Healthy and Environmentally Correct House Building in Denmark using quality levels A and B

By:

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1. Background

House building in Denmark today is far from being characterised by considerations for urban environmental qualities in order to make house building more healthy and environmentally correct. Healthy and environmental correct house building mean building with an aim to obtain a reduction of resource consumption, environmental stress and an effort to improve natural content, at the same time as the background to secure a healthy indoor climate are ensured.

There are only a few reasonably good examples in Denmark. There is the Munkesøgård development in Roskilde, the Dalgasparken and Hammerthor housing projects in Herning, and the Bioclimatic House 99 buildings at Skejby, Ikast and Kolding, all Jutland. However, generally speaking the urban environmental considerations are only to a modest extent included in the house building, despite the fact that a lot of experience concerning several urban environmental solutions, have been achieved.

In addition to this the experiences achieved show that these buildings, with considerable environmental advantages, actually only require a quite small extra investment in excess as compared to standard buildings. This often corresponds to savings in connection with the operation of the buildings, so the buildings are often not more expensive for the user compared to standard buildings when a total economic perspective (building and operation) is made. Therefore, it seems paradoxical that