Development Project "Munkesøgård", Trekroner in Roskilde



Final Report
Incl. Green Account

December 2002

CENERGIA

Cenergia Energy Consultants,
Sct. Jacobsvej 4, 2750 Ballerup,
Tel: +45 44 66 00 99, Fax: +45 44 66 01 36,
e-mail: cenergia@cenergia.dk, WWW.cenergia.dk

LIST OF CONTENT:

PREFACE 3

1. SUMMARY – CONCLUSIONS 4

2. BASIS OF IDEA/VISIONS 7

3. DETAILED DESCRIPTION OF IMPLEMENTATION AND BUILDING PROCESS IN CONNECTION WITH MUNKESØGÅRD SETTLEMENT 10

4. PRESENTATION OF THE FINALISED MUNKESØGÅRD PROJECT 15

5. RESULT OF GREEN ACCOUNT PREPARED BY MUNKESØGÅRD ASSOCIATION 27

6. RESULT OF GREEN ACCOUNT PREPARED BY CENERGIA 30

REFERENCES 34

Preface

This report gives an introduction to the Munkesøgård settlement and a description of realisation of the project, the building process and results. Furthermore there is a presentation of the whole idea behind the project.

Further more results of green accounts made by Munkesøgård Association and Cenergia are included.

The background for the project is the establishment of the ecological association Munkesøgård, which is an ecological joint living. This joint living has been put together by grass roots who have been involved in living in an ecological joint living where the main purpose is sustainability. The Munkesøgård settlement consists of 5 different dwelling groups with 20 apartments in each. Three of the dwelling groups are public housings for young people, seniors and families. The other two groups are of type ownership and multi-ownership.

This is a whole new way of building in Denmark and together with the ecological objectives there will be an interesting base for presentation of results from the building.

The main idea of Munkesøgård building was that the building should be most possible sustainable regarding to the environment. The tenants have during the whole progress participated actively in decisions regarding to the design of the building and it has during whole time been necessary to find the solutions, which meet the demands of the tenants best possible both for environment and economy.

The building consists of different experimental initiative, a result of compromises, to fulfil the demands of the tenants regarding to environment, economy, ecology, sustainability and well-being.

The Munkesøgård association obtained on the base of the ideas of the project first price in the competition "The sustainable living in the 21st century".

1. Summary – conclusions

The Munkesøgård settlement was built during the year 2000 as an ecological housing with 100 dwellings close to the railway station and RUC University in Roskilde.

The building is divided into five dwelling groups with 20 apartments in each group. The five groups are:

1. Youth
2. Senior
3. Family
4. Ownership

5. Multi-ownership

An area of 5 ha east for the settlement has been rented to the tenants with regards to ecological farming and possibility of keeping animals.

The objective in Munkesøgård have been to build an ecological joint living across social, age, political and other differences. The ecological project is about creating reasonable energy and source recycle and healthy environments for people and nature. This has been obtained by designing buildings, technical systems and outdoor area from an ecological and social point of view.



Picture 1.1. Picture from Munkesøgård settlement, which was completed at the end of year 2000.

Each dwelling group consists of three 2-floor buildings in horseshoe shape with a communal house on the fourth side. All dwellings have entrance from inner side and a little private garden in connection to the dwelling. Picture 4.1 on page 15 shows a plan for the settlement.

The settlement has been built with bearing construction of wood, extra insulation in exterior walls and roofs, facing of wood and with tiles or metal sheets on roof. For the double apartment partition and interior gables unburned earth stones are used. Other walls are plastered. For ownership group there are unheated porches and sun spaces built on facades.

The dwellings are heated with central heating system with radiators and floor heating. The heat comes from a communal heat central with wood pill oven. For supply of hot water in summer months solar heat is added from locally placed solar heating system on communal house in each dwelling groups.

The settlement works without any connection with the municipal outlet system. In all dwellings urine separation is used. Other waste water is lead to a collecting tank from where mud is emptied with intervals by a mud suction apparatus and the rest of waste water is lead to a sand filter and further to a local brook.

Rain water is collected from roofs and cleaned and used for soft water in communal laundry.

The Munkesøgård project is developed over a two year period in close dialogue between representatives from the tenants and the architect company *Thure Nielsen & Rubow* and *Cenergia Energy Consultants* who have developed the total energy and environment solutions. *Wissenberg* engineers have also participated in the project and have been responsible for the building constructions.

By end of 1997 the three consulting companies delivered a large development report. On base of this and as something new the mortgage-credit institute (RD) succeeded in approving the financing of an ecological building without any problems.

At the same time it was the intention that a large part of the extra costs of the building should be supported by a total economic base.

The consulting team behind the Munkesøgård project was unfortunately not allowed to

finish the project practice beside an extended pre-project because there was a clear demand from Ministry of Housing that for the public houses the tendering directive of the EU regarding consultants output had to be followed.

