped with very energy-efficient white goods, especially for food preservation.
- All flats will be equipped with biogas stoves. Also the apartments will have microwave ovens and electric kettles to additionally lower energy uses when cooking.
- The buildings will be connected to a refuse suction system, which will take care of wastes. SBC assists refuse sorting via simple, intelligent systems for taking care of recyclable paper, glass bottles, aluminium cans, etc. in or near the flat.

**Building components**

- The smaller of the buildings (the "studio annex") will become autonomous from an energy-supply viewpoint thanks to solar collectors, solar cells and "transparent insolation".
- The heliostats and combined IT, TV and telephone net will reduce the entire block's environmental impact material by eliminating 160 kg of copper and 500 kg of plastic (polyethylene). All wiring is shielded.
- Wireless telephones save resources via fewer telephone points and considerable meters of wiring.
- Energy-efficient elevators will be installed. These elevators do not require an elevator machine room, which therefore reduces the amount of corresponding building material.

Figure 2: The SBC Kobben block seen from the park (Hammarby Sjöstad, Stockholm).

**Architecture**

The ecological building creates good conditions for the residents' relationships with each other and their surroundings. The district's arrangement is based on openness and visibility, which is visible in a series of inner and outer "castle courtyards" and central rooms.

Alternative entrances from streets and courtyards on different levels lead into both buildings. Here are both buildings' sole stairways and two elevators, which means that all residents will have the opportunity to get to know each other.

Feelings of community are strengthened when pleasure and security develop in direct contact with neighbours. The architecture in the Kobben district can therefor be one contribution to solvingpsychological problems having their roots in alienation and lack of nonmaterial values. People themselves are the greatest resource in a biological-economical connection. Thus, the residents' own health has received the highest priorities given economic realities.
The planning is based on ecological standpoints in the form of passive solar heating and climate shelves, and will provide a good view of parks, water and sky. Sun-warmed, southern facades are always desired in Swedish latitudes. Therefore, the buildings have a shallow, intimate courtyard that is directly oriented towards the park to the south. A smaller, inner courtyard is roofed over with glass and functions as a passive solar collector.

The buildings invoke a historical connection to the time of warehouses, industry, dockyards and ships. The configuration is cast in a classic form and connects to modernism. The openness of Nature along the waterfront complements and contrasts with a self-conscious simplicity and purity of form.

The simplicity also reflects a view of architecture that assents to durableness and energy and resource conservation. The residencies' building materials are also tied to this concept. The facades are plastered, the bulk of the surface area is yellow ochre, and its indentations are white, which creates an effect of a light, building mass. The recessed roof storey is white.

The inner courtyards are protected, intimate places for daily life and parties. The ground is paved with dark grey granite and equipped with open channels for rain water, and leads to the park's ducts. High plinths are equipped with stone to accommodate all possible silliness and clumsiness and to store heat for such things as the lemon trees, for example. The depressed courtyard between the buildings is a leeward depression designed as a solar "roasting pan".

Figure 3: View over "the roasting pan" (The SBC Kobben block, Hammarby Sjöstad, Stockholm).

**But also…**

- Efforts to minimise environmental impact have permeated the entire project. Planning for environmentally friendly and energy efficient living has been integrated in the process surrounding the buildings' design beginning on Day 1. Digital techniques were incorporated into the planning from the start, which means that no car-based courier services were needed to shuttle paper copies of drawings and descriptions among project collaborators.

- The choice of building materials will be based on optimal choices for the environment given other limitations. Renewable and recycled materials will be prioritised. Even the construction machinery and tools will be chosen with respect to minimising environmental impact; similarly, attention will be paid to expendable supplies.

- Even the construction work itself will handle materials carefully to will avoid unnecessary damage such as mildew, for example. Waste materials and packaging will be sorted to pure fractions on the construction site for later recycling.

