

Final Technical Report - EGC

Project
European Green Cities

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5 PUBLICITY, COMMERCIALISATION AND OTHER DEVELOPMENTS

5.1 *Publicity and Publications*

5.1.1 Abruzzo, Italy

The project has been well accepted by the local public Institutions.

In May 1999 the project was presented to the local institutions and to private users and a public meeting was organised focused on the energy saving technologies in the public residential building.

The Avezzano project was also presented in a local regional newspaper and during a public conference focused on the building new policies held in March 2000.

The future benefits of the rehabilitation project mainly interest:

- The tenants because they'll obtain an economic saving and they'll have an improvement of the indoor air quality and comfort of the apartments
- The designers and the contractors because they could acquire specific experience about the application of innovative building technologies.

The future actions will be focused on:

- how to diffuse sustainable building intervention
- how to reach energy saving objectives
- which tools to apply energy saving technologies in building sector

5.1.2 Brescia, Italy

The project has been well accepted by the local public Institutions.

It was presented to local institutions at regional and district level but also private users, (technical and building enterprises, housing associations) have been contacted and involved in order to obtain a better diffusion of the project.

A public meeting was organised to illustrate the most interesting aspects of the project, taking advantage of the activity of the existing local energy local public association (PUNTO ENERGIA).

The local energy public association (PUNTO ENERGIA) is actually developing a energy policy carrying on strong actions to diffuse the energy problem and low energy strategies in the local contest.

The intention is to diffuse the European Green Cities project by informing the Local political building sector (Municipality, District, Region) at private and public level; an important aspect is also the involvement of all associations that work on energy and environmental field.

An other important action was the direct information of tenants by means of ALER publications: a publication was realised to illustrate the most interesting aspects of the project.

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- The tenants because they'll obtain an economic saving and they'll have an improvement of the indoor air quality and comfort of the apartments
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5.1.3 Copenhagen, Denmark

The demonstration project at Hedebygade, Vesterbro in Copenhagen is part of the largest urban ecology project made in Denmark till date, with 360 apartments in all. Due to this there has been an extensive promotion of the project in Denmark and visits from people from all over the world. When the project was finished there was made a special celebration with the chief mayor of Copenhagen being present together with the minister of interior and with television interviewers.

Cenergia has arranged site visits to Hedebygade Vesterbro:

Date	Participants	Number of people
25.02.00	Cadet meeting	25
20.09.00	technical administrations, Norway	25
13.10.00	Danish architects	10
26.02.01	Final PV-Vent meeting, EU project JOR3-CT97-0160	7

The project has been reported in a technical magazine "VVS" in November 2000, and also in reports in Danish.

SBS Urban Renewable is continuing the work from this project in new urban renewable projects in Copenhagen aiming at urban ecology and energy savings.

Concerning the Byskoven project in Røddekro there has been a lot of interest from Danish housing associations, especially due to the good economy and the good indoor air climate. The project has been reported in the magazine "Boligen".

5.1.4 Grenoble, France

Rhonalpénergie Environnement, an environment and energy regional agency was associated during all the preparation of the project. It is an OPET Network member and also a regional agencies networks member (RARE, FEDARENE). It is a good partner for the dissemination. There is also a local energy agency, which was created trough a SAVE program in 1998.

Another partner is the association AGEDEN, which promote renewable energies. The AGEDEN is based in Grenoble. It was a good technical partner and also for communication and local dissemination.

An important dissemination plan target was the housing association because they own a lot of dwellings. It is a very large potential for energy saving and renewable energies through the annual buildings and retrofits.

Another target, which is linked to the previous, concern consultants and architects which often consider that renewable energies have no future and are not important for their buildings.

A communication plan has been organised : journalists, meetings participation, technical reports for partners, consultants.

The project has been a reference for environment and energy local partners. They have used this reference to convince others local authorities.

Meetings :

- national meetings in Paris about energy and social housing – 28/06/99 and 06/07/1999
- national meeting in Strasbourg “Environment and building” – 14/01/2000
- meeting in Meylan about sustainable development – 24,25,26/03/2000 ;
- meeting in Lyon about energy and social housing – 15/05/2000
- meeting “Journées de l’environnement “ in Echirolles – 05/06/2000
- meeting and exhibition for the tenants in Echirolles –21,22/06/2000
- meeting in Saint-Etienne about energy and housing – 21/06/2000
- national meeting in Besançon – 27/06/2000
- meeting in Grenoble with housing association representatives – 12/09/2000
- national meeting in Dunkerque with French government representatives about housing and energy saving – 28,29,30/11/2000 ;

Visits :

- visit for the energy local agency and its partners – 16/09/1999
- visit for the state representatives and responsables of building and equipment – 21/01/2000
- visit for journalists 28/07/1999,12/08/1999
- visit for student from Grenoble university – 06/12/1999
- visit for the association “Energie,environnement 74” –12/10/2000
- official inauguration with political personalities – 09/10/2000

Documentation :

- one page presentation : project description – 1998
- one page presentation with results – 2000

5.1.5 Herning, Denmark

The buildings have been visited on a number of occasions. Among these were a delegation from the government, a “green” delegation from Bulgaria, and several times a class from the school of civil engineers in Aarhus.

The same school is part of a collaborate project, where a number of students in their last semester, makes a final report as part of their final exams, including one or more of our “green approaches”.

5.1.6 Hulshout, Belgium

An exhibition of the project was organised on 26 September 1997. The Flemish minister of Social Housing Mr. Leo Peeters participated in this exhibition. He was very interested and he is prepared to support the project.

The project got a number of times into the press. For instance, the project was proposed on the regional television RTV Kempen and different articles were published in the national newspapers.

In the energy month October 1998, the Flemish Minister of Energy Mr. Van Rompuy visited the project. An information program concerning energy efficient and sustainable building was made for the Flemish television (VRT). This project in Hulshout was shown as an example of energy efficient and sustainable building.

In December 1998, the project was visited professor Hens (construction and building physics of the Catholic University of Leuven).

The European project was officially opened on 24 March 2000 by the Minister – vice President, Minister of Mobility, Public Construction and Energy Mr. Steve Stevaert and by the Depute of the Province of Antwerp Mr. Ludo Helsen. A lot of interested people were present at the official opening.

The project was detailed described in newspapers and local Television Company RTV (Regional Television Vlaanderen). By this way information about the European Thermie project was disseminated to a broad public.

After the official opening a lot of interested people from inland and abroad (the Netherlands, Poland, ...) have had a guided tour to the project.

Every two years the Flemish Government organises a “month of energy saving”, mostly in October. In October 2000 the project was open to the public. Guided visits were organised to interested Flemish people.

The project was presented in the international conference “Sustainable building 2000”, 22-25 October 2000 in Maastricht (NL).

Since July 2000 the energy measurements started in the new social houses. The monitoring is in close co-operation with the research institute Vito and the University of Leuven (KUL). The University of Leuven started in October 2000 with a sensitisation of the tenants.

5.1.7 Kuopio, Finland

The Kuopio city government decided on 29.1.1996 that the city would apply to join the EC Thermie programme in the European Green Cities group. The decision was published in the regional newspapers. The final decision on participating in the Thermie programme with experimental construction of the Pirtti school was made on 2.9.1996.

After the construction work was started a press conference was held on 17.6.1997 by the builder, the Kuopio city property management department. The local media, journals for professionals in construction industry from entire Finland, the local radio, planners, contractors, suppliers for the innovative section and the Kuopio city partners in the

project were invited to the press conference. The experimental construction gained a lot of attention in newspapers and on the radio.

The following journals and publications have paid special attention to the Pirtti school:

1998: Project News, journal for professionals in construction industry

No 4/1998

1998: Green Building Challenge '98. An International Conference on the Performance Assessment of Buildings, October 1998, Vancouver, Canada. Conference Proceedings, CD-ROM

1999: Sähköviesti (Electric News) Publication for the clients of the local energy company No 3/1999

2000: KART SURVEY THERMIE 96 PROJECTS. Helsinki University of Technology. 2000

A city planning report has been drawn up of the project, where the location of the school in the structure of the city is described as well as the planning solutions, their effects on the service structure of the city and the principles of the architectural planning of the building. The report is in Finnish only and has not been published.

Several dozen groups from other Finnish schools have visited the Pirtti school.

General information on the school and the experimental building project have been on the Internet since the beginning of 2000 at:

<http://www.kuopio.fi/tevi/tilak/pirtti/etusivu.html>

Energy conservation and international connections feature in the educational curriculum of the Pirtti school. The school participates in the EC Sokrates/Comenius programmes which aim at developing international connections and making cultures meet. The Pirtti school belongs to the network of energy conservation schools co-ordinated by MOTIVA, the Energy Information Centre for Energy Efficiency and Renewable Energy Sources in Finland. In addition to the Pirtti school, there are six other Finnish schools and foreign participants from Norway, Austria and Estonia in the network.

The presentation of the education in Pirtti school is in internet:

<http://www.koulut.kuopio.fi/~Pirtti/index.htm>

5.1.8 Portsmouth, GB

Portsmouth City Council has made publications and videos on the project also shown to the other Green Cities partners. Further initiatives are being made at the moment.

5.1.9 Radstadt, Austria

There have been organised several excursions to the Radstadt project to have a look at it and to discuss it.

Some energy experts from other countries in Austria (Vorarlberg and Tirol) have visited the project to look especially at the construction and material (combined massive and wooden-construction) and the house technique (especially the heat distribution-system).

In spring 2000 a delegation from Belgium (contact from the green city network) came for a three day visit to Salzburg. One important point was the visit of the Radstadt project.

Visits:

Autumn 1998: Excursion for architects and politics from Salzburg

October 1999: Meeting of the green cities. Nearly 50 representatives from the other cities and projects of the green cities came to visit the Radstadt project and to discuss the important facts.

Mai 2000: Three day visit from a delegation of Belgium housing-associations (contact from the green city network) in Salzburg and Radstadt.

July 2000: Excursion from energy experts of other Austrian countries (Tirol and Vorarlberg)

Documentation:

A special coloured booklet of 20 pages. There the process, the ideas, the aspects of design and the technical details are documented. With this paper we want to produce a material for users, politicals and also experts. This coloured booklet was printed as an edition of 2500 pieces in German. It was sent to all partners in the German speaking area, to all communities in Salzburg and to all housing associations in Austria.

Three times articles in the Information-newspaper of the SIR "SIR-Info" at the start, when the EU-support was fixed and when the dwellings were handed over to the tenants.

An Article about ecology on the housing sector in the "Salzburger Fenster" (in 1996)

An Article in the "Pongauer Nachrichten" when the positive message of the acceptance of the EU-proposal came (1997).

An article in the "Wohnen Plus" magazine in 1997

A detailed description of the project and the technical details and innovations (6 pages) in the scientific book "SIR-Mitteilungen und Berichte" in winter 1998.

A short message in the newspaper for Austrian communities (1998).

An Article of the technical news in the project in the "Bauen & Wohnen" (autumn 1999).

A three page article in the "BAU-Zeitung" an important medium for the building economy in Austria (January 2000).

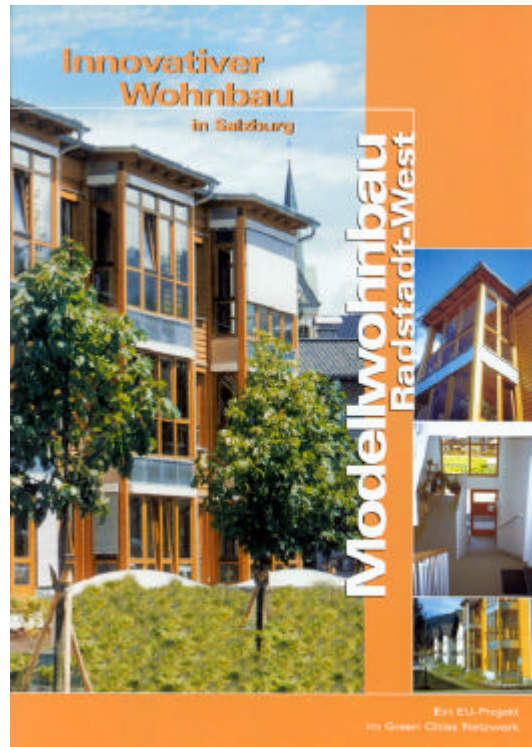


Figure 5.1.: The frontpage A special coloured booklet of 20 pages.

Video:

For a good documtation and dissemination we produced a 20 minutes lasting video of this project. In this video the situation in Radstadt, the project itself and the details are shown and explained. With aerial-views of the situation and a good music it is refreshing to watch it. The first time this video was presented at the EU-Meeting in Salzburg in October 1999. It was handed over to all partners within the green cities, to the city of Radstadt, to all partners involved and also to the technical schools in Salzburg, so that they can use it in their lessons.

5.1.10 Vilanova, Spain

Local actions planned to be taken are mainly two:

firstly dissemination actions,

and secondly a user's satisfaction rate measurement.

Public dissemination of the European programme Green Cities

The disseminating action is addressed to professionals of the construction industry, local authorities, and in general to people interested in the domestic sector.

- To publish a facsimile that gathers these sorts of construction's characteristics and its advantages. It will be addressed to the general public, with examples of existing edification.
- Publication of a videotape that shows through animation the low energy consumption practice ways. It will be handed over to the dwellings' owners and people interested.