The solution for this was then to have the project completed by a total contractor. For the 80 supported dwellings the choice fell on the contractor *Monberg & Thorsen* and for the 20 owner-ship dwellings the contractor *Ejen Vinding & Datter* chosen. Thereafter a number of the qualities of the building were excluded, partly because it was decided very late to decrease the costs of the project to fit into amount of maximum limit and the solutions for heat supply were wished to be financed as a part of dwelling project instead of a special kind of A.m.b.a. as originally planed. However the realised total economic plan showed that it should be possible in principle to complete most of the suggested initiatives based on a total economic acceptable way. This was however not the case for use of the original planned individual compost toilets, which among other things demands a special concrete basement for treatment of the compost, which is very expensive and source demanding and also difficult to have accepted from work supervision in practice. As alternative Cenergia developed a proposal for a common compost solution and urine separation.

One of the things that unfortunately was excluded from the project was use of ventilation with heat recovery. This is something that tenants complain about because the solutions for ventilation, which have been made instead are unsatisfying, among other things with noise and draught. At the same time this choice means that it will be difficult to obtain low energy level in practice.

In an article from "Renewable Energy" from June 2001 one of the architects from owner ship dwellings wrote that he actually was satisfied with that there was not enough budget for ventilation with heat recovery in Munkesøgård.

This shows that he like many others has only a very poor understanding for ventilation area, among other things regarding need for fresh air supply for indoor air climate and necessary need for heat recovery to obtain a low energy level.

In the article it is mentioned that there is an objective of a yearly energy consumption for heat and hot water of 57 kWh per m^2 dwelling. By help of an acceptable ventilation this goal will obviously not be accomplished without heat recovery on ventilation air.

Measurements from the first year in Munkesøgård certifies also this, there is a total energy consumption in the dwellings for heat and hot water of 91 kWh per m^2 dwelling area, equal to 97 kWh per m^2 when the communal houses are included. Also electricity consumption is only 2845 kWh per dwelling and thereby below normal standard in Danish building. Water consumption is approx. 63 litre per person per day and is very low. This is described more in chapter 9 and 10 where results for green account is shown made by Munkesøgård and Cenergia for year 2001.

Results from Munkesøgård building has beside this report also been presented in connection with the EU supported Green Solar Regions project. This will also be realised in co-operation with Roskilde Housing Fond and the tenants.

In a final thesis from RUC University the process and results regarding Munkesøgård building have been tried to clarify. It is here concluded that Munkesøgård is a very interesting building, which has been ended up like some kind of "eco-light" edition. This is according to the writer mainly because there were a mix of enthusiastic tenants with environment knowledge that were first time builders and then a traditional housing association with large experience in housing buildings but without experience in environment. Very late in the process people became good enough to take advantage from each others knowledge.

2. Basis of Idea/Visions

Munkesøgård settlement is an attempt to create a place of living that can be attractive for everyone. The first step was to create a so wide selection of dwellings so that anyone had an economical opportunity to join. By mixing different types of living, boundaries between different groups of people are demolished, which other wise are quite firm in our society today.

In joint living one has tried to integrate different functions and different age groups to

achieve a greater level of unity and exciting frameworks for expansion of the individual and unity.

A strong social network planted in an inspiring local society has been a good starting point to meet the challenges, which whole internationalising and the so-called global village offer.

The Munkesøgård project is the result of the dream and desire to establish an alternative way to order oneself in the society. There have been working for the following:

✓ To build an ecological joint living across all social, age, political and other boundaries.

✓ To try to make versatility in tenants composition.

✓ To build up a place where there is possibility for unity and harmony between people and nature and where the tenants can live a good life with respect to the unity of the earth.

✓ That the solutions can be source of inspiration for other with same dreams and ideas.

The social thought of closeness have been repeated in the ecological part of the project. There was built an alternative for alienation of the modern human being against water, air, energy and earth.

There has been a desire to:

✓ Seek sustainable solutions with regards to energy, water, materials, food, waste and other necessary sources in connection with modern life style.

✓ Make a larger settlement based on ecological management of the resources.

✓ That the material base for our lives should be a practical ecology that ensured a reasonable energy and source cycle.

It was wanted that people around the settlement discovered that there are other ways of arranging matters than the traditional. At the same time it is important that the joint living does not isolates it self according to the local society but instead starts an interaction. The joint living shall not be an ecological spot on the map of Roskilde but a living and breathing power centre for the local area.

There has been made an internal fond where one can borrow off for e.g. a new low energy refrigerator or maybe for a part in windmill. It should at least not be a burden to live up to ecological ideals. The tenants want to help and inspire each other to live environment friendly.

There are especially two things that are important to emphasis: the project is especially about joint living and ecology. These two things are gathered in the conception ecological joint living, which is the place where one puts his or her visions and dreams about a better world.