## 6. A MORE DETAILED DESCRIPTION OF MEASURES TAKEN IN THE KOBBEN DISTRICT

**Climate shell - esthesics**
Buildings have a heavy skeleton. This produces a lower energy usage and higher comfort in the form of a more even indoor temperature than would a light skeleton. A heavy skeleton allows daytime solar heating to be stored in the walls and reradiated at night. Similarly, stored night time coolness is recovered during the day. Walls, floors and roofs simply function as temperature equalisers.

The buildings are generally very well insulated. All structural parts have low heat transmission losses (i.e., low U-values). For example, the buildings utilise the market's best windows, having a U-value of 1.0W/m$^2$ ºC. The buildings' mean U-value is less than 0.23 W/m$^2$ ºC.

NUTEK's (STEM's)[2)] continuation of technology procurements of windows (which is the basis for the SBC's choice of windows) have greatly focused on the aesthetic design of windows. Energy-efficient windows are therefor more consciously designed and esthesically attractive than standard windows.

The design of the buildings' thermal bridges are very well thought out. The energy losses thought the thermal bridges are very small (Class 1).

**Hard-to-beat comfort**
The energy-efficient windows provide a very nice indoor climate, because they do not give rise to downrushes of cold air and radiation draughts. The chosen ventilation system using pre-warmed air and heat recovery from the exhaust air also actively contributes to a good indoor climate. This, in combination with underfloor heating in the flats, gives those living in the Kobben block a hard-to-beat degree of residential comfort.

**The sun**
Positive energy contributions from the sun will be used in the buildings, for example in the building's atrium courtyards and central spaces. But during the warmest months, shading is required to prevent excessive heat from entering the building. One example of protection against overheating is the balcony design, which will work as sun blind during that time of the year that the sun is highest.

A hybrid solution of solar cells and collectors will be connected to the "studio annex." In truth, the panels will actually be placed on the roof of the two larger buildings, but connected to the annex, and thanks to the annexe's transparent insolation, this building will be energy self-sufficient throughout the year. The placement of the solar hybrids on the two larger buildings' roofs is ideal both technically and esthesically, because they are at no risk of being shaded by surrounding buildings, with its incumbent loss of efficiency, and because no nearby residents risk reflective glare or other discomfort from the new technology.

The transparent insolation also reduces additional need for outside energy sources to the studio annex. Transparent insolation is becoming increasingly popular in Ge rmany, for example, but has not previously been installed in Sweden. It functions by holding even more heat in the walls than does the heavy carcass described above.

**Ventilation creates comfort**
The buildings are provided with exhaust and supply ventilation with heat recovery (FTX-ventilation) having a high degree of heat recovery. This solution provides a low total energy consumption and very good comfort.

By using FTX ventilation a large part of the heat that would normally be cast to the wind is recovered. The FTX system also provides pre-warmed supply air to the residencies. This avoids the draught problem. In addition, the maintenance becomes simpler, and thus cheaper, since the supply air filters can be replaced centrally. Thus the maintenance staff doesn't need to enter each flat to change filters, or trust to the residents to be able to change them - and as often as needed.

The ventilation is energy-efficient with low SFP values (specific fan power) and low pressure drops in the system. This also contributes to comfort, as the supply air enters the flats at a gentle, low velocity without causing a feeling of draught.

The advantages of a FTX system includes:

- Heat recovery from exhaust air.
- Purer air is supplied to the flats (filtered air)
- The filter exchange is limited to the fan room and since there are no filters in the flats this creates simpler, cheaper maintenance.
- Better indoor climate because the risk for draughts from the vent to external air is reduced.
- The supply air is pre-warmed.
- There is little risk for noise from the exhaust air vents.
- Even from the viewpoint of appearance, a facade with many exhaust vents - which is avoided here - is of questionable beauty. Furthermore, exhaust vents are difficult to place.

**Water and Sanitation**

All service water mixers in the buildings save resources (both heat and amount of water). Even the toilets greatly conserve water and have a dual flushing ability.
As a part of the life-cycle thinking, chrome has been chosen for surface of the service water mixers. Chromed mixers are better from the environmental viewpoint, because they last twice the life time as mixers with paint surface treatment.