- Party where all the El Llimonet neighbours will be invited, and all the several participants of the project will take part. The keys will be symbolically handed over to the owners.

Dissemination aims:

- To spread low energy consumption buildings use, knowledge and its advantages and profits among El Llimonet users.
- To disseminate among Vilanova i la Geltrú population the existence of El Llimonet building constructed by *Qualitat Promocions*.
- Spread among general and specialised mass media this kind of construction, and particularly El Llimonet.

Action plan:

March 2001:	Participants co-ordination and actions proposals debate.
1st April 2001:	Ordering of the dissemination material to the corresponding professionals.
May and June	Progress meetings among the managers.
1-15 July:	Meeting during the delivery of the 4th phase of El Llimonet building. Event for the owners with some food and music. Publication of the facsimile and the dissemination videotape.
15-30 September:	Spreading through Vilanova i la Geltrú. Presence of the Press and the Technical services of the Municipality.
1-15 October:	Realisation of a dissemination document about the event and about this sort of construction for the general and specialised mass media.

User's satisfaction measurement action

At the end of year 2001 a specific inquiry among the users of the dwellings in El Llimonet is planned to be done. They will be asked to evaluate several aspects of their dwellings, as functionality, comfort, energy saving or appropriateness of the materials used.

The results obtained will allow us to strictly evaluate the suitability of the realised project, and therefore to act consequently in the future.

5.1.11 Volos, Greece

A lot of publicity has been given to this demonstration project in local newspapers and TV because of the importance of the buildings and their uses in the area. As well it has been presented at national and European level through seminars and conferences due to the application made on them while Tsalapatas building is a unique building of cultural and historical heritage, not only in Greece but in Europe as well. We are preparing a guide for this project that will be given not only to schools but to engineers and architects that have already show a growing interest as the project was finalized.

5.2 Outlook

5.2.1 Abruzzo, Italy

Many public residential buildings in Regione Abruzzo were built during the 70s and they need refurbishment with the aim of reduction of the present energy consumption.

The interventions proposed in the EGC project could be extended to the existing building stock object of maintenance programme (in cooperation with Abruzzo Region where 28000 apartments could be involved) and the solution proposed could be considered as a repeatable solution on a large scale.

On the basis of the experience from this project the future commercialisation of the technologies will result in a cost reduction.

Regione Abruzzo disseminated and diffused the project intervention in public conferences and gave it publicity.

The intention of the Regione Abruzzo is to carry out a new approach in retrofit actions of existing building stocks, but the problem concerns the culture and availability of the tenants.

5.2.2 Brescia, Italy

The intention is to diffuse the application of low energy cost systems in public residential buildings and also museums, schools, hospitals, taking advantage from the national and regional financial resources; the projects can interest both general big intervention both small interventions on specific parts of the building energy systems (staircases lighting, domestic hot water, etc...).

ALER of Brescia can be an important tool for the development and approval of the local Green Action Plan by means of proper institutional channels and proper competence.

A specific local need is the intervention on residential buildings that aren't still connected to the local district heating network: the application of energy saving technologies can result a good solution for these buildings and it's expected to obtain a better result than in the realised intervention (Thermie project).

The future intention is to improve the performance and efficiency of the installations and to reduce electricity consumption and maintenance costs.

5.2.3 Copenhagen, Denmark

The project has demonstrated a number new energy savings technologies, which are important elements to reduce the emission from the energy use in the building sector. The knowledge between architects, engineers and constructor are very limited in respect to performance, investment and installation. The constructor has no experience in new energy savings technologies, which cause high investment and many construction failures. In the design phase the architect and engineers have no useful design tools which can find the best solutions for the environment and for the inhabitants too.

The first meeting of the European Green Cities was held in the City Hall of the municipality of Copenhagen in May 1997. The mayor of housing in Copenhagen was chosen as the first chairman of the network co-operation.

The idea of the European Green Cities cooperation was to start a development of a European Green Cities energy and environmental standard. The inspiration was given from the efforts in Copenhagen and the projects that Cenergia had already implemented

since 1990. E.g. also the "Skotteparken" project in Ballerup just outside Copenhagen, which received the "World Habitat Award" in 1994.

In Copenhagen an effort to introduce urban ecology in the city planning already started several years ago and in 1998 a website on urban ecology projects (www.byokologi.dk) was made as well as new regulations with "minimum standards" and "recommendations" for new-built and urban renewal projects.

The partnership structure between Cenergia and the municipality of Copenhagen has been very open and connected to the realisation of practical projects, e.g. the European Green Cities co-operation. In this project Cenergia has been responsible as a fundraiser and for the technical inputs on the practical projects. Another important partner of the Danish part of the European Green Cities project has been the SBS urban renewal company, which was co-ordinator of the Hedebygade urban ecology demonstration project.

The city of Copenhagen is working with very ambitious plans for a 15% CO₂-reduction in 2010 (compared to 1990) and sustainability development. The CO₂ reduction aim has now been obtained so the task is now to increase it.

In connection to this, there is an ongoing effort to develop requirements and standards, to make demonstration projects and to participate in projects like "The European Green Cities".

5.2.4 Grenoble, France

The results of this project will be used for other OPAC 38's refurbishment programs. 2 refurbishment programs (454 dwellings) with solar panels and PV panels are yet scheduled. This project is an example concerning the technical solution but also concerning the renewable energies project management methods: tenants consultation, technical choices, call for tenders, performances guarantee, communication.

The project has been often presented in meetings. A lot of articles have been done concerning this project. The aim to have an exemplary project in France is really reached.

5.2.5 Herning, Denmark

A complex project involving several "green approaches" is bound to give some experience to architect and engineer, as well as building owner and constructors.

This project, being our second "green", is a well-founded basis for the next building of the same kind, already in the hands of consultants.

Our hope is, in time, to have a catalogue with all the relevant facts, economy and owners/users experience, in order to create a better foundation for future projects.

5.2.6 Hulshout, Belgium

Solar systems for hot sanitary water production are not very common in Belgium. The cost of such a system is rather high compared to the energy cost savings. Pay back times are thus quite high. More solar systems should be placed in case of lower investment costs or in case of governmental subsidies. The same can be said for mechanical ventilation with heat recovery. Most of those systems are quite expensive, especially the air ducts and the construction works are costly. In existing buildings it is not possible to install such ventilation systems. Condensing boilers are more and more common in new dwellings. In the renovation projects is more difficult to install those heating systems because of the low return temperatures needed.

The monitoring results of this project will be publicised in technical reports and brochures. These information (reports and brochures) will be distributed by the Flemish Government and the VHM (Vlaamse HuisvestingsMaatschappij) to architects, engineering companies, other social housing companies,

5.2.7 Kuopio, Finland

From the components and equipment of the Pirtti School project are ready to adapt to new construction projects:

- the thermal insulation of the building envelope and the superwindows
- LON-technology in building automation system for the control of ventilation and lighting
- mechanical ventilation after demand

The City of Kuopio was also responsible of the new building for the university education and high technology centre Microtekna. The LON-equipment was used in that project.

The use of LON-technology in access control seems to need more planning and development of the equipment.

5.2.8 Portsmouth, GB

The result of this refurbishment will be used to set standards for Portsmouth City Council's housing refurbishment policy. It is the aim to continue to improve energy efficiency of housing, which is a key part of the Local Agenda 21.

Portsmouth City Council has a development programme for CHP and district heating schemes which this project forms part of. On the back of the result of this installation two other housing estates within the city are to be considered for CHP.

5.2.9 Radstadt, Austria

The experience of the Radstadt project is used in several new housing projects in Salzburg, especially of the gswb (the biggest housing association in Salzburg) and also

The gswb does the monitoring in their own technical department and develop new programs for efficient and good monitoring.

The technical system of heat contribution in the building has become nearly standard in the now built houses.

The controlled air ventilation was used in Radstadt first in Salzburg and is now integrated in a lot of the new housing projects.

With the solar- collectors we are still learning how to situate them best in areas with a lot of snow in winter. Radstadt gave a lot of important know-how.

The politic in Salzburg was satisfied with the results of the Radstadt project and a second "Salzburger Modellwohnbau" was chosen in January 2000. In this housing project the experience of Radstadt shall be continued. Also a project committee co-ordinates the projects with about 90 new dwellings in the city of Salzburg, with solar architecture, controlled air ventilation and an own district heating plant with pellets.

5.2.10 Vilanova, Spain

Already five blocks of flats are being constructed which incorporate environmental criteria similar to the ones in El Llimonet. Three of them are from QUALITAT PROMOCIONS and two of them from another constructor of the city.

On the other hand, the outlook for the municipality is wide considering that they have applied a tax reduction during this project for environmental and energy saving buildings. A political effort will as well contribute to promote this kind of construction all around the municipality.

5.2.11 Volos, Greece

Because of the scale of this demonstrative project already the local engineers and Architects became very conscious about energy saving in the building sector and the awareness will be greater when the project will be fully in operation.

The Ministry of Environment and Public Works has asked details of the project and they want to promote it to other cities in Greece.

5.3 Commercialisation

Copenhagen, Denmark

Results of the Green Cities project and other projects concerning use of ventilation systems with heat recovery ventilation, where the relation between electricity use and heat saving is better than 1:8 (e.g. 30 W electricity use per housing unit and 90% thermal efficiency), has lead to interesting results. Afterwards it has been decided by the municipality of Copenhagen to propose heat recovery ventilation as a minimum standard in retrofit and new-built projects in addition to many other things. Based on the work on PV integration in practical projects, a large-scale PV-implementation plan for a whole city part with 40,000 inhabitants has now received the support, e.g. from the mayor of environment and the local authorities in Copenhagen.

As described in the previous material it has been possible to realise some very interesting demonstration projects according to the use of a sustainable global solar low-energy design in Copenhagen and other European cities in the European Green Cities co-operation.

Examples of best available technologies have been demonstrated in this project. But it is still a very difficult task to ensure a development where use of sustainable and global solar low-energy building becomes the used approach in normal projects, e.g. without EU-support. It is here that the work on defining a European Green Cities energy and environmental standard is very important. E.g. also inspired by the work in Copenhagen and the use of minimum requirements and recommendations but also looking at performance requirements and using the "Green Build" energy and environmental point system.

An important result from the European Green Cities co-operation has been the development of the "Green Build" energy and environmental tool, which can work as a "point" system where you give most points to the things you want to promote. This can be done for the areas: building site, materials, energy, water, waste, indoor air climate and general promotion of environmental issues.

In a new project, Green Solar Regions, a questionnaire has been made, where a large number of questions for each of the above areas had to be answered by the builders who wanted to buy land. In this way they had to deal with energy and environmental issues

from the start of their projects and they had to take it seriously as they were told that both the price of the land and the questionnaire would be judged when they came with their offer. So a competition of being most sustainable was started in this way. Also for the European Green Cities co-operation this is important because experiences can be gained by claiming a certain number of points in each area to reach a certain European Green Cities level.

In cooperation with SBS Urban Renewable and the Danish Building Research Institute, SBI a new project dealing with how to integrate energy efficiency, renewable and urban ecology in urban renewable projects has been started.

Besides the city of Copenhagen, also the city of Kolding and Ålborg is partners in this project.

Grenoble, France

It is difficult to evaluate the commercialisation effect but this project is a good communication support for the renewable energies network and for the professionals.

In France, there is now an important program to develop solar energy : the program name is "Plan Soleil". There are a lot of communication and financial helps from the national agency ADEME.

Herning, Denmark

Our need for commercialisation is partly motivated in a desire to be able to let out our 84 apartments now as well as in the future, and partly to inform the public of our attitude towards environment.

Kuopio, Finland

The use of passive solar energy for the preheating of the incoming ventilation air was not quite a success. The realised solar wall was planned by the Pirtti project team as a prototype. The construction of the sun collector was satisfactory, but the situation on the roof was chosen poorly. In Finland the use of solar wall is not common, because the northern climate limits the amount of sun hours and the power of the sun radiation. The result was that use of solar energy in the northern zone is possible but the equipment must develop and make many tests to have experience in medium size and large commercial, industry, and public buildings.

Portsmouth, GB

Home Energy Conservation Act (HECA) 1995 required every UK local authority with housing responsibilities to prepare, publish and submit an energy conservation report identifying practicable and cost-effective measures. Portsmouth City Council's report and action plan sets out a target to improve energy efficiency in homes throughout Portsmouth by 27% by the year 2006.

The HECA discusses energy efficiency, affordable warmth and local well-being as key topics. Whereas it is agreed that this should be achieved in unison the Government's other policy of fighting fuel poverty with the provision of cheaper domestic fuel does not coincide with the environmental objective of encouraging economic use of fuel. It has often been proven that cheap fuel result in an increase in fuel use to achieve higher indoor temperatures.

The solution is to 'ration' the amount of fuel that can be used by households or increase the promotion of the HECA providing households with more efficient appliances.

Radstadt, Austria

The project Radstadt-West was the first to connect the tasks of living-quality, ecology, architecture and economy in this consequence in Salzburg. It was chosen as the first "Salzburger Modellwohnbau" by the Salzburg-policy. This was very important because the discussion of this themes became a political theme. So the funding system got aspects of energy and ecology and a special funding for model-projects and research in this field was used for this project.

The results were positive, so the way shall be continued. A second "Salzburger Modellwohnbau" was chosen in January 2000.