The joint efforts and the social dimension is also about multiplicity. It was the goal to create a wide compound local society with young and old, strong and weak, rich and poor, workmen and "spirit-men". Therefore the joint living contains both rented dwellings, multi-ownership dwellings and owner-occupied dwellings and dwellings for young people and old people. The joint efforts was thought this way that buildings and outdoor areas should be arranged so it gave wide opportunities for joint efforts. One has his own dwelling with kitchen, toilet and bathroom and furthermore communal houses, laundries, workshops, outdoor areas etc. in joint effort.

Beside liability to contribute in necessary work is participation in joint efforts voluntarily because it is expected that those people who have decided to live here are interested in participating in joint efforts. It has been desired to frame the joint living in a way so the functions that are placed on the communal yard and in communal areas can be used to give the tenants interest and wish to take responsibility for this.

At the same time it has been worked for to create workplaces in connection with joint living. However these workplaces shall be established on base of the energy and desire of the individual and is thereby juridical independent from joint living. In practical there are plans of creating farming, eco-grocer, treating room, offices and children institution.

Local workplaces are important for creating life also in daytime and for example farmer and kitchen gardens contribute at the same time to a local supply with among other things provisions and give opportunity to recycle organic waste locally. This way the ecological and social objectives supply often each other and establish a joint base of values for the

joint efforts.

The ecological dimension is about creating reasonable energy and source cycle and healthy environments for people and nature. This was completed by designing buildings, technical facilities and out door areas from both an ecological and social considerations. Also activities as joint eating, shopping and transportation were arranged according to these considerations.

The spirit in the project:

- Visions for a green joint living
- People in all ages and from all social classes
- Midsummer party
- Harvest festival
- Big Empty Day
- Communal workshops

The social structure:

- Decision process for 200 people
- To take responsibility for oneself and each other
- Green shopping fond
- Sharing cars
- Joint eating
- Children house in joint living
- Life in daytime
- Workgroups

Infrastructure:

- Renewable energy: passive solar heating, electricity savings, bio mass, sun and wind
- Water: compost toilets, rain water gathering and local water cleaning
- Electric cars and location close to public bus and train
- Joint solution for telephone and computer net

The ecological mind:

- Ecological building materials: wood, paper, earth stone
- Waste minimising, composting and sorting
- Ecological grocer
- Kitchen gardens and ecological farmer
- To learn from others

To establish this ecological joint living one has worked in the concrete world of technical solutions, project management, authority contact, housing associations, laws and rules. One has not before taken much time to see the social and cultural aspects, which are built in the project but has now started to formulate these things.

The last years progress in the society has created a row of basic social and environmental problems, which an ecological joint living can contribute with a solution. The society is characterised by increasing socially isolation, particularly for many older people but also younger people with bachelor lifestyle. More and more people live by themselves and the generations have only a limited contact with each other because they are spread everywhere. Many people do not either have anchoring to the local area in which they live.

3. Detailed description of implementation and building process in connection with Munkesøgård settlement

The development of the Munkesøgård project started already in 1995 with the goal to establish an ecological joint living, which could hold people in al ages and from all social classes.

A great meeting was arranged in March 1995 in Copenhagen with the objective to create an ecological joint living and in June 1995 an association was established for this, called ØKOBO (ECO-LIVING).

After working with concretising the ideas and find a suitable building ground it was decided in June 1996, after negotiation with the municipality of Roskilde, to go further with a placement north of Trekroner station by Roskilde.

On Marbjerg field, 1,5 km north for Trekroner station, is the yard Munkesøgård. On the areas around the yard it was decided to establish a big joint living that should try to take into account the ecological and social considerations.

Munkesøgård is located at the remotest area of the new Trekroner urban development area between Roskilde east and Roskilde University Centre (RUC). When the present municipality planes are realised the joint living will be located with open farmland against east and with dwellings, institutions and eventually small businesses on the other sides.

The location was chosen at the outer fringes of the town to integrate agriculture activities while one at the same time could be near different town functions (approx. 4 km to Roskilde central). The settlement is located close to railway station with walk and bicycle distances to Trekroner station, which have good public transportation connections (approx. 25 minutes by train to Copenhagen central station). For the benefit of the environment own car is not necessary when living in Munkesøgård settlement. There is approx. 2 km to the bay by Himmelev.

During autumn 1996 a co-operation with the architect company *Thure Nielsen & Rubow* was made and subsequently also with the engineering companies *Cenergia* and *Wissenberg*. This resulted in spring 1997 that a pilot project of the settlement was prepared with 5 different dwelling groups, each with 20 apartments.

By the end of 1996 the members were allowed to choose the dwellings they wanted, which lead to waiting lists for leasing apartments, a smaller waiting list for multi-ownership apartments and need for more members for ownership apartments.

The description and drawings in connection with the pilot project made the basis for the tenants desire for the apartments. This did also make basis for negotiations with external partners, e.g. credit association etc.

The pilot project consisted at first a description of the basis of values, which was the base for the whole project, and after that an overall description of the settlement, of the dwelling groups and of communal grounds. Finally a short description of the economy in the project. The material was finalised in January 1997.