All of the buildings' pipes and ducts are well insolated. No copper is present in water pipes.

**Electricity and cables - large and small savings**

SBC decided to install a five-wire system in the Kobben block. All electric cables are free of PVC. In addition, all wiring is shielded.

The flats will be installed with a single cable for telephony, TV and IT. The flats will be equipped with wireless telephones. Naturally, this means a large savings in material, because a traditional flat generally has five telephone points.

In addition, the installed amount of copper in the entire block will be reduced by 160 kg and the amount of plastic by 500 kg, thanks to the single cable for telephony, TV and IT, and because the common room will by lit by heliostats. The heliostats do away with the need for 50 armatures in the central room, which thereby reduces the amount of several kinds of material such as aluminium, copper and plastic.

Low-energy elevators (Monospace brand) will be installed. These elevators also do not require an elevator machine room, and only half the number of elevators normally installed elsewhere are truly required, which means the amount of building materials will be reduced by the corresponding degree.

**Lighting - a unique daylight solution**

The buildings' lighting will be very energy-efficient. Daylight will be extensively used for lighting in the buildings' common room. The reason for this is the so-called heliostats and a holographic material in the bannisters and railings that spread daylight into the building.

Heliostats have been previously used in other types of buildings, but this will be the first time they will be installed in residential housing. The idea is to guide daylight into the building in order to enjoy natural lighting throughout much of the day in much of the building. The large share of daylight will increase well-being and reduce the need for artifical lighting.

Use of Heliostats mean that 50 armatures, typically "bracketed candlesticks" or the like, will be unnecessary. This corresponds to approximated 5,000 kWh electricity in operational costs. The savings also eliminate the amount of aluminium and other metals that would have been needed in manufacturing the traditional luminaires.

Energy-efficient luminaires will be installed in all the common spaces on the property (laundry, bicycle storage room, access balconies, service gallery, etc.) and all fixed armatures in the flats.

The energy savings due to the low-energy luminaires in the flats - 4 per flat on average - will be 300 kWh per flat per year; for all 91 flats this becomes 27,000 kWh annually.
In addition, lighting in common spaces will be steered using motion and sound detectors.

For addressing the lighting need within the flats, SBC is collaborating with the lighting manufacturer Belid, which has created a line of energy-efficient luminaires for home use, which will be offered to new residents

when they sign a contract and move in. SBC will present a gift certificate for an energy-efficient luminaire during attendance at the planned ”moving-in” orientation course.

Belid will also demonstrate for the residents how the residents can use energy-efficient lighting throughout a type-layout flat.

**White goods for the future**
All flats will be equipped with very energy-efficient white goods. The refrigerator-freezer installed in the flats will be the market’s most energy efficient[3)].

Each flat will be equipped with a washing machine[4)] and drier[5)] of the most efficient model. The laundry nook, with the drier atop the washer, will also have a pleasantly designed retractable clothesline, so that wash not requiring immediate drying can be hung.

The tenant-owners’ society will have a common laundry for heavy laundry. The common laundry will be installed with self-dosing washers with the lowest available energy and water use.

All flats will be equipped with self-heating dishwasher attached to a cold water pipe[6)]. Studies have shown that these dishwashers save more energy and water in comparison with traditional hand-washing in households. The cold water connection ensures that no unnecessary energy is used to heat the rinse water.

In addition, the buildings are designed so that all households can receive food and other deliveries ordered over the Internet. There is currently no standard in e-business for either when or how goods are to be delivered. Currently e-business represents 0.8% of the total daily shopping in Sweden. According to e-business estimates, this figure is expected to rise to about 10% within five years. e-business can be expected to increase faster than the national average in newly built localities like Hammarby Sjöstad. SBC is an active partner in the future development of e-business via its collaborations and discussions with deliverers of daily goods. Thus, SBC is actively developing this field in many ways.