Vilanova, Spain

- (a) El Llimonet building was commercialised during the period from September to November 1998. **Full commercialisation was completed in the first quarter of 1999.**

The commercialisation process was basically internal, among the co-operative's members. Public commercialisation was minimum.



Figure 5.2.: Diptych of EL Llimonet publicity.



Figure 5.3.: El Llimonet. February 2001.

A stand of El Llimonet ecological building and its characteristics was showed in the local Exhibition "November Exhibition 1998".

Though the prize factor brought about the commercial success of the building, the specific qualities related to both conventional construction and energy saving properties of the dwellings should be mentioned. **It must be also taken into account that this is the first building of such characteristics in the city.**

- (b) The persons who acquired a dwelling in the ecological building El Llimonet, will or have already assisted two meetings, where the main distinctive characteristics from a conventional building are explained, and the advantages incorporated specified.

It must be said that **the owner's attendance to the meetings is high, and they are mainly satisfied about the building's performance.**

6 LESSONS LEARNED/CONCLUSIONS

6.1.1 Abruzzo, Italy

The European Green Cities project in Abruzzo demonstrated how low energy interventions in buildings can produce economy saving results and an improvement in the management of the technological systems of the buildings only if tenants are involved and are available to cooperate in the projects.

In fact, economy saving results can be obtained with a good management of the technological systems in addition to a good manufacturing and installation.

A previous analysis of the type of users and of the intervention reality are important aspects for individuating and programming future interventions.

During the project activity, in connection with the activity of the European Green Cities Network, general guidelines of how to integrate energy saving measures into retrofitting projects were prepared.

The designers and the contractors could acquire specific experience about the application of innovative building technologies.

6.1.2 Brescia, Italy

ALER Brescia learned that high energy saving can't be obtained in buildings where the energy consumption is originally quite low comparing to other buildings in the city of Brescia.

Moreover the innovation of the technological systems requires special competence for maintenance and a higher cost for plants conduction and management.

Solar system for DHW production is not very cost-efficient in Brescia because of the presence of the local district heating network that is a high efficiency system and it provides good cost rates for heat supply. The buildings were not adapt to apply solar systems for DHW production. Comparing to this reality a solar system for DHW production resulted not cost-efficient. The project demonstrated that in Brescia can be certainly more cost-efficient to realise solar systems for both space heating and DHW production.

In this case the integration with the local district heating network peraphs could be more efficient.

The designers, the contractors and the builder could acquire specific experience about the application of innovative building technologies.

Another lesson learned concerns the development of a project taking into account that the apartments are occupied by tenants.

6.1.3 Copenhagen, Denmark

Since 1996 the Danish energy and environmental specialist company Cenergia has together with the municipality of Copenhagen and other municipalities in the Copenhagen region been involved in practical oriented projects concerning implementation of solar energy and urban ecology planning.

An important basis of this has been the involvement in the European Green Cities cooperation, starting with the European Green Cities EU-Thermie target project from 1996 and followed up in connection to the Green Solar Regions, EU-Energie project from 2000 and new cooperation within the European Green Cities Thematic Network.

It has been a very important thing for the municipality of Copenhagen to be directly involved in the European Green Cities cooperation and there is no doubt that this involvement has had an influence f.ex on the development of minimum energy and environmental standards for public supported building in Copenhagen. For the SBS Urban Renewable company there has been interesting results in connection to the demonstration project but also concerning use of the Optibuild and Greenbuild tools work has continued on this by support from the Danish Ministry of Housing. An important lesson has been that it is extremely important with clear performance quality demands for the best available technologies and check systems concerning this.

6.1.4 Grenoble, France

The most important lesson concerns the role of the local partners : it is very important to have a good consultation with all the partners, particularly the energy associations representatives because there is a risk to have a lot of unexpected problems.

The architectural integration was an important theme to convince about the architectural possibilities of renewable energies. It is important to have a good architectural integration to keep a good aesthetic and not to transform the site to have an industrial site.

Moreover, this project has to implement an energy and friendly environmental policy by the use of renewable energies and by the way develop a dynamic information process towards inhabitants.

This site is a reference in France for solar energy with a lot of visits, press articles or TV programs. Other local authorities representatives have visited the site and some of them have renewable energies installation project.

The monitored results are good and the OPAC 38 has other retrofit programs or new buildings projects with total energy approach, thermal solar panels and PV modules.

6.1.5 Herning, Denmark

An overall experience is, that in order to monitor each approach in years to come (to optimise and to learn about payback-times), it's necessary to implement a large number of measures (meters), and a number of possibilities to make adjustments.

A final note would be, that while building dwellings, it's very important to keep costs at an acceptable level, and so it can be economic difficult to implement expensive approaches, even though there most likely will be savings in consumptions each year.

6.1.6 Hulshout, Belgium

The general objective of social housing companies is to build houses for low-income people at reasonable costs. Mostly limited attention is paid to energy saving technologies. Energy saving is, however, important because of the limited family budget and because of the important share of energy costs in the budget. This project paid special attention to energy savings and sustainable building at acceptable incremental construction and installation costs while maintaining a high level of comfort.

Construction of energy efficient houses is however not so easy. Installers have to learn new equipment, installation is mostly more difficult, tenants have to know how to handle new systems, These facts have of course an influence on the efficiency of the new systems. Some elements are not proper installed, control settings are not right, The expected efficiency is not reached. One has to control the different system, explain working conditions to tenants, check again, ... before expected efficiencies are measured.

So the most important lesson for this project is: it is very important to control and check the installations and to measure energy consumption and energy efficiency of the system. Problems can be detect and solved in the right time.

6.1.7 Kuopio, Finland

The results of the demonstration are described in chapters 4 and 5. The builder is satisfied to the results although the pre-set numeral energy saving goals were not fully achieved. The investment and job for the demonstration project will be paid back both as energy savings in the Pirtti School and as acquired knowledge and experiences for other building projects.

The main conclusions were:

- the good mechanical ventilation is important for the good indoor air quality, which is also health factor in school buildings
- the distribution of the energy consumption is possible to examine only by measuring, not by calculating
- when the price of electricity is going up faster than the cost of heating, the energy consumption of lighting and mechanical ventilation machines must be observed

- the use of solar energy should be developed by further demonstration projects
- the cheap energy causes the long pay-back time of the saving investments

6.1.8 Portsmouth, GB

The structural problems identified early in the project (see section 3.3) have highlighted a potential problem with system built structures of this type. It should be common procedure that large proportions of the structure is very carefully inspected to prove that the building meets its original design criteria and is able to support any additional loading proposed.

Despite being normal procedure the refurbishment of an occupied building can be very time consuming and the programming of works becomes critical. It is important to be specific in output expected by the contractor. Firm completion dates should be stipulated and high penalties incorporated into the contract for failure to meet these completion dates.

To enable a true evaluation of tender returns project programmes should be prepared and submitted in detail by the contractor.

This project is a 'green' project using measures and technologies with which a building contractor is not necessarily familiar. The delay in completion by the contractor could for some part be attributed to this. It could be a criteria for selection of contractor that they are familiar with energy efficient measures and that they previously have been involved in similar work. Alternatively or in combination with, a meeting could be held at contract start between the contractor, local authority and the M & E consultant to go through the design and the purpose of the works. Any critical issues and/or the importance of aspects of the contract can be discussed and assistance given to the contractor at an early stage.

Despite the problems and delays to this project it is our firm believe that the completed project will meet its design specification. It is already being considered to carry out similar refurbishment work to the twin building of Leamington House – Solihull House.

6.1.9 Radstadt, Austria

The detailed technical project results are listed in the technical part.

The main technical innovation of the project were:

- Optimised heat insulation
- Passive solar use
- Controlled air ventilation with heat recovery
- Ecological heating system with a wood-sheet-district heating and solar panels
- Efficient heating technology and distribution in the building
- Collection and use of rain-water

In the preparation and organisation of the project also some new points were mentioned:

- A neutral project co-ordination of the SIR
- A project committee deciding all important questions together
- A good preparation with a architectural study and an architect-competition
- A study to chose the ecological and economic best material

The most important lessons we have learned:

- Local funding for research in housing is best to use for projects to be realised

- They are the motor for innovations and base for projects worth to be supported from the EU and be part of a green city network
- Very important is a consequent co-ordination and project management
- The project committee was very useful for best information of all partners but also for crises-management
- A good heat insulation and innovative heating technology causes low heating and maintenance costs for the tenants.
- Energy-saving building technology and heating does not automatically causes higher building costs
- Controlled air-ventilation and modern heating technology increase the living comfort and the air quality
- Controlled air-ventilation and modern heating technology have to be further developed to became standard in modern buildings

6.1.10 Vilanova, Spain

The project has demonstrated that it is possible to design and build an environmentally friendly building area, following acceptable market prizes.

The result is not only a reduction in the building's energy consumption, but also an improvement of the quality of life in the dwellings. (The response of the buildings was deeply improved by optimising the solar characteristics to create a better living environment, which helped to achieve the expected energy reduction).

About the technical installation

One of the lessons learned related to the collective heating and hot water system, is that there is no tradition in this country for such installations, therefore the cession into the individual system was the logical step to achieve the required balance between energetic response, economic constraints and social acceptance.

The extra cost of solar collectors and appliances to the system is reasonable, but only if the hot water system works under an appropriate maintenance. The extra cost is overcome in a rather short time, and the reductions in energy used for this purpose are about 65% in most cases.

About the market acceptance

Regardless of the commercial results previously mentioned, and the spreading actions towards the users, it must be emphasised the good acceptance among the owner's for the fact of acquiring the dwelling.

However, it is at the moment too soon to talk about experiences, critics or praises of the owners towards their dwellings.

Another important thing is the internal repercussion among Qualitat Promocions associates. During ten years the co-operative has been working in dwellings construction, not considering environmental criteria until year 1997. So that at the moment two blocks of 58 flats that incorporate sustainability criteria have been delivered, apart from El Llimonet building.

This decision has had positive effects on the associates arouse, which are more than 1.000 families, as it shows an inquiry that has been recently done (December 2000) among the Qualitat Promocions dwellings' owners.

In this context, specific aspects related to sustainability criteria in dwellings' construction have been asked. Regardless of that these aspects were not included in the asked owners' dwellings, they found very positive the possibility to have them included:

- In particular 65% of inquired people, who acquired the dwellings during the last year, think that it would be good to include sustainable elements.

To summarise, it can be concluded that:

- The client's demands for the next years point to a preference for sustainable buildings, which might increase as its knowledge is spread among the citizens.
- At the same time, the promotion and construction sectors are slowly pointing also to this direction. The following aspects are increasingly being included in buildings:
 - renewable energies
 - water saving measures
 - more ecological materials.

In general, the buildings tend to a more rational use of energy and more environmentally friendly buildings. As long as the acceptance among users is good and its demand increases, efforts of the constructors will follow this trend, which is completely desirable.

6.1.11 Volos, Greece

Four completely different buildings were rehabilitated in the framework of this project. Three old industrial buildings were transformed to satisfy public cultural purposes (i.e., museum, cinema, library, video wall room, exposition hall) and an old useless grain sanitation building was transformed to a live bioclimatic building.

Several energy saving applications were incorporated in those buildings and energy monitoring is just starting. The expected energy savings can be up to 70% in some cases. However the most important gain from those applications is the experience gained by the local engineers and important long term benefits are expected from the replication of such application in other municipal and private buildings.

7 PERSPECTIVES

7.1 *horizontal activities.*

The EU-Thermie target project in the building sector has been realised as a new innovative concept where it has been possible to realise demonstration projects, which does not have the main focus on addressing the demonstration of new innovative technologies but instead addresses the organisation of and market for sustainable solar low-energy building in Europe.

The benefits of this type of projects are that it then becomes possible to realise demonstration projects which have some overall energy saving goals as their aim and in this way it is very instrumental in developing of real market for sustainable solar low-energy building in Europe. This approach will e.g. be very relevant in connection to the new EU-member states, where it is not as important to demonstrate a new kind of advanced solar heating system as it is to demonstrate an overall optimised energy efficient thermomodernisation of old buildings.

Unfortunately it is the experience that the normal evaluation system concerning EU-supported demonstration projects does not give priority to such issues which makes it difficult to realise new European demonstration projects in the building sector of this kind.

In connection to the European Green Cities project, new tools which can support global sustainable solar low-energy building policies in practice have been developed. Examples of this are the Optibuild tool, which can be used to make lifecycle costs optimisation and which can be downloaded e.g. from Cenergia's homepage www.cenergia.dk and the Green Build tool, which works as an energy and environmental checklist and point system that can be used interactively from the www.greenglobal.com website.

At the same time suggestions have been made of a European Green Cities sustainable and energy efficient urban planning and building process, which focus on introducing quality measures to ensure the wanted results from solar low-energy building projects.

The here mentioned ideas have at the same time been used in connection to an international cooperation within the International Energy Agency, IEA, concerning a possible new cooperation task on "whole buildings".

Since 1996 the Danish energy and environmental specialist company Cenergia has together with the municipality of Copenhagen and other municipalities in the Copenhagen region been involved in practical oriented projects concerning implementation of solar energy and urban ecology planning.

An important basis of this has been the involvement in the European Green Cities cooperation, starting with the European Green Cities EU-Thermie target project from 1996 and followed up in connection to the Green Solar Regions, EU-Energie project from 2000 and new cooperation within the European Green Cities Thematic Network.

In connection to the European Green Cities cooperation the aim has been to work with principles and tools that can be used to promote the use of a global energy and environmental concepts in connection to urban planning in the cities, also aiming at obtaining an improved indoor air climate.