It was as mentioned before the idea to establish five dwelling groups with 100 dwelings in total, centred around the existing Munkesøgård, which should work as communal house for the whole settlement. There is in the settlement 20 senior dwellings, 20 youth dwellings, 20 regular family dwellings, 20 multi-ownership dwellings and 20 ownership dwellings. The rental dwellings should be built by a public utility company. The dwellings are of 2, 3, 4 and 5 rooms terrace houses/apartments. The settlement is a close low-rise settlement of two floors where each dwelling group constitutes an independent group. Beside private gardens of the people there are opportunities for having kitchen gardens. There is also made a playground, playing field etc. in a big outdoor area.

In spring 1997 ØKOBO was replaced by the Munkesøgård Association, which is the superior association that has gathered workgroups and dwelling groups around the united project. The purpose with the Munkesøgård association has especially been to realise the planed dwellings by Munkesøgård.

At this point the co-operation with KAB Housing Association had been going on. However it was not possible to realise the building under the auspices of KAB. This lead to that the leasing groups established a co-operation with Roskilde Housing Association.

In 1998 the committee constituted itself with a flat structure where the five members of the steering committee continuously took on the big work of the concrete negotiations in the steering committee, communication and dialogue with the dwelling groups, committee and co-operation partners etc.

The work was in 1998 about tendering the building in enterprise and negotiating a contract with one or more contractors. This was very complicated and took longer time than first expected.

The problem was mainly that the tendering rules of EU demands that consulting work (architects and engineers) of social tenant houses above a certain size must be in EU tender. The 60 social dwellings are in total above this size but it was tried to get dispensation because the co-operation otherwise could not continue with those architects and engineers that have been working with before.

This problem was clear for the committee in 1998. The opportunity for a total contractor with *Højgaard & Sch*ultz (now *MT Højgaard*) was investigated, because the EU tender could be avoided this way. However this was abandoned after a short negotiation.

During the spring and summer 1998 the contract with Thure Nielsen & Rubow was negotiated and there was co-operation with them about finishing the drawings for the project proposal. This was available at the beginning of August.

In August a co-operation with *Birch & Krogboe* (B&K) as business manager was initiated, which in the beginning looked very successful. But short after the Housing Ministry refused the dispensation for EU tender and it was accepted that the rental dwellings had to abort the co-operation with the consultants. After rather short time the multi-owner and owner occupied dwellings chose to participate in a total EU tender. The form of tender was then the so called "opposite tender for negotiation in total contracting" because the project was at this point not drawn sufficient in detail to a regular proper tender.

In autumn 1998 a suspend was applied for and achieved until March 1999 for sheet B of multi-ownership dwellings, which should have been submitted by September. Ownership and multi-ownership groups achieved their financing with Credit Association Denmark and over new year an opportunity was created for the owners to ensure their rents while the rent still was low. Negotiation with RUC took place over shift between Munkesøgård and Nymarksgård and in November one thought that there was a deal. By the end of the year a decision was also made to give up the individual compost toilets regarding among other things cost savings. Instead a solution with urine separation low water flush and communal collecting and composting of faeces worked into the tender material.

The last part of 1998 was mainly about the co-operation with the consulting engineering company Birch & Krogboe about preparing the tender material. It was not very well succeeded, which resulted in that the tender material was not very well described. Therefore the co-operation with Birch & Krogboe was interrupted after the tendering. Once again the co-operation with the external consultants did not work very well.

However there were 8 contractors who were interested in building the houses of which 4 were chosen to make a tender. One of them backed out of the project so in February 1999 three tenders were received from the contractors *Monberg & Thorsen* (*M&T*), *Skanska* and *CC Contractors*. They were all too much expensive so a number of changes and savings were suggested in the project, like not to build communal houses, sun spaces, balconies, solar collectors and much more. With the tenders that were received one was afraid that there would not be much ecology left in the building.

Meanwhile the owner group gathered price information from a minor contractor*, Egen Vinding & Datter* (*EVD*), who had experience with ecological building. It was possible to chose to build with EVD because it was only the social housings that were under rules of EU-supply. This was quite interesting because EVD among other things tendered to build sun spaces at a much lower price.

In the economical priority it was chosen to send out a new tender to RUC which only tendered an equal exchange of real property between the two yards, that means without restorations. This was occasioned by that RUC in February further demanded restoration of *Nymarksgård*, which there were not found money for. RUC replied that they would not accept this tender.

For rented and multi-owner dwellings Roskilde Housing Association (RB) and the management team chose hereafter to negotiate further with M&T and temporary stopped negotiations with Skanska and CC Contractors. M&T contacted EVD to hear about their experiences with low energy windows treated with linseed oil, paper insulation, earth stones etc. some members of the management team had the idea to negotiate a deal about a co-operation between M&T and EVD about the whole project. It ended with a solution where M&T made ground work, fundament and communal systems for all 100 dwellings and EVD built owner-occupied dwellings. This lead also to a co-operation about other parts of the building.