Several measures have been taken to lower both total energy use and electricity consumption in food preparation. All flats will be equipped with biogas stoves. Microwave ovens are also standard in all flats. Use of a microwave oven can substantially reduce energy use in preparing food (SBC will include an information session on how to easily save energy in cooking food in a microwave during its ”moving-in” orientation course). In addition, all residents will receive an electric kettle as a moving-in present from SBC. Even electric kettles save a lot of energy in comparison to boiling water in a pan on the stove top.

Also, SBC will offer all residents a discount on new pots and pans in order to further reduce energy use in cooking food.

**Reduce transport!**
Bicycling is an environmentally friendly way to get around. In order to increase the use of bicycles in the city, one requirement, among many, is improved bicycle parking. There will be excellent bicycle parking space in Kobben’s buildings. Flats with no more than two rooms and a kitchen will receive two bicycle parking spaces, and larger flats will receive three bicycle parking spaces each.

As mentioned above, deliveries of goods will be facilitated, and their reception will take place in the ”service gallery” in the building’s ground floor. A study by the Institute of Technology in Lund shows that shopping and delivery by e-business of daily goods reduces energy consumption and carbon dioxide discharge by up to 7% when e-business reaches a sales share of 10%.

SBC will enrol the tenant’s owner society to Statoil’s fleet of cars. Reservation of a car should work through both SBC’s IT portal and by phone. To make participation in using the fleet of cars more attractive, and thereby reducing the need for private car ownership, SBC will have parking places for the fleet adjacent to the tenant owner’s society’s garage.

**IT solutions - a future**
The flats’ will have individual measurement and debiting of heating, electricity, gas and water. This will probably reduce the environmental impact by 10 to 15%. The resident’s own consumption, both at the time and historically, must be easily accessible, for example via a display on the "thin client" installed in each flat.

The IT portal will even have a ”virtual re-use room”. The residents can post ads on furniture, tires, strollers and other property they want to buy or sell. This is to encourage re-use of goods.

All rooms in the flat will have multimedia possibilities. Reservation of the laundry and guest rooms, etc, are examples of options found on the computer.

All electrical outlets, or a selection (depending on the resident’s wishes), can be turned off when the door is locked from the outside. Smart card systems will be used; for example, to assist accessibility for janitors.

Another example of an IT solution is giving the resident an option to have a security alarm.

**Refuse handling - a smart system**
The buildings will be connected to a mobile refuse suction system, which will take care of refuse in three fractions. Should the city find a solution for garbage disposers as discussed in the framework of the Hammarby Sjöstad project, SBC is prepared to install it. In addition, SBC will facilitate sorting via simple, intelligent systems for taking care of recyclable paper, glass bottles, aluminium cans, etc. in or near the flat.

**Energy supply - green in both the flat and property**
A contract will be signed for so-called ”green electricity” for the entire property. Furthermore, SBC will investigate the availability of ”green” district heating.

In addition, SBC’s members can sign an advantageous contract for Green electricity through the general agreement SBC signed with Graninge AB, that is, a ”green” alternative outside of the property’s own electricity.

The studio annex will be self-sufficient in energy as defined by yearly consumption. This will be assisted by solar cells and efficiency measures such as transparent insolation.

**Water - a resource**
Storm water will be handled locally. In addition there will be special rainwater cisterns for watering the lemon trees in the buildings’ inner courtyards.

**Making urban land work better Environmentally**
Where concrete paving stone is needed, products with substantially lower ecological impact than other paving products will be used. Environmentally friendly soil cover will be used; the stone fill underneath will have a very durable weathering profile and was quarried in a nature-friendly manner. At the common courtyards plenty of bushes and flowers will be planted.

**Other measures**
The Kobben block will have a guest room that anyone in the tenant’s society can book via the "thin client". The existence of the guest room at a very reasonable rent gives the resident a degree of flexibility concerning the family’s composition and change over shorter and longer periods, and provides the opportunity to host relatives and friends for longer visits without having to rent a flat with its own guestroom.