As an important inspiration here, the European Green Cities partners has in several years been inspired from an innovative funding system from Austria which was used in the Salzburg region to promote good solution by help of "energy points".

In Figure 7.1 it is illustrated how you can get an improved financing of your building projects by help of energy points in such a way that you get 200 ATS per m² for each point you obtain.

In Figure 7.2 you can see how this has affected use of low-energy features (9% improvement) and use of solar collectors (increased use from 9% to 44%).

In the European Green Cities project work has been made to develop and present tools for lifecycle costs optimisation and promotion of sustainable and energy efficient building.

Another important experience gained in connection to the European Green Cities cooperation has been to agree on the importance of improving the quality and the follow-up in connection to realised projects where best available technologies are used as part of a global solar low-energy design concept.

At the European Green Cities final partner meeting in October 2000 in Kuopio in Finland it was agreed to focus on this e.g. like in the following:

"Performance Indicators" and "Quality assurance"

An innovative approach for the European Green Cities cooperation could be in cooperation with interested cities/builders to identify

- Performance indicators for best practice technologies.

- To agree on aimed values of performance indicators and methods of monitoring these.

In this way also verifying the aimed at saving results.

The following areas could be in focus here:

- Inspection procedures to avoid coldbridges and ensure air tightness of constructions.
- Principles for energy labelling of windows.
- Definition of maximum electricity use for ventilation and definition of electro thermal relation for heat recovery systems (relation between electricity use and heat saving).
- Introduction of PV-modules for combined electricity and heat production (f.ex. by preheating of ventilation air), and norms for this.
- Use of principles for guaranteed results for solar energy systems by EMS or similar survey systems.
- Norms for maximum electricity, heating and water consumption, and registration equipment towards users/tenants.
- Supply and demand optimisation concerning energy use in low energy building projects (e.g. with a low cost heat supply system in low energy housing projects).

General use of Energy Management Systems to ensure a quick follow-up and optimised operation. Can be used to produce “energy signatures” in European projects by direct link to monitoring coordinator.

H:5401098/fbr/engl.doc

Funding system with „energy points“

class	Houses for 1 or 2 families or farmhouses	Other houses	valuation							total	
			insulation	heating		Solar-energy	Low-temperature heating	Heat-recovery			
				Heizlast W/m ² BGF	Heizlast W/m ² BGF				Biomass		Heating-pump
0 ⁵⁾	>70	>55	0	-	-	-	-	-	-	-	-
1	70-66	55-52	1	-	-	-	-	-	-	-	-
2	66-62	52-49	2	-	-	-	-	-	-	-	-
3	62-58	49-46	3	3	1	2	1	1	1	1	1
4	58-54	46-43	4	3	1	2	1	1	1	1	1
5	54-50	43-41	5	3	1	2	1	1	1	1	1
6	50-46	41-39	6	3	1	2	1	1	1	1	1
7	46-42	39-36	7	4	1	3	1	1	1	2	2
8	42-38	36-33	8	4	1	3	1	1	1	2	2
9	38-34	33-30	9	4	1	4	1	1	1	3	3
10	<34	<30	10	4	1	4	1	1	1	3	3

Funding = total points x \$ 200,- each m²

Figure 7.1

Heizlast - Calculation

Area	x U-value	x Faktor	= AXUXF (W/K)
of the wall			
Window		0,15 for floors to the ground	
Roof		0,5 for walls to the ground and cellar Otherwise 1,0	
Total:			$\Sigma AXUXF$ (W/K)
Additional:		Heat loss because of necessary fresh air	+P1
		0,14 (W/m ³ K) for singlehouses, 0,18 (W/m ³ K) for bigger houses	
Climate dates		Difference between temperature inside and outside	x Δt
Total energy-need for heating			Heizlast (kW)
Classification		Calculated for each m ²	W/m ²

Figure 7.2

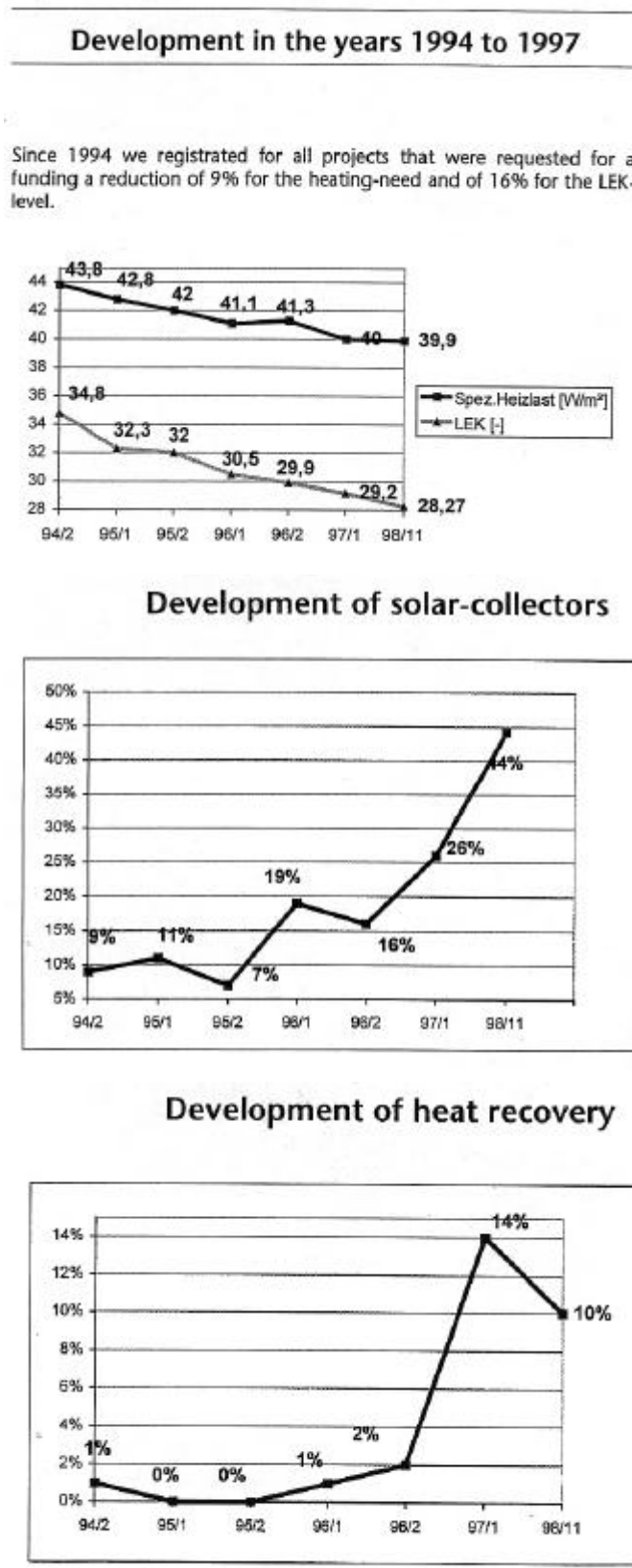


Figure 7.3

During the realisation of the European Green Cities project a training process has taken place, going on towards the involved cities and builders and this has led to an agreement that it is important to focus more on using tools like the developed Green Build tool to promote good energy and environmental solutions in the cities and discussions have taken place of actually use energy and environmental points for this, e.g. by introducing different European Green Cities quality levels by help of the energy and environmental points.

The ultimate solution here would then be to support a development where these energy and environmental points could also be used as basis of obtaining an improved financing, like e.g. in Austria for the energy points. In the ongoing European Green Cities Thematic Network focus on this in the form of a Green Build financing system is an important task (See also: www.europeangreencities.com).

A tool for total economy optimisation of building projects "Optibuild" has been developed and used for all the European Green Cities projects, this can now be downloaded from either Cenergia's own website: www.cenergia.dk or the ecobuilding website: www.ecobuilding.dk. In addition to this the above mentioned Green Build concept has been developed with an introduction to performance verification principles and a Green Build questionnaire/check system concerning ecological and energy efficiency quality, which at the same time can be used as an energy and environmental point system. An initial version of this can be studied at the greenglobal21.com website, which can be reached at www.greenglobal21.com.

In cooperation with the municipalities of Copenhagen/Glostrup and Roskilde who are all partners in the European Green Cities cooperation, practical work concerning the use of the Green Build principle has later been made in connection to a new EU-Energie projects Green Solar Regions in Copenhagen in connection with urban renewal and a school project, in Glostrup in connection to sale of land and in Roskilde in connection to the development of a large city development area "Trekroner", where e.g. an ecological housing project "Munkesøgård" with 100 dwellings has now been realised. A part of the Trekroner area is also in 2001 used as the Danish part of the EU-Altener supported "solar energy planning" architectural competition, Insolplan (see also www.eu-competition.org).

Finally it should also be mentioned that there has been special focus on improved indoor air climate and use of healthy building materials in the European Green Cities project.

In the following chapters there is more detailed information on the issues mentioned.

7.2 The "Green Cities" global energy and environmental optimisation concept.

7.2.1 Introduction

The main idea of the global energy and environmental optimisation concept in connection with realisation of building projects is that an optimisation of the following conditions should always be made:

- Energy savings;
- Energy demand and supply optimisation;
- Indoor air climate;
- Use of building integrated solar energy;
- The energy supply system;
- An overall sustainable building design, including use of healthy building materials;
- The total lifecycle CO²-emission.

– Local energy and environmental management

Furthermore the global energy and environmental optimisation concept includes a concept for follow-up and documentation of the chosen solutions and a general initiative concerning optimisation, which also includes water use, wastewater, building waste and waste handling in general.

The background to focus on the global energy and environmental optimisation concept is many years of work between Cenergia and other European partners, in the European Green Cities cooperation, concerning use of building integrated solar energy in practical building projects, where the demand for a wider and more general energy-saving and environmental-oriented effort has become apparent. At the same time we are in the unfortunate situation that energy savings are not taken very serious today. In connection with new building and rehabilitation projects they are usually just considered in the heating, water and sanitation department in a consulting engineering firm, which do only focus on a normal building design and normal technical solutions. And architectural companies do often focus more on nice architectural designs than considering energy and environmental issues.

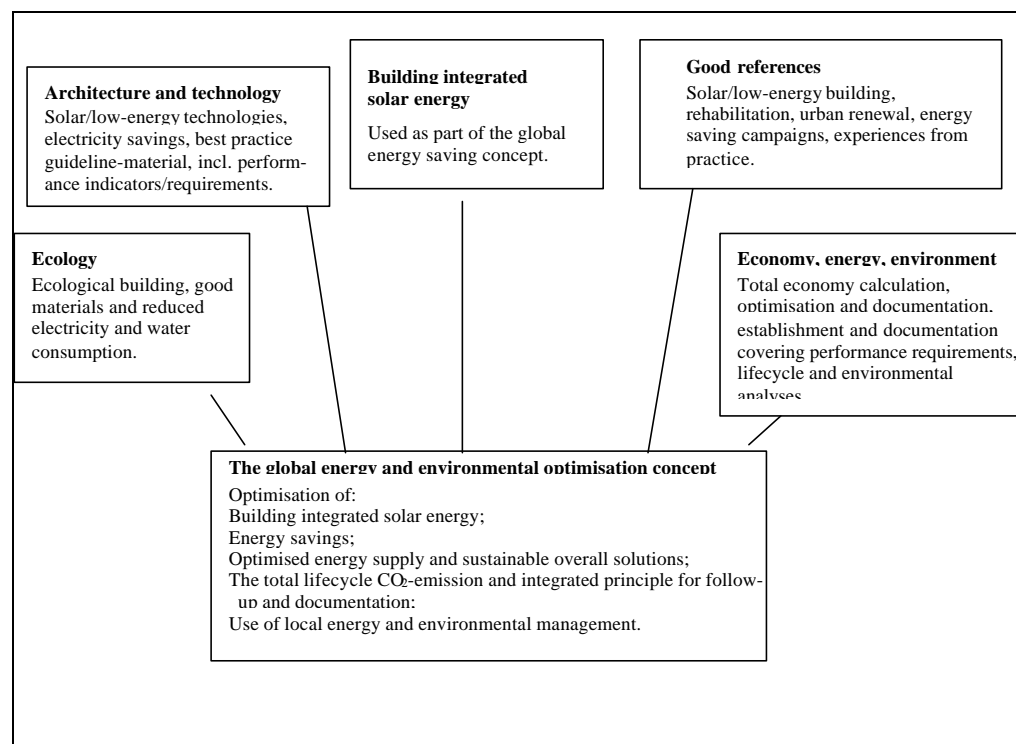


Figure 7.4: Principles of the global energy and environmental optimisation concept.

In Denmark and other European countries, general principles of an environmentally acceptable design have already been developed. And these can be used as a working method, if you would like to secure a positive effort concerning energy and the environment in specific building projects. However, there are still insufficient specific contents and practise for application of expert know-how in practical building projects and it is also needed to include a focus on an optimisation of the total economy of building projects concerning the balance between investment costs and operation and

maintenance costs. There is also a need to agree on performance requirements for best practice technologies and principles of how to document these.

When you want to make a global optimisation of e.g. low-energy building projects it is very important to have a reliable “quality model”, which can be used to compare different types of energy saving measures and which can support performance demands you will define e.g. in the form of keyfigures you will have to live up to either for each area alone or as a well-documented overall demand. Here special quality figures can be introduced based on an assessment by help of the above mentioned quality model.