This was a negotiation which gave some new possibilities because EVD's urban ecological competence and low price in some areas could be beneficial to all dwellings. However at the same time the negotiations caused some economical considerations about distribution between the three ownership forms, extra building site costs etc. This caused some serious conflicts between the dwelling groups.

A builder adviser was hereafter involved in the negotiations with M&T, which in co-

operation with RB got the contract with a good result for everyone. An important part of this work have been to make a deal about some distribution keys for the communal systems. A great work was done to make a contract with M&T so sheet B could be passed and building permission could be obtained before the town council went on summer vacation.

Including the two contractors was basically an interesting construction where one has taken benefit of the competence M&T and EVD have in different areas. however it has also been a construction where one had to do something actively for not to create partition between the dwelling groups because of differences between the completed dwellings and one has been very aware of which organisation was achieved about among other things communal systems.

In connection with that the tenders were so expensive the idea raised to save by constructing the communal houses as withbuilt straw houses. This gave at the same time a chance to involve the tenants directly in the building and to learn to know each other in another way, also across the dwelling groups.

After some long contract negotiations, which ended with that the contract with M&T was signed the 19th of May 1999 and also contract with EVD the building construction was started in September 1999.

After the contracts were signed the technical detail solutions were designed and the dwellings were finally designed by new architects. For the 80 dwellings it was Mangor and Nagel and for the other 20 it was EVD. In August 1998 sheet B was approved and the build permission was settled. There were among other things problems with approving the toilet seats that were not VA approved and a lot of work was also done with deciding e.g. how big slope there should be on pipes for gathering urine. When sheet B was approved at the end of August the building permission was still not ready, in fact a lot of work was needed. In stead it succeeded to get dig permission and found permission so the construction could start in the beginning of September.

Meanwhile the owner group had during the spring got approved the building of their communal house as straw house building and was way ahead with the building as self builders. The first spit on the straw house was held as a common festiveness the 22nd of June 1998.

Whole autumn 1999 and January 2000 went with making roads, piping and fill up in ground and found foundations. In February 2000 the work with the central boiler house began. In middle of February M&T delivered the fundaments to the owner group and EVD started hereafter on the building site. After that the construction of the houses went very fast. During March M&T made the roof constructions in family group. Mean while the fundaments etc. were finalised in all groups.

In 1999 there were long clearing and negotiation work both in relation to M&T and the authorities. It was complicated to find out how the different solutions should be designed in best possible way within the available economy.

When the contract with M&T was made just before summer 1999, so-called "reverse tender after negotiation" no one knew that there would be so many problems with small and big building technical relations. There were a number of things that were not very clear in the contract and which therefore was negotiated afterwards and this was both very tiring and time-consuming.

However the negotiations went basically very well. Some solutions were achieved which as a whole could work but not without compromises.

There has also been a lot of authority work in connection with the work in builder group. Especially the building permission has as mentioned take time. A number of relations needed to be defined precisely before the building permission was given. It has been about everything from pipe slopes to fire safety and land planning. In February 2000 right before the first walls on central heat boiler were to be built the complete building permission was finally obtained.

The land planes have created some problems. There have been working on to have as little as possible fixed so that it could develop by it self but some departments in the municipality wanted more detailed planes.

Another problem has been that one wanted to utilise the excess earth from the building site on own area, also to avoid transportation. Among other things one wanted to use some of it for toboggan run but that was refused. In stead the earth was used for establishing Parkvejen, so it was still local but one paid a lot to get rid of it.

The builder group has done a great piece of work and since the participants each have their forces they have supported each other well. It has been a great advantage for the overall project that the owner group has had another contract to compare with. The owner group has often lead a harder negotiation that RB, which probably has moved the level up

so everyone has achieved a better result. There has been a lot of work with re-calculating e.g. the prices of M&T and following with the technical solutions so they were designed as well as possible from the knowledge one could gathered together. Here there were also other from the management and the association that performed a great piece of work in different way.

Parallel with the M&T contract the owner group has designed their houses from EVD and at the same time they have been very diligent with building the straw house and painting approx. 15 km facade boards and put down a floor etc.

The building is built in a jerk and with common solutions. There are however more variation and more experiments at the owner group, especially the straw house but also e.g. some minor mass ovens in the dwellings and paper wool in walls.

Parallel with the building process the three rent groups organised themselves, which resulted in founding of a common department under RB. In the department one has among other things taken care of rules for right of disposal and procedure for moving in. There were no right of direction from the municipality and dispensation was given from regular waiting list procedure after some new rules for joint living.

The dwelling groups have of course also co-operated with builder representatives among other things concerning choice of kitchens, yard spaces, communal houses and the each apartments. There have also been different social activities like summer camp and dwelling group weekends and winter holidays. There have also been round tours on building site in co-operation with M&T.

There was a common topping-out ceremony. In the middle of May 2000.

4. Presentation of the finalised Munkesøgård project

In this chapter photos from Munkesøgård are shown.