All residents will receive a notebook for the flat that holds special information about energy and environmental measures. SBC will also be organising study circles and/or information meetings about environmental issues as well has having permanent environmental information in its home pages.

As already mentioned, the desire to have a minimum impact on the environment has been the guiding light. Digital techniques have been used in the planning from the very start; no car-based courier services were needed to deliver paper copies of drawings and descriptions. The possibility of taking environmentally friendly measures and creating energy efficiency has been integrated into the project from the first project meeting and has been a natural part of the process of designing the buildings.

The choice of building materials will be based on optimal choices for the environment. Renewable and recycled materials are prioritised. Even the construction machinery and tools will be chosen with respect to minimising environmental impact; similarly, attention will be paid to expendable supplies.

Even the construction work itself must be examined to avoid unnecessary damage such as mildew, for example. Waste materials and packaging will be sorted to pure fractions on the construction site for later recycling.

**Technical aspects of the energy system**
SBC has chosen district heating, and solar energy in part, to heat the buildings. Heat pumps would have been chosen had the property boundaries been the system boundaries. Instead, the system boundary includes all of Hammarby Sjöstad, and there one of the world's largest heat pumps already exists (via Birka Energi AB). The existence of this heat pump means that a new investment in our own heat pump for the Kobben block would have been a suboptimal solution.
The underfloor heating system chosen increases the possibility of utilising a low-temperature energy source, and allows the future exploitation of more ecological energy.

**Potential solutions examined but not chosen:**
The process of designing and building a facility such as SBC's Kobben block must naturally sample and examine all possible solutions that favours both the residents and the future development of a sustainable society. During the designing of the Kobben block we examined a number of technical systems that we chose not to employ. One example of such a system is demand controlled ventilation, which was rejected for reasons of cost and amount of material consumed. For example, demand-controlled ventilation requires many more shafts and more costly installation than the system chosen for the Kobben block. Another such measure was "frameless windows", which are intended to reduce energy usage and thermal bridges. However, these windows are not commercially available, they are currently found only in the research and development stage.

## 7. SUMMARY

SBC is building the future's housing where energy efficiency and environmental actions are integrated into the building from its inception. SBC is building the Kobben block in the new Hammarby Sjöstad of Stockholm in which energy consumption is calculated to be less than 90 kWh/m$^2$, which corresponds to only a third of the average for other housing.

An overall life-cycle cost approach is used when creating SBC's homes of the future. Four specific energy-efficiency and environmentally friendly areas have been given particular attention in the design process. These are:

Lighting: Increased use of daylight, unique solutions in the residential sector, energy-efficient luminaires almost everywhere in the building, and lighting control sensors.
IT: individual metering of energy and water, car-fleet bookings, security and maintenance alarm features.
Comfort: High-performance windows, a low-temperature heating system (floor distributed), energy-efficient appliances, and efficient and environmentally friendly waste-handling system.
Building components: Hybrid PV cells and solar collectors, cables combined for electricity, telecommunication and IT. All building components well insulated.

The first SBC multi-family building following this new concept, an award winner in the Environment 2000 Competition[7)], will be erected in Stockholm (the new city district Hammarby Sjöstad). The construction phase will start in February 2001, and the inhabitants will be moving in beginning June 2002.

## 8. ENDNOTES AND REFERENCES

1 *Miljötävling 2000 - premiering av goda nybyggnader inom stadsdelarna Hammarby Sjöstad, Skärholmen och Östbergahöjden. Tävlingsprogram. Stockholms stad, LIP-kansliet,* Stockholm, Sweden, 1999.
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2 *Välj rätt fönster, Statens energimyndighet ET8:2000, och Välsisolerade fönster bidrar till bättre miljö, Statens energimyndighet. ET14:2000* Eskilstuna, Sweden, 2000.
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7 op cit, endnote no. 1.