In the following there is a suggestion on how use of building integrated solar energy and the global energy saving concept can be implemented in practice. To realise this in the most efficient way EU-funding has been obtained to realise an EU-Save project, where a catalogue or manual is developed with a definition of performance indicators and performance requirements/recommendations for best practice technologies, including check systems, the “Green Catalogue” project.

7.2.2 Sustainable urban planning and management by means of the newly developed energy and environmental rating system “Green Build” in connection to a “Green Cities” sustainable building process.

“Green Build” is an energy and environmental rating system for buildings, focusing on use of healthy and sustainable urban planning and sustainable building materials and optimisation of heat, electricity and water consumption, energy supply, indoor climate and waste treatment.

The idea about development of an energy and environmental rating system took its start in the attempt to make a classification system (by rating) of healthy building materials for in-door use in connection to the European Green Cities cooperation. This work was made in a cooperation between environmental coordinator Jan Kaare Oxlund, architect Klaus Boyer Rasmussen, SolarVent and Peder Vejsig Pedersen from Cenergia. It was after a while recognised that the best way to promote healthy building materials was by using an “energy and environmental point” rating system, which we have named “Green Build”.

On the basis of a holistically oriented recommendation list for constructions, which was made at the same time, it was then decided that the “energy and environmental point” rating system could be expanded to all recommendations. Pointing towards more sustainability and then applying the rating system “Green Build” to elements from this recommendation list.

This was done in order to present an operational tool for sustainability evaluations to decision makers, builders, engineers and other people involved in designing building projects of all sizes, from single houses up to whole urban areas.

It was at the same time the idea that documentation of individual solutions would then be simple to compare from case to case, e.g. for the European Green Cities cooperation. This means that the individual cities in the European Green Cities Network could have this energy and environmental rating system as one of their working platforms.

The “Green Build” system is in the beginning most likely to be used in connection to new urban development plans, which are dealing with newly-built or retrofit building projects.

But in principle it should also be possible to apply the system for large existing city areas in general.

It is a quality with this tool that you are not forcing people to use certain materials or components, but instead you are promoting good solutions by connecting the highest number of “points” to these. In the involved cities it is then possible to increase the demands by increasing the number of points that are necessary and in this way you can introduce a sustainable city development in the speed that suits the individual involved cities.

This means that the use of the “Green Build” tool can be an option for a green urban management system that can actually work in practice and it could form the basis of an actual “European Green Cities” labelling or certificate system.

At the moment the “Green Build” tool is being applied in actual urban development projects in the two Danish cities Glostrup and Roskilde as part of the EU-Energie funded Green Solar Regions project. In the city of Copenhagen, the Green Build is used in connection to an ecological urban management plan in the city part of Valby.

Tools for sustainable urban behaviour

The practical tools we can use in connection to sustainable urban management are the following:

- Green accounting directed to end users, e.g. according to SBI’s method, which is already being used several places until now;
- Environmental declaration of building materials and systems;
- Environmentally friendly management and design systems together with sustainability evaluations;
- The ”Optibuild tool” (includes life cycle cost optimisation);
- An “energy and environmental point” system to promote and evaluate environmental performance in a simple way (“Green Build” system);
- Life cycle analyses in general e.g. using the BEAT tool from SBI;
- Environmental rating systems like Green Building Challenge.

The green accounting includes input/output of:

- Heating;
- Electricity;
- Water/waste water;
- Solid waste;
- CO₂;

This practice with green accounting can be used at an advantage in the building phase and when the houses are occupied and it is often considered as a practical way to start an environmental rating system.

”Green Build” is divided into the following areas:

- A. Methods of sustainable urban management;
- B. Urban development area, including site, infrastructure, energy/supply and immediate environment;
- C. Waste management;
- D. Materials;

E. Energy efficiency and renewable energy;

F. Indoor climate conditions;

G. Water.

The first three of these (A, B and C) are areas where the involved city and municipality are evaluated in connection to urban management, site and waste management.

The remaining areas concern the individual building projects. Here it is especially difficult to handle and evaluate "Materials" (D) and for the moment mainly the general conditions here will be looked at. Generally the "Green Build" system gives most points to the solutions that one would like to encourage.

In connection to each of the above-mentioned areas it would be possible, together with the involved cities, to define different "Green Build" levels, which can be defined as a target for how important it is to have sustainable solutions introduced in the different areas.

Then it is possible for a certain city or a certain urban development area to judge which minimum demands for energy and environmental points they want to introduce, and the chosen level can then based on experiences be regulated later.

In the beginning it seems most relevant to use agreed upon "energy and environmental point" levels to ensure documentation concerning minimum demands for a sustainable development in new urban development areas and building projects.

Generally the points are given on the basis of the following conditions:

- Outside environmental considerations;
- Indoor environmental considerations;
- Characteristics of materials (sensitivity of smell/particles);
- Energy to production;
- Prevalence of materials and regeneration;
- Functional and physical suitability;
- Operation and maintenance;
- Social circumstances.

An interactive version of the Green Build tool and a Green Build questionnaire can be found in the website: www.greenglobal21.com.

In Figure 7.5 is shown an illustration of the energy part of the Green Build tool.

In the following is shown a proposal for "urban ecology planning, design, building and follow-up" in connection to a Green Cities sustainable and energy efficient building process, which was agreed to be a good approach at an European Green Cities meeting in the city of Kuopio in Finland in October 2000.

E) Energy	PHASE 1	PHASE 2
1. The building project is being coupled to the local district heating [1]	<input type="checkbox"/>	<input type="checkbox"/>
2. User controlled mechanical ventilation with heat recovery of outlet air is installed. The thermal efficiency rate must be at least 80% and the electrothermal ratio ⁹⁾ must be at least 1:8. Power consumption max. 40 W and noise level from the installation must be below 25 dB [5]	<input type="checkbox"/>	<input type="checkbox"/>
3. Individual consumption displays are installed [2]	<input type="checkbox"/>	<input type="checkbox"/>
4. The number of hot water taps are limited and are placed centrally with short and small diameter tubing [2]	<input type="checkbox"/>	<input type="checkbox"/>
5. Main meters are placed at the entrance of each main plot of land, so losses from the distribution system can be monitored [1]	<input type="checkbox"/>	<input type="checkbox"/>
6. It is documented to the municipality that the heating system in the house ensures maximum cooling of district heated water and with the lowest possible return temperature [1]	<input type="checkbox"/>	<input type="checkbox"/>
7. Energy consumption for heating below ⁶⁾ 46 kWh/m ² is documented [2]	<input type="checkbox"/>	<input type="checkbox"/>
8. Energy consumption for heating below ⁶⁾ 40 kWh/m ² is documented [2]	<input type="checkbox"/>	<input type="checkbox"/>
9. Energy consumption for heating below ⁶⁾ 35 kWh/m ² is documented [2]	<input type="checkbox"/>	<input type="checkbox"/>
10. Energy consumption for heating below ⁶⁾ 30 kWh/m ² is documented [2]	<input type="checkbox"/>	<input type="checkbox"/>
11. Energy consumption for heating below ⁶⁾ 25 kWh/m ² is documented [2]	<input type="checkbox"/>	<input type="checkbox"/>
12. If a domestic hot-water tank is installed, this should be of the standardised type prepared for solar collectors [1]	<input type="checkbox"/>	<input type="checkbox"/>
13. A solar collector for domestic hot water is installed. Sized for 100% coverage in the summer period [3]	<input type="checkbox"/>	<input type="checkbox"/>
14. The housing design is performed in a way that maximises the contribution of passive solar energy without reducing the comfort in periods with high solar exposure [1]	<input type="checkbox"/>	<input type="checkbox"/>
15. Use solar walls as an alternative to conventional façade solutions – for example for preheating of ventilation air [1]	<input type="checkbox"/>	<input type="checkbox"/>
16. Integrated solar protection is installed where passive solar energy is utilised [1]	<input type="checkbox"/>	<input type="checkbox"/>
17. Both hot- and cold water taps are installed at washing- and dishwashing machines [1]	<input type="checkbox"/>	<input type="checkbox"/>
18. All white goods must be certified as “low-energy” types ⁷⁾ A. (As white household electrical appliances goods is understood freezers, refrigerators, kitchen range, washing- and dishwashing machines and tumbler drier [2]	<input type="checkbox"/>	<input type="checkbox"/>
19. Low-energy basic lighting is installed. Supplied with user-activated specific lighting [1]	<input type="checkbox"/>	<input type="checkbox"/>
20. Electricity savings amounting to 10% lower than normal is planned ⁸⁾ (Documented) [2]	<input type="checkbox"/>	<input type="checkbox"/>
21. Electricity savings amounting to 20% lower than normal is planned ⁸⁾ (Documented) [2]	<input type="checkbox"/>	<input type="checkbox"/>
22. A local, covered clothes drying ground is established [2]	<input type="checkbox"/>	<input type="checkbox"/>
23. Tumbler driers are not installed [1]	<input type="checkbox"/>	<input type="checkbox"/>
24. Tumbler driers of the condensing type is installed [1]	<input type="checkbox"/>	<input type="checkbox"/>
25. Only low-energy bulbs are applied [1]	<input type="checkbox"/>	<input type="checkbox"/>
26. Solar cells as power supply for circulation pump in the solar heating system is installed [2]	<input type="checkbox"/>	<input type="checkbox"/>
27. Solar cells as power supply for the ventilation fans are installed [2]	<input type="checkbox"/>	<input type="checkbox"/>
28. Grid-connected solar cells are installed [3]	<input type="checkbox"/>	<input type="checkbox"/>
29. Movement-activated lighting is installed [1]	<input type="checkbox"/>	<input type="checkbox"/>
30. Low energy lighting is installed in all common areas [1]	<input type="checkbox"/>	<input type="checkbox"/>
31. Common covered drying grounds are established at the different block of flats [2]	<input type="checkbox"/>	<input type="checkbox"/>
32. A common laundry is established [1]	<input type="checkbox"/>	<input type="checkbox"/>
33. Low temperature floor heating [1]	<input type="checkbox"/>	<input type="checkbox"/>
34. Energy management system survey [2]	<input type="checkbox"/>	<input type="checkbox"/>
35. Energy optimised windows, U-value of total window below 1.2 W/m ² °C [3]	<input type="checkbox"/>	<input type="checkbox"/>
36. Use of condensing boilers [2]	<input type="checkbox"/>	<input type="checkbox"/>
37. Biomass based district heating [2]	<input type="checkbox"/>	<input type="checkbox"/>
38. Heat pumps with COP over 3.0 [2]	<input type="checkbox"/>	<input type="checkbox"/>
39. Local CHP plant [2]	<input type="checkbox"/>	<input type="checkbox"/>
40. Primary energy use which is not coming from renewable energy is less than 120 kWh/m ² . year [3]	<input type="checkbox"/>	<input type="checkbox"/>
41. Deviation of the longest building facade from south is less than 45° [2]	<input type="checkbox"/>	<input type="checkbox"/>
42. As a mean solar energy irradiation to buildings should not be reduced by more than 20% because of shadows, orientation and topography [2]	<input type="checkbox"/>	<input type="checkbox"/>
43. The relation between building surface A and volume V should be A/V < 0.65 m [2]	<input type="checkbox"/>	<input type="checkbox"/>

Figure 7.5. Illustration of the energy part of the Green Build questionnaire/checklist, which can at the same time be used as an energy and environmental point system.

Proposal for a “Green Cities” energy efficient urban ecology building process.

1. Urban planning and sketch design situation.

Green Build procedure – use of Green Build tool.

- The Green Build tool can be used as a checklist including identification of energy and environmental points in 7 different areas.
- The results will be compared with the proposed Green Cities standard, e.g. as levels between A and M. Also comparison to local standards.
- Difficult areas as “materials” will be evaluated compared to the actual kind of case type.
- Possibility of improved financing based on point levels should be investigated.

2. Initial design including costs.

PO procedure – performance optimisation.

- By help of the Optibuild tool a calculation of the reference project is made together with a total economic optimisation where investments are optimised in comparison to operation and maintenance costs.
- The aim of the Optibuild calculation is to identify the most cost-effective energy saving package.
- On the basis of the Optibuild calculation an energy signature is calculated for the reference situation and for the proposed project.
- Possibilities for electricity savings in combination with use of photovoltaics are investigated. Qualitative solutions are identified by help of the Green Build tool.
- There is a special need to focus on a good ventilation design to avoid moisture problems, emissions from materials and bad user habits.

3. Detailed design and building project.

PV procedure – performance verification.

The Green Build and Optibuild tool can be used to document the quality and a “performance verification” process is part of the design work. In this specification of performance demands and performance indicators are documented, e.g. defined in a “Green Cities manual. Also quality assurance procedures are important here. E.g. by means of “specialist” companies to check design and tender material, and inspection procedures and performance tests by such “specialists” as part of the building process.

E.g. cold bridges, airtightness, ventilation design, solar energy and heating systems, electrical appliances, water systems and waste handling can be checked here.

4. Commissioning and green auditing.

The Green Build and Optibuild tools can be used to evaluate the project and document the results, e.g. based on actual building project, prices and actual savings.

An energy survey system can be used to ensure follow-up and a continuous registration of an energy signature. The energy signature is going to be calculated with respect to measured exhaust air temperatures (indoor air temperature level), weather conditions and user assessment.

Based on this the measured energy signature can be compared with the expected energy signature. Payment for consultants and contractors can be increased on the basis of good final results, e.g. after one year's operation where also a green audit is made.

“Green Cities” performance indicators and quality assurance.

In connection to the necessary work on “performance indicators” and “quality assurance” it can be mentioned that it has been agreed to focus on the following aspect in connection to decisions made at a European Green Cities meeting in Kuopio in October 2000.

The following areas could be in focus here:

- Inspection procedures to avoid cold bridges and ensure air tightness of constructions.
- Principles for energy labelling of windows, including check of U-values of complete windows.
- Definition of maximum electricity use for ventilation and definition of electrothermal relation for heat recovery systems (relation between electricity use and heat saving).
- Introduction of PV-modules for combined electricity and heat production (e.g. by preheating of ventilation air) and norms for this and for electricity production from grid connected PV-modules.
- Use of principles for guaranteed results for solar energy systems by EMS or similar survey systems.
- Norms for maximum electricity, heating and water consumption, and registration equipment towards users/tenants.
- Supply and demand optimisation concerning energy use in low energy building projects (e.g. with a low-cost heat-supply system in low energy housing projects).
- General use of Energy Management Systems to ensure a quick follow-up and optimised operation. Can be used to produce “energy signatures” in European projects by direct link to monitoring coordinator.
- Definition of maximum heat losses for buildings in dependence of average outside temperatures in the heating season.
- Definition of minimum efficiency of heating systems, including distribution losses.

7.2.3 Global energy optimised building projects

The experience in Denmark since the oil crisis in 1973 is that on one hand it has been possible to introduce considerable savings on the energy consumption for heating and hot water by means of the legislation, e.g. the building regulations. On the other hand it has been difficult to create a marked for real low-energy building and total economy optimised building, where additional investments in energy saving measures have been made due to relatively high energy prices, to obtain a reduction of the current operating costs.

In most building projects the reason for this is that it is difficult to get additional money to invest in energy-saving measures as the budget often is fixed and the builder does not get any advantages by saving energy. At the same time there are at present no guarantees that you actually obtain the savings that theoretical calculations show.

It is, however, possible to reach far as regards introduction of considerable energy saving measures in buildings, if you are not only looking at the individual energy saving measures separately, but instead aim at a large overall energy-saving package. An important question in this connection, is how to optimise the use of energy saving measures compared to the necessary investments in heating systems and heat supply systems. And by making a consumption and supply optimisation at the same time, you can in many cases get a considerably improved economy for the energy saving measures you prefer; so a present economy calculation of your project can become very favourable.

By use of a combination of the most economic insulation, new types of low-energy windows with a considerably reduced heat loss compared to previous and mechanical electricity saving ventilation systems with counterflow heat recovery in buildings today, the heat demand will be very low, maybe only approx. 2 kW for a rather small housing unit. This is almost equal to the heat from the cooker when it is turned on.

Here it is obvious to use alternative energy supply solutions with cheap heating systems. E.g. it is not necessary to install a natural gas furnace with an output of 10-20 kW in a low-energy house and put radiators under all windows. Due to the good windows it is not so necessary with radiators to neutralise the coldness from these as it was before. So principally the radiators can be put on half power and placed centrally in the house and some of the heating can also be supplied from the ventilation system.

As regards the heat supply it is also here important not only to choose a standard solution, but instead also base the choice on the fact that the actual heat demand that is going to be covered in the housing unit is very small. It is in this connection important not to keep the stand-by loss in e.g. heat distribution pipes and heating systems on the usual and relatively high level, but to make a real low-energy heat supply with e.g. low temperature/pulse operation. And if you only dimension for the necessary size of the heating system, an overall heat supply solution can result in a considerable reduction of the investments. Experiences show that in the most favourable cases it can be possible to obtain so high savings by an overall consumption and supply optimisation that the rise in prices by choosing a low-energy standard is almost compensated for by savings in the heating system and the heat supply system.

In these cases a total economy optimisation of the lifecycle costs for a low-energy housing project over e.g. 30 years will be very favourable.

These conditions can at the same time improve the use of solar energy solutions, which are not profitable yet. An overall energy saving solution can e.g. include use of building integrated photovoltaic (PV) modules to cover the current electricity demand, e.g. for ventilation. Then some of the profit from optimisation of the lifecycle costs are used to cover the additional expenses by use of PV modules, which many people consider to be one of the most important renewable energy solutions for the necessary solar energy architecture of the new century.

If you follow the above mentioned approach in specific building projects you have in principle gone through a global energy optimisation process, which is an important part in the general global energy saving concept.

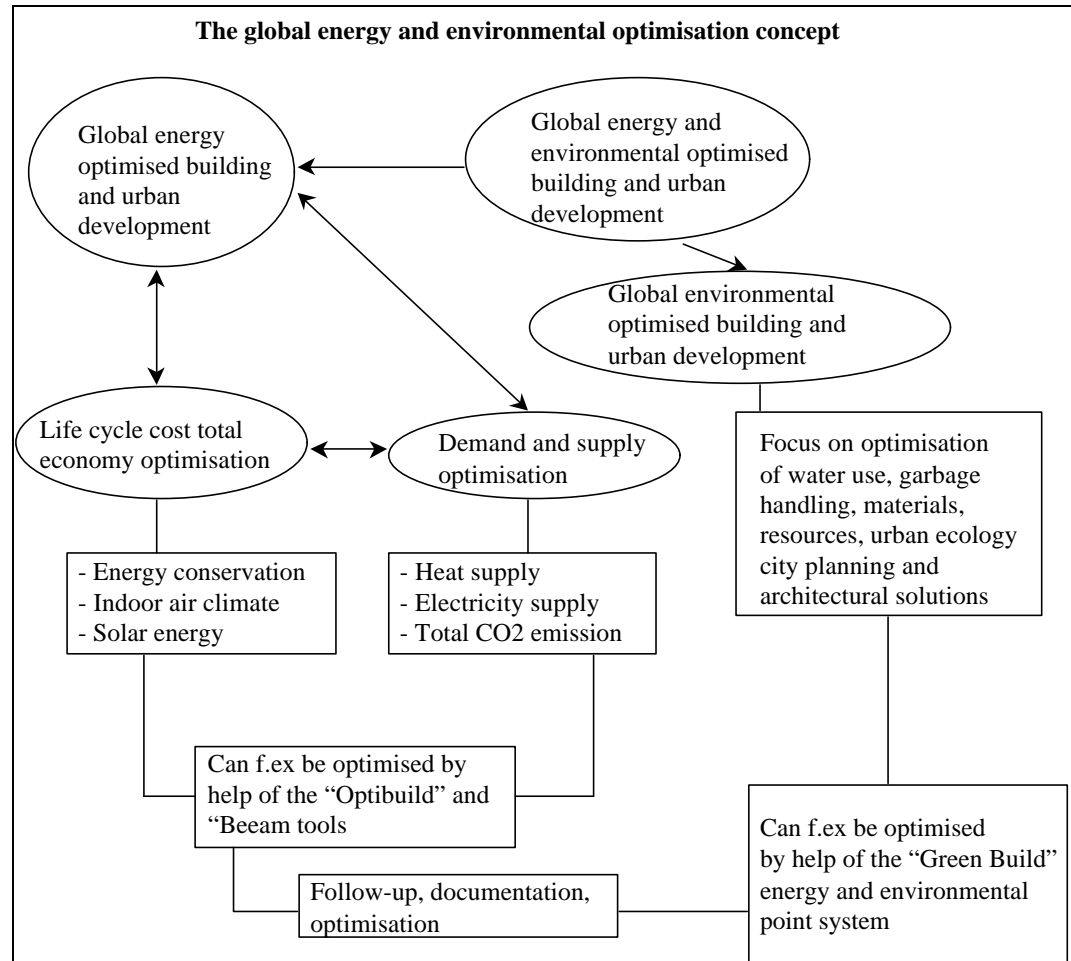


Figure 7.6.: Shows a review of the above mentioned solutions.

Development lines for application of the global energy saving concept and global energy and environmental optimised building.

Low-energy/solar energy building;

Building projects with total economy assessment;

Building projects with total economy optimisation;

Building projects with consumption and supply optimisation, including use of solar energy;

Building projects that include both item 3 and 4 and this way use the global energy saving concept;

Building projects that in addition to the global energy saving concept include a global environmental optimisation, which can be called a "global energy and environmental optimised building project".

Figure 2.2.4. Development of global energy and environmental optimised building projects.

2.2.4. Implementation of the global energy and environmental optimisation concept

An important basis of large action plans for energy savings and use of renewable energy is to establish a possibility of a local initiative in the field, within the framework of municipalities and counties, where many already have green action plans on the agenda. These should also include implementation of the ideas of the global energy-saving concept, e.g. on the basis of the below figure in connection with building projects.

Local energy and environmental management	Key figures, quality requirements, total economy assessment and minimum performance requirements.
Design	A sustainable and energy saving building design based on: <ul style="list-style-type: none"> - Total economic lifecycle optimisation; - Environmental and energy assessment; - An overview of sustainable building criteria, good material and best available technologies; - Use of building integrated solar energy.
Reporting and dissemination	<ul style="list-style-type: none"> - Reports, brochures, video films; - A website based reporting, documentation and dissemination tool.
Follow-up/evaluation	<ul style="list-style-type: none"> - Individual supply meters; - Energy management as the basis for quick follow-up and continuous measuring of results and function; - Green accounts; - Revised total economy calculation after installation and measurements as basis of a total economic evaluation.

Dissemination of good results, but certainly also focus on problems, are very important parts of the work with the global energy saving concept.

The global energy and environmental optimisation concept is about introduction of a more holistic view of which solutions that secure an optimum combination of energy savings, use of renewable energy and an optimised energy supply. An example of this could be that in connection to the design of a solar heating systems for hot water supply in district heating areas you should first ensure as large savings on the hot water consumption as possible and afterwards use the local solar heating system, so it is able to cover the hot water demand by 100% during the summer with a very limited electricity supplement. And this can result in a stop of the district heating supply in the summer months leading to a large reduction of the heat loss in the district-heating network.

The above mentioned does also show that in many cases it is reasonable to define the contribution from the local renewable energy system in accordance with energy savings rather than as an energy supply source.

Use of a solar heating system is here going to be seen as a way to save hot water and is not going to be regarded as a competitor to the district heating supply. In the above-mentioned case it is more a part of a reasonable energy supply solution. Here the necessary quantity of fuel to obtain a specific yield, in this connection it is hot water in the summer period, is reduced as much as possible.

7.2.4 Total economic optimisation of building projects

In the targeted EU-Thermie project the European Green Cities, a total economic optimisation over 30 years has been made for 11 different European building projects. Here additional investments in global energy saving measures have been estimated in comparison to the value of the possible savings and operation and maintenance expenses. Calculations are here made by means of the so-called "Optibuild" programme, which is a total economy optimisation /calculation programme. At the same time also a general energy and environmental optimisation with lifecycle analyses have been made by means of the so-called Building Energy and Environmental Assessment Methodology, "Beeam", which has been developed in a cooperation between specialist companies in Denmark, Spain, England and Holland.

Unfortunately such analyses are not made very often, when projects are not funded as demonstration projects.

In Denmark the Ministry of Cities and Housing has in this connection decided to abolish financing of social housing by help of a certain cost subject to adjustment within a maximum and a minimum limit and replace it with a total economic assessment. This ought to promote the possibilities of application of energy savings and solar energy in building projects, but in practice people prefer to keep to the old type practice. E.g. because it is at the same time required that the municipalities have to pay an increased 14% contribution to the total investment (where it was 7% before). As the municipalities are in low water it is often difficult to support increased investment budgets, even if the total economy is reasonable for the users.

The latest Danish building regulations, BR-95, has not resulted in considerable heat savings in new houses even though it has been the aim to reduce the energy consumption for heating and hot water by 25%. The main reason is that at the same time as there were increased requirements to insulation, especially to low-energy glass in the windows, there were also increased requirements to ventilation. This was among other things to meet the raising problems with moisture and degassing from poor building materials. At the same time there are no requirements of a persistent total economy optimisation of building projects.

A total economy assessment covers the total expenses of a building from erection to operation and maintenance, e.g. over a 30 years period. The advantage of a total economic assessment is that different solutions can be compared directly as regards economy, because all expenses in the total life of a building are included.

The aim of continuing and making an actual total economic optimisation is to find the most economic project. Typically different solutions are assessed and only a total economy optimisation can show the optimum solution. By use of energy saving technologies it is always the important thing to find technologies that gives the best economy for the building.

In the following you can see an example of an Optibuild calculation in connection to a rehabilitation project with an old block of flats. Here are shown a total economy optimisation of the investments in different energy saving measures. The analysis includes three parts: 1: the investments, 2: expenses for supply and 3: maintenance and

cleaning. The value of each initiative has been found by calculating the net present value over 30 years of the three elements. The result is shown graphically in figure 7.7. In Figure 7.8 is shown the calculated savings of district heating for heating and hot water and in Figure 7.9 is shown the investments for the different energy saving measures.

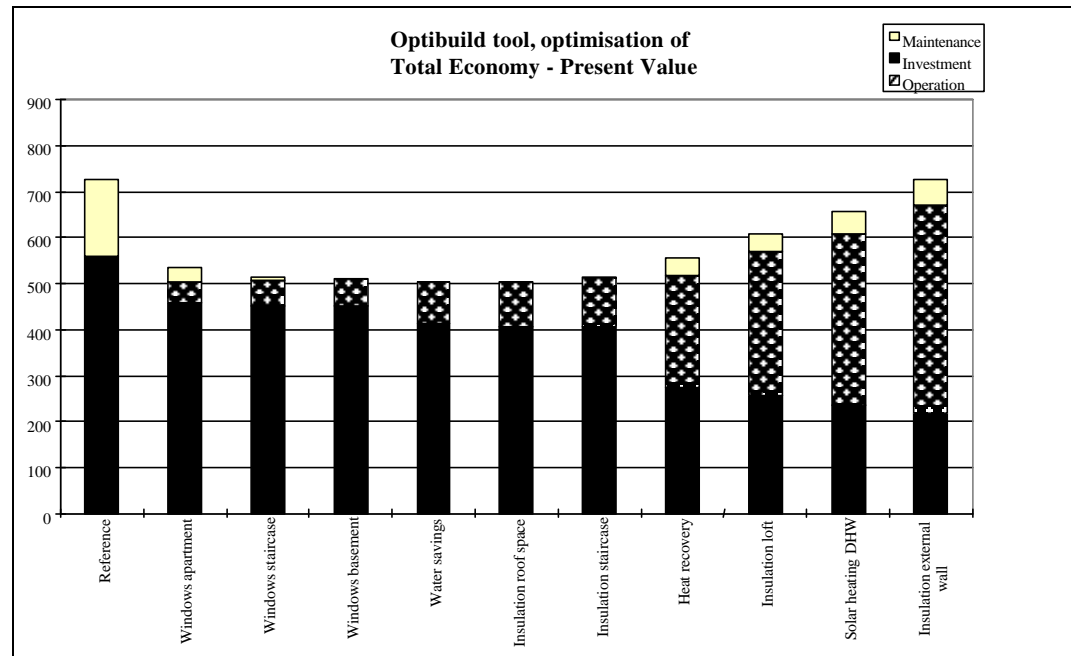


Figure 7.7: Total economy optimisation of sustainable and energy efficient rehabilitation of an old block of flats. The calculation tool “Optibuild”, which has been used here, includes a database of the expenses relating to different types of windows, thickness of insulation, ventilation systems, solar heating, etc. and on the basis of a number of calculations it assesses which one is the most profitable over a 30 years period. First it chooses the most economic solution (here low-energy windows). When this has been chosen it choose the second best until you have a list of all the measures and can see how they influence the lifecycle costs during 30 years. When the lifecycle costs increase you must pay attention to if it is worth to include the energy saving measures in the energy saving package. The total lifecycle costs must not reach or exceed what is stated for the reference building.

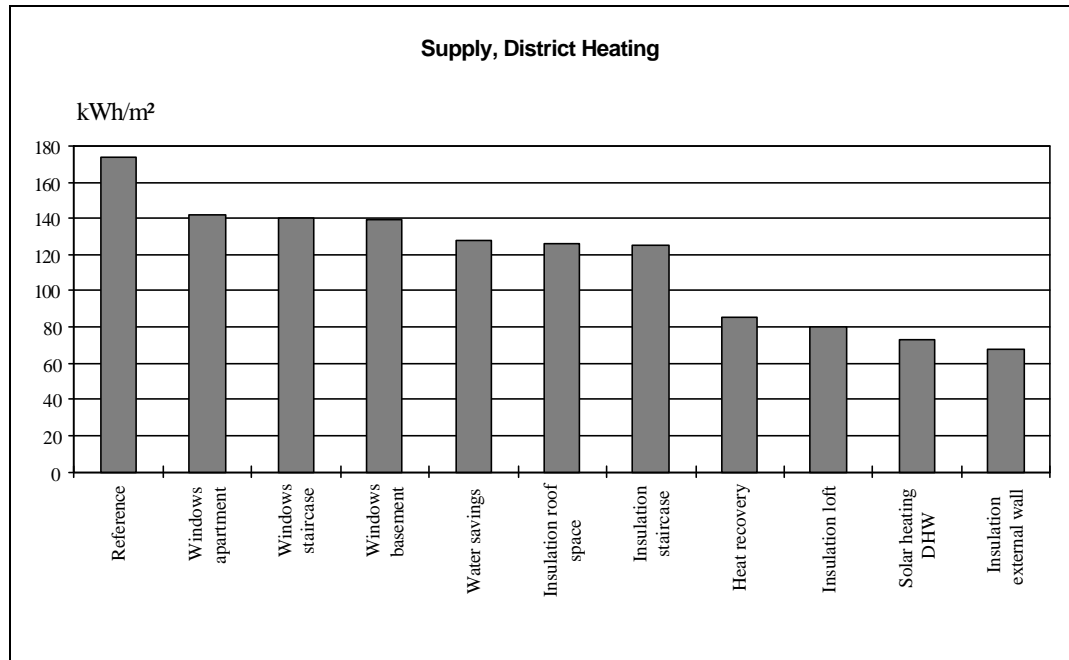


Figure 7.8.: Optibuild calculated annual district heating consumption for domestic hot water and room heating.

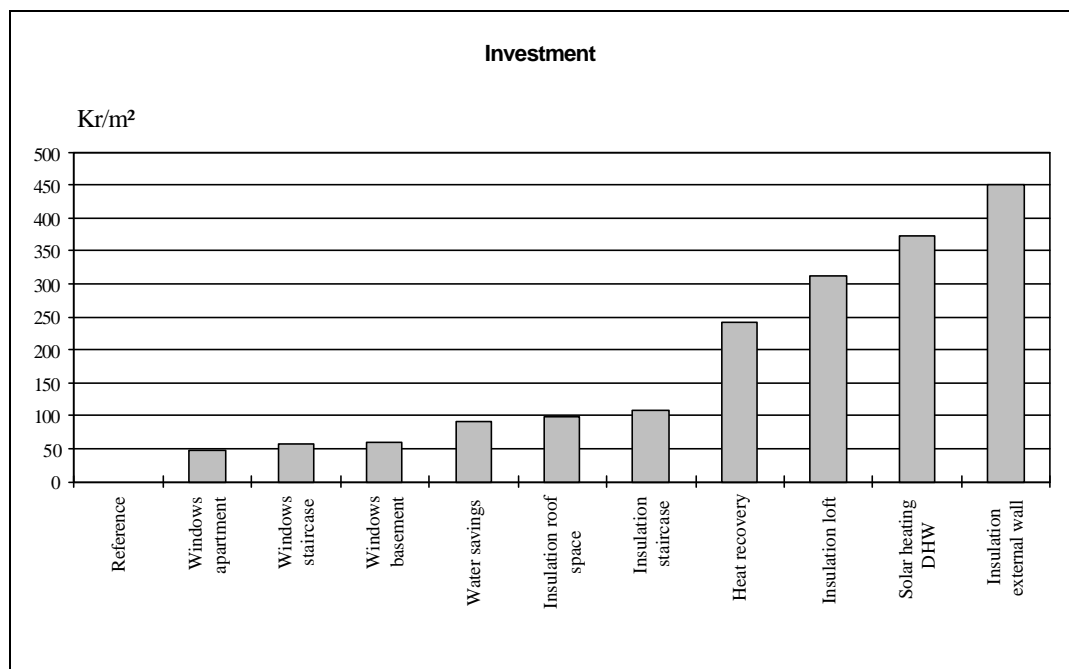


Figure 7.9: Necessary investments by introducing one or more energy saving measures.

By introduction of ventilation with heat recovery it should be noted from figure 2.2.5 that the district heating consumption is reduced considerably but also with a rise of the investments and somewhat increased running and maintenance costs. But it can also be seen that the total "energy saving package", including heat recovery ventilation gives both a large energy saving and an improved total economy compared to the reference.

If you choose to introduce all the measures, figure 2.2.5 shows that the district heating consumption is reduced in return for an increase of the investments and a small increase of the operation expenses. The total lifecycle costs by introduction of all energy saving measures are not larger than the reference; thus there will be a saving of these even if all measures are introduced. But if you on the other hand choose to insert a low-energy level as a criteria for what is going to be introduced, the figures shows that a 50% saving will be obtained by realisation of all measures until and including heat recovery ventilation. At the same time it must be considered as the total economic best "package" of energy savings.

In figure 7.7 is shown the net present value of the energy savings for different energy saving measures and levels of savings. As long as the net present value goes down or becomes the same it is good to include the investment in the saving package. For this project it is seen that the net present value is rising for the 4 last energy saving measures.

If you compare with figure 7.8 it is seen that if you choose a package solution which includes heat recovery and ventilation air but excludes the 3 last energy savings then you will have at least a 50% saving of energy for heating and hot water and still have a good economy for the total energy saving "package" solution.

The total economic "positive list" for the Optibuild calculation is shown below:

1. Replacement of windows in the flats, type: low-energy;
2. Replacement of windows in the staircases, type: low-energy;
3. Replacement of windows in the basement, type: low-energy;
4. Water savings by new fittings;
5. Insulation of the cupboard under the roof slope, 50 mm, U-value = 0.39 W/m²K;
6. Façade insulation of the staircases, 45 mm, U-value = 0.46 W/m²K;
7. Heat recovery on ventilation;
8. Insulation of the ceiling, 50 mm, U-value = 0.39 W/m²K;
9. Solar heating for domestic hot water;
10. Façade insulation of flats, 45 mm, U-value 0.46 W/m²K.

The main result of the completed Optibuild total economy calculation is to get information of how the positive list for a given project will be. This can also be shown with information on investments, energy savings and simple payback time. The list describes which energy saving measures are the most profitable. The most profitable measure is on the top of the list. The following measures are chosen under the assumption that the measures mentioned above will be installed. The positive list does usually also show when you reach the lowest possible lifecycle cost (the optimised solution). The positive list can exceed the optimised solution because even if the lifecycle costs are getting a little higher, the energy saving measures below can have lower lifecycle costs than the reference situation. The Optibuild total economy optimisation and the positive list can include just as much energy saving measures as the user would like.

It is now possible to find an interactive version of the Optibuild tool in the website www.ecobuilding.dk under download. Here is also a presentation of 9 different EU-Thermie target projects and other EU demonstration projects in the building sector.

7.3 Optimum ventilation design and use of healthy building materials

Within present years there has been much focus on how to secure a good indoor climate. At the same time it has been proven that the many new types of building materials that

are used today can be a considerable reason to a poor indoor climate. This is one the reasons why the requirements to ventilation have been raised in the latest building regulations, BR-95. Many people think in this connection that there is a great need to do more to protect ourselves against building materials that are degassing during long period and thus implement on the indoor climate in a negative way. E.g. professor Fanger from the Danish Technological University's Institute of Energy Technology, the department of indoor climatic research, think that we are going to introduce more source control and thus avoid the poor building materials.

In connection with the EU/Thermie project European Green Cities, there has been a special emphasis to try to develop optimum ventilation solutions in combination with use of healthy building materials.

The intention is on the basis of an energy saving target to examine if use of healthy building materials can cause that we can be satisfied with a smaller basic ventilation than required in the present building regulations, so user and moisture control of the ventilation will be possible to a large extent.

7.3.1 Indoor climatic conditions

Adults produce by medium activity approx. 18 litre CO₂/h. CO₂ is often used as a standard for the air quality regarding how it is influenced by human beings. The content of CO₂ is 300-500 PPM (parts per million) in the air outside. The requirements to the air inside are usually approx. 1000 PPM, sometimes up to 1500 PPM.

The content of CO₂ can vary in a sleeping room from 500 PPM by day (by airing) and up to 3000 PPM by night. To secure a CO₂ level of approx. 1000 PPM in houses an air change of 25 m³/h per person is considered to be sufficient. But if there is a smoker in the room the demand is increased to 625 m³/h per person.

The moisture inside the house should at the same time be kept at a suitable level with a relative humidity of 30-60%.

The standard for a required air change in houses is usually fixed at 0.5 times per house. If it is above this level the result can be too dry air in the winter.

The standard demand to air change in wet rooms as kitchen and bathroom is 20 l/s (72 m³/h) and 15 l/s (54 m³/h) respectively, a total of 126 m³/h. In small houses (less than 120 m²) the demand of 126 m³/h the toughest. The ventilation demand increases in large houses due to the requirements of an air change of 0.5 times per hour.

In sleeping rooms there are special requirements to a high air change to avoid problems with house dust mites, which might result in allergy and that are on a high level in September/October. Tests have proven that if you can secure that the moisture does not exceed 7 g water vapour/kilo air it will have a useful effect on avoiding house dust mites. Another test has shown a very useful effect by use of mechanical ventilation with both air extraction and air supply. Ventilation in sleeping rooms of approx. 5 l/s per person will usually be sufficient.

A Canadian examination have also shown the necessary requirements to a minimum ventilation due to the indoor climatic conditions (regarding particles, VOC, formaldehyde, radon and CO₂). The demand varied between 10-50 l/s (36-180 m³/h) so the highest demand was due to particles and CO₂ (1000 PPM). At the same time the worst problems with the indoor climate seemed to be from spring to autumn.

At the Institute for Energy Technology at the Technical University in Denmark, the Department for Indoor Climate Research they work with development of models to anticipate how the air quality will be inside a building before it has been built. This does

e.g. happen in connection with a database with healthy building materials, Indoor Air Pollution Sources in Buildings. The idea is here to work with source control about degassing from building materials. The philosophy is that health and comfort are the most important background for making buildings and approx. 40% of the total energy consumption are for this purpose.

Tests at the Technical University in Denmark have shown that the three most important things that influence on the indoor climate is human beings, degassing from building materials and ventilation systems that have not been maintained.

In connection with the development of the database of healthy building materials they have at the Technical University made a sensory test (odour test) of different building materials with 40 testees, after the materials had been ventilated one time per hour in 30 days after they had been provided. The temporary results are shown in Figure 7.10.

	Number of unsatisfied (%)
Jointing materials	3-4
Medium hard floor covering (vinyl, polyefine and linoleum)	8-89
Hard floor materials (mainly wood)	45-93
Carpets	82-97
Ceilings	17-93
Walls (including paint)	
Concrete	75-85
Plaster	33-94

Figure 7.10.: Temporary results of test of how building materials influence the indoor climate made at the Technical University in Denmark.

As you can see there are very large variations. To be sure not to use materials that influence the climate regarding odour, it is important to develop a practise for construction, to document how the used materials will react in this field.

7.3.2 Energy consumption for ventilation

Swiss research has tried to find an improved basis for how to define requirements to ventilation in houses, also houses with ventilation with heat recovery and air ducts for preheating of the ventilation air in the ground.

They have e.g. defined how much electricity it is reasonable to use compared to the size of the ventilation system. On this background they work with a required maximum electricity consumption of 0.35 W/m³ per hour for ventilation systems with heat recovery, which in Denmark is equal to approx. 44W (at 126 m³/h) and about 50% if it is an exhaust ventilation system. Compared to this the requirement in the Danish building regulations from 1995 is 87 W.

For ventilation systems with heat recovery a size has been defined, ETA, the electrothermal utilisation factor, which is the ratio of the heat output to the electricity consumption. In test houses in Switzerland measurements have shown between 5 and 11 ETA and the suggested standard requirement is 7 ETA.

It is suggested to use a 20 metre duct in a depth of 1 metre as air ducts for preheating of ventilation air, with an velocity of maximum 2 m/s. It has been proved that there are not problems with condensation in the ducts in summer as they had feared.

At the same time the following three ventilation levels have been suggested:

- Basic ventilation: 0.3 times per hour;
- Increased ventilation: 0.5 times per hour;
- Forced ventilation: more than 0.5 times per hour.

As regards the sound level it is stated that even though the standard requirements are 30-35 dB for ventilation it is going to be considerably lower if people are going to be satisfied – rather 20-25 dB. This is equal to Cenergia's experiences.

If we are going to use the same philosophy in Denmark we could take basic ventilation of 0.3 times per hour as our starting point or alternatively the minimum requirement to ventilation on account of CO₂, which is of 25 m³ per hour per person. The basis ought at the same time to be to document use of building materials without degassing so it is healthy materials.

We could also make user and moisture control possible to increase the ventilation in some periods, e.g. to 0.5 times per hour or 126 m³/h. This would cause a 50% reduction of the air change into and out of a house in long periods and at the same time it reduces the electricity consumption to 20-30% of what it would have been. A considerable heat saving can also be obtained.

In the so-called Passiv Haus project near Damstadt in Germany they have during some years proven that under the right conditions it was sufficient with a ventilation level of 25 m³/h per person or an air change of 0.22 per hour. Here an earth exchanger has been used in connection with a ventilation system with counterflow heat recovery and low electricity consumption, as it secures against frost in winter and makes cooling possible in summer, where the heat exchanger is bypassed.

In this project it is also possible to change the ratio of air supply to living rooms, sleeping rooms to bathroom/kitchen in the ratio (30/70%) and (70/30%) – but this is a rather expensive solution.

7.3.3 Development of energy efficient ventilation designs for housing ventilation

With the increased requirements to ventilation in BR-95 there are both in connection with new building and rehabilitation projects a demand to development of energy efficient ventilation system for living-quarters in blocks of flats.

Today the usual ventilation system consists of exhaust hoods in kitchen and bathroom. Either in the shape of a small ventilation unit, which can be turned on when there is a demand, or common exhaust ventilation for several flats at a time.

In the new building regulations it is as something new required that mechanical ventilation has to be turned on all the time. This is due to consideration of the indoor climate that has been worse within the last decades because the houses are too tight and have moisture problems and to the use of new materials with unhealthy emissions. The regulations do also require maximum electricity consumption for ventilation, which will be approx. 87 W or 762 kWh per year due to future requirements of mechanical ventilation of 126 m³.

The heat supply that is necessary to cover a ventilation demand of 126 m³/h is approx. 2600 kWh per year. In a situation with improved insulation and windows this means that in the future the ventilation field is considered to be the most difficult to secure good solutions of. In this connection we must pay attention to the fact that it is not possible just to have natural ventilation if we want to reduce the energy consumption for heating by 50%.

Due to the increased requirements to ventilation in the new building regulations and also a reduced energy consumption we can expect a much increased commitment to ventilation systems with heat recovery in the future, where the exhaust air is used to heat the supply air.

In several years Cenergia has been working with development of energy efficient ventilation systems with heat recovery in connection with a number of EU-funded demonstration projects in Denmark and abroad. This development has primarily taken place in a close cooperation with the ventilation company TermoVex, which market an efficient so-called counterflow heat recovery unit with approx. 80% efficiency.

In recent years this development has been characterised by a want to develop ventilation systems with heat recovery, where the electricity consumption is as low as possible. In connection with the building projects Skotteparken, Egebjerggård and Havrevangen a new type of ventilation system for four dwellings with heat recovery has been developed. Where the electricity consumption even with this old type of ventilation system is approx. 50 W/dwelling with an air change of 54 to 100 m³/h.

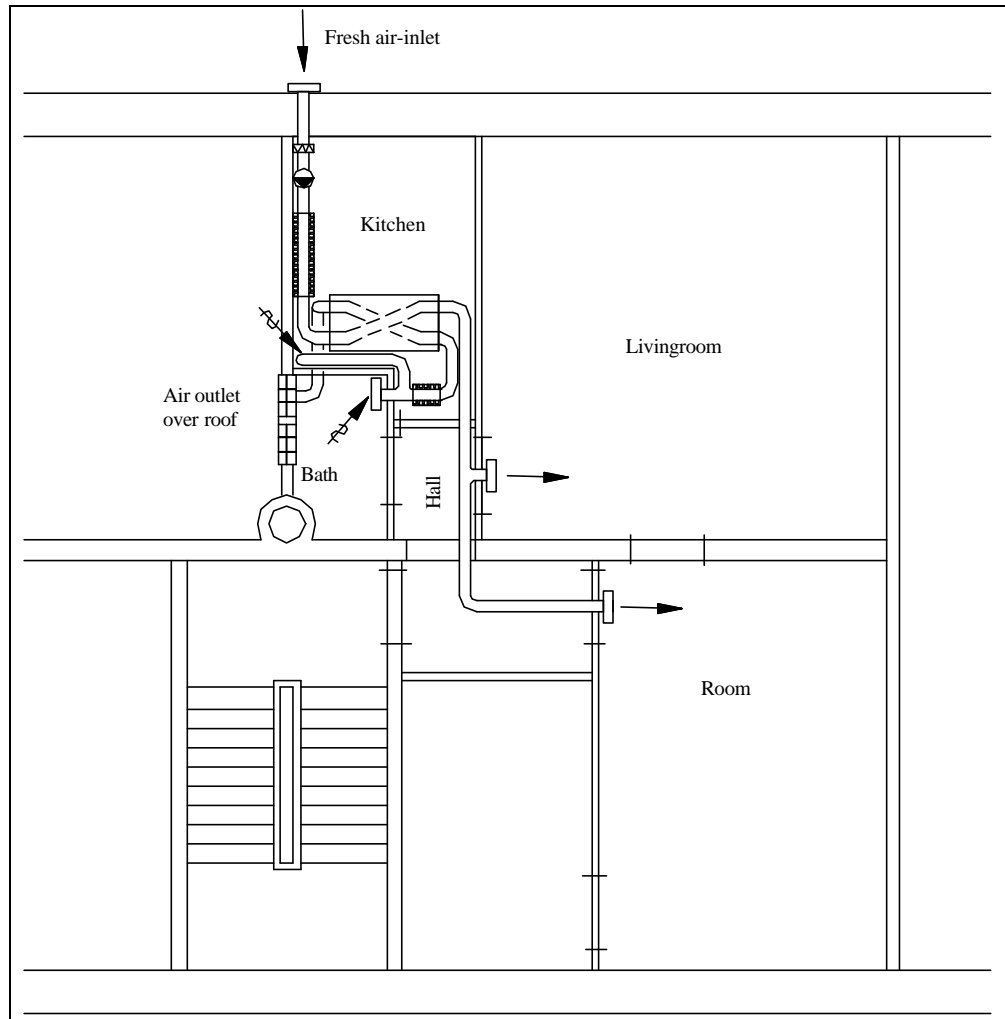


Figure 7.11: Example of how an individual heat recovery ventilation unit can e.g. be placed over a suspended ceiling using an exhaust fan in the attic and taking fresh air in from the facade. With an extra cost compared to normal exhaust ventilation of approx. 10,000 DKK (1,400 Euro) this is already quite economical in Denmark.

7.4 Validation of the Green Build Quality model with performance quality figures

To obtain an effective impact concerning utilisation of a global solar energy/low-energy design in practical building it is important to utilise good methods to secure and verify that the results are also obtained in practice. This can be done by putting forward a number of performance indicators and key-values, which can be checked by measurement and monitoring for different used technologies.

When a general-orientated assessment of low-energy ecobuilding projects is going to be made, in the future it is the idea to use the so-called Green Build Quality Model for comparison of different types of energy savings and which can also be used to support the made demands in the shape of key-figures that are either met separately or in the shape of total well-documented framework requirements.

By help of the Green Build Quality Model, general assessments of low-energy ecobuilding will be made, e.g. within the “heating field”, by integrating an assessment of thermal bridges and tightness of constructions, sash/frame loss of windows, efficiency

and electricity consumption by ventilation with heat recovery, compactness and orientation of buildings, heatloss in connection with the heat distribution system and efficiency of heat supply and heating systems.

This kind of assessment can be made by means of so-called quality figures for the individual technologies, which can be used in an overall calculation and assessment where different types of energy savings are compared to each other.

The following quality figures should be defined and checked/monitored as to the used technologies with a view to validation of an overall quality model for general-orientated low-energy building. It is expected to start initial work on this in connection to the EU-Save project "Green Catalogue".

1. Solar heating systems for domestic hot water and PV-systems. System efficiency (yield compared to insolation), annual yield in kWh/m². Monitoring as basis of guaranteed results is a possibility.

2. Ventilation systems with heat recovery. Thermal efficiency is measured, the electricity consumption ought to be registered continuously, ought to be below 30-40W in dwellings and the electrothermal relations are determined (ratio between electricity consumption and heat savings). This ought to be better or equal to 1:8.

Possible contribution from renewable energy should be estimated.

3. Indoor air climate. Air change, moisture/temperature conditions are measured, hours above 26°C are registered, just as hours above 50% relative humidity.

Assessment of moisture from outside is made.

Control of indoor climate labelled materials are used. Check of CO₂-emission in the air.

Function of natural or hybrid ventilation if any is checked.

Utilisation of daylight is measured/assessed.

Lighting is registered.

4. Quality of constructions/ building envelope. Use of energy labelled windows is confirmed. The total U-value of the window is stated. Thermal bridges and tightness requirements are checked by

- design and by inspection on the building site. Tightness is measured by so-called “blower door tests”, which is a tightness measuring.
5. Heat distribution system. Operating hours, operating temperatures and the relative heatloss in the heat distribution system are registered. Both as regard joint installations and individual piping in each dwelling.
6. Boiler system/heat pump heating system. The real efficiency is registered by comparing the fuel consumption to the produced waterborne heating. The annual efficiency is registered for the heat pumps.
7. Heat consumption. The heat consumption is measured continuously so an energy signature can be made. At the same time measurements of the temperature of exhaust air. Circulation loss is registered for the domestic water circulation.
8. Electricity consumption. The annual electricity consumption is measured. Both for individual electricity consumption in dwellings and shared electricity consumption if any.
Assessment of electrical equipment.
Assessment of heat contribution from the electricity consumption.
9. Water consumption. The annual water consumption is registered, divided into hot and cold water.
The circulation loss as to domestic hot water is registered if any.
10. Local electricity and heat measurement. Local energy meters will be used for electricity and heat consumption and domestic hot water consumption. These can also be read locally.
11. Passive solar heating function and optimised building construction. The relation between the window areas with different orientations are assessed together with thermal mass and possibility of airing.

Compactness of the building is assessed in the shape of the area/volume ratio, A/V.

12. Lifecycle assessment of building materials and environmental indicators. e.g. An overall lifecycle assessment can be made, including the latent energy in materials and energy conditions can be balanced in proportion to environmental conditions by means of environmental indicators and other environmental assessment methods.

13. Total economy and general assessment. On the basis of the above mentioned, a justified assessment of the annual energy and water consumption is carried out.

Electricity and heat consumption is converted into annual CO₂-emissions and annual costs per m² by means of energy prices.

To be able to make credible calculations with the overall Green Build quality model for low-energy and validated ecobuilding, all the above mentioned conditions ought to be measured/registered for a number of buildings.