Picture 4.1. Plan of settlement of Munkesøgård project with the 5 dwelling groups.





Picture 4.2. Example of wood constructions and unfired earth stones in partition walls between dwellings.



Picture 4.3. There are solar heating system on each of the 5 communal house for production of hot water. Rain water is reused for laundry in the communal house. In the background the Munkesøgård yard is seen.



Picture 4.4. Example of hot water tank in communal house and district heating pipes and connection to solar collector.



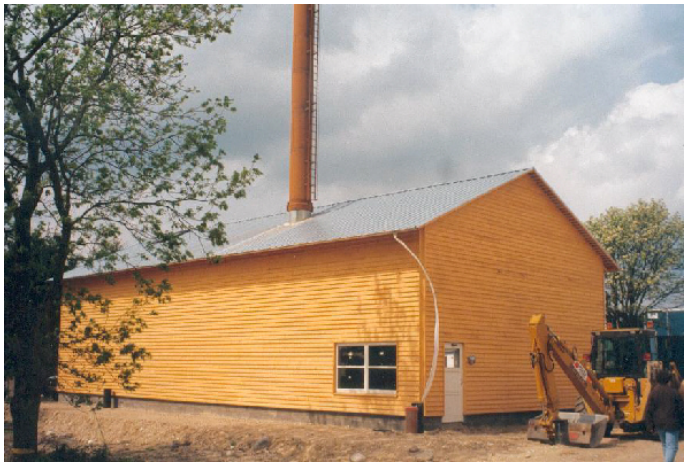
Picture 4.5. Solar collectors for hot water production, here placed on the roofs of the dwellings to obtain a better orientation against south.



Picture 4.6.A. Topping-out ceremony, summer 2000.



Picture 4.6.B. Another picture from topping-out ceremony. Here the inside wood constructions can be seen very clearly.



Picture 4.7.A. Heating station with wood pill oven.





Picture 4.7.B. Wood pill oven and storage of wood pills.



Picture 4.8. Heating station from inside.



Picture 4.9. Owner occupied dwellings, which have maintained the original architectural design that the architects Thure Nielsen & Rubow designed. With small sunspaces, red tiles and a black surface treatment of the wood.



Picture 4.10. There are energy measure equipment for district heat consumption in each apartment, which are easy to read.





Picture 4.11.A. Showing round to mud tanks and sand filters in the settlement.

Picture 4.11.B. Separation toilet in one of the apartments where urine is collected in a special tank



system and after cleaning can be used for manure by local farmer.



Picture 4.12. Exhaust ventilation in the 80 supported dwellings. Fresh air is obtained from fresh air valves in windows. This was obviously a low-cost solution, which does not fit into an ecological building.





Picture 4.13.A. Straw house which is communal house to owner occupied dwellings. The straw walls are seen clearly during the construction but are now plastered.





Picture 4.13.B. Mass oven and the very efficient daylight solution.

Picture 4.13.C. Topping-out ceremony of the house built with one's own hands.





Picture 4.14.A. Official opening summer 2001. Here tent on the parking place.







Picture 4.14.B. Speech by mayor of Roskilde. A cow and a calf were used for a special kind of cow par game. Showing round for the interested people.





Picture 4.14.C Official opening in summer 2001. There were opportunities to play and senior and family dwellings were showed.

5. Result of green account prepared by Munkesøgård association

The total energy consumption for heat and hot water in Munkesøgård is according to the

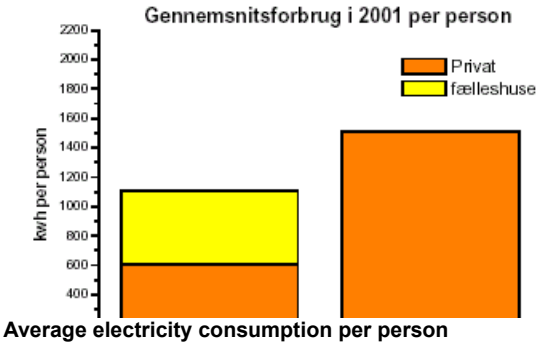
Munkesøgård Association 779 MWh. This is equal to 91 kWh per m^2 dwelling area. Of this is 72 kWh/m^2 for heat consumption. The total energy use for heating is measured to 1.287 MWh. Of this comes 914 MWh from the 188 tons of wood pills that are used in the bio mass heating system and 373 MWh is coming from supplement oil based heating, equal to 37.579 litre oil. The expected oil consumption was only 5.000 litre oil.

8 % of the heat requirement is covered by the local solar heating systems, equal to 58,3 MWh or approx. 240 kWh/m^2 solar collector, which means that 1/3 of the requirement for hot water is covered. This is expected to be increased to 50 % when the last of the 5 solar heating systems is activated and the operation is optimised.

The heat cost has been 622 DKr. per MWh incl. all expenses. The heat consumption per dwelling is 1.530 kWh in average and per person it is 708 kWh in average. At the same time the measurements show that it varies between 142 kWh per person and up to 2.843 kWh per person, which is a very big variation.

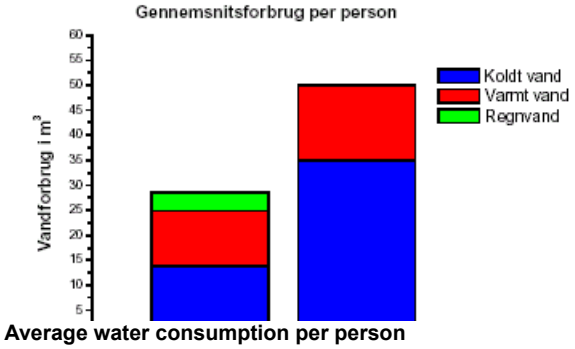
The electricity consumption in the dwellings is of 146.971 kWh, equal to 1.480 kWh per dwelling. For a m^2 it varies between 4,1 and 42,7 kWh with 18 kWh/m^2 in average, equal to 700 kWh per person in average. So also here there is a very big difference in the consumption. The electricity consumption in the communal houses are relatively high with 136.500 kWh, due to many activities here including washing facilities.

The total electricity consumption in Munkesøgård is thus 283,5 MWh or 2.835 kWh per dwelling, which is a little below the normal.



Picture 5.1. Total electricity consumption for Munkesøgård (average per tenant) compared with average for Denmark.

For the water consumption is measured a total consumption of 5.335 m^3, equal to 53 m^3 per dwelling. In communal houses 694 m^3 water is used. In average 25 m^3 water per person is used, which is rather low. The water consumption varies at the same time between 6,5 and 97 m^3 per person.



Picture 5.2. Total water consumption (average per person). The blue area (bottom) shows for cold water, the red area (in middle) shows hot water and the green area (in top, for Munkesøgård only) is use of rain water.

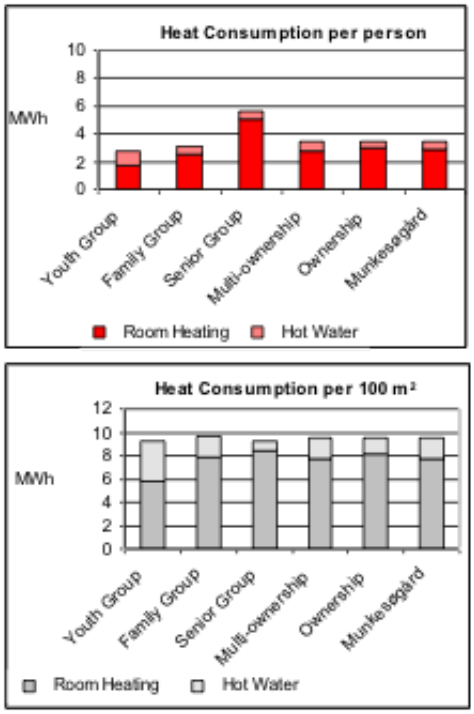
The cost for water was in 2001 37 DKr./m³ and heat cost of Munkesøgård including all expenses according to the heat system was 622 DKr./MWh.

6. Result of green account prepared by Cenergia

Cenergia has prepared a green account for Munkesøgård for year 2001 in a special Excel sheet. The sheet has been brought from homepage of Danish Building and Urban Research.

Further information for use to green account is also gathered from the book "Munkesøgård – En økologisk bebyggelse ved Roskilde" and from the report of Munkesøgård it self about green account for the settlement.

There is approx. 8.870 m^2 heated area in total for dwellings and communal houses together and the number of tenants was in 2001 of 243.



Energy for heating comes from approx. 188.000 kg wood pills and 37.579 litre fuel oil. Further more a total energy amount of 60 MWh was delivered from the sun to water tank of the dwelling groups. Altogether this is equal to approx. 96 kWh heat consumption per m^2 for room heating and hot water use. Of this is approx. 18 kWh7m^2 for hot water use when the sun heat is included. The heat consumption per person is approx. 2,8 MWh for room heating and 0,6 MWh for hot water use.

Picture 6.1. Heat consumption for room heating and hot water use per 100 m^2.

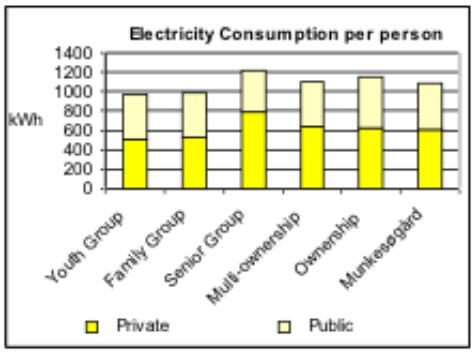
Picture. 6.2. Heat consumption for room heating and hot water use per person.

The two graphs above show that per area unit the heat consumption is almost the same

for the five dwelling groups while it per person is much larger in senior group.

The electricity consumption varies between 1 and 1,2 MWh per person and is thereby also below Danish average. In average there was in whole Munkesøgård an electricity consumption per person of 605 kWh in dwellings and 477 kWh in communal houses.

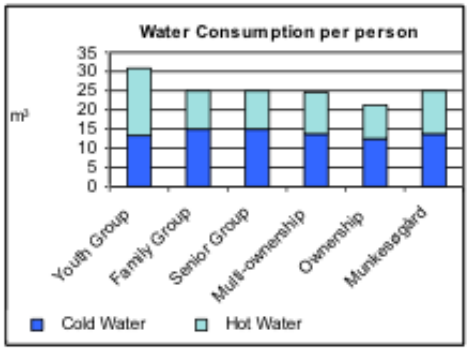
Beside the electricity consumption in dwellings and in communal houses there is also an electricity consumption in other communal installations, which in 2001 was of 5.513 kWh, equal to 22,7 kWh per person. This gives a total electricity consumption of 1.105



kWh in average per person.

Picture. 6.3. Electricity consumption per person for dwellings, communal houses and other communal installations.

The graph above shows that also the electricity consumption is highest for senior group, and youth and family groups have the lowest.



The water consumption is in average approx. 25 m^3 per person, which is very low as shown in table 6.1. The average consumption for whole Munkesøgård of cold water was 14 m^3 and 11 m^3 for hot water per person.

Picture 6.4. Water consumption per person for cold and hot water.

Graph 6.4 shows that the youth group has the highest water consumption per person while owner-ship group has the lowest.

Below in table 6.1 the results for heat, electricity and water consumption in Munkesøgård are compared with Danish average.

	Low consumption	Danish average	High consumption	Munkesøgård
Heat [*MWh per 100 m^2*]	6	11,5	25	9,6
Electricity [*kWh/person*]	800	1.563	2.500	1.105
Water [*m^3/person*]	30	49,6	75	25

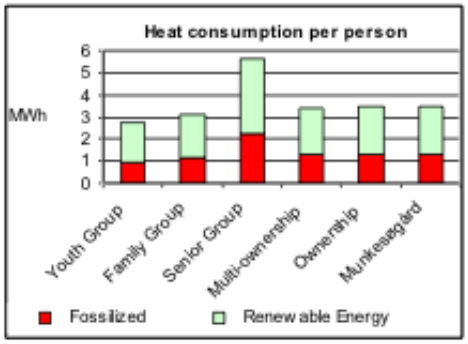
Table 6.1. Consumption of heat, electricity and water for Munkesøgård and Danish average for a year.

Reference: Energy Council and Statistics of Denmark.

As table 6.1 shows are all numbers for Munkesøgård below average.

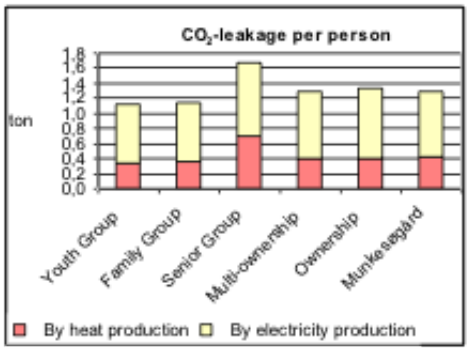
Here is among other things also shown distribution of heat consumption between fossil fuel and renewable energy and CO_2 leakage by heat and electricity productions.

Heat consumption per person is 1,3 MWh from fossil fuels and 2,1 MWh from renewable energy.



Picture 6.4. Heat consumption per person from fossil fuels and renewable energy.

400 kg of CO_2 leakage per person comes from heat production and 900 kg from electricity production, that means that the total CO_2 leakage is 1,3 tons.



Picture 6.5. CO_2-leakage per person by heat and electricity production.

Below in table 6.2 the results for CO_2 leakage in Munkesøgård is compared with Danish average.

	Low consumption	Danish average	High consumption	Munkesøgård
CO_2-leakage [*ton/person*]	1,5	3,2	6	1,3

Table 6.2. CO_2-leakage for Munkesøgård and Danish average.

Reference: Energy Council and Statistics of Denmark.

As it can be seen from table 6.2 above the CO_2 leakage of Munkesøgård is very low.

References

1. Mette Søe Henriksen

   Økologisk Byggeri – Bygherrers erfaringer og beslutningsprocesser belyst ved Munkesøgård-byggeriet, Roskilde

   Specialerapport, Institut for miljøteknologi og samfund, Roskilde Universitets-Center, 2000

2. Peder Vejsig Pedersen

   Udviklingsrapport, maj 2002

   Udviklingsprojektet ”Munkesøgård”, Trekroner i Roskilde

   Cenergia, May 2002

3. Det Økologiske Råd

   Munkesøgård – En økologisk bebyggelse ved Roskilde

   Det Økologiske Råd, december 2002

4. Foreningen Munkesøgård

   Munkesøgårds grønne regnskab 2001

   Foreningen Munkesøgård, 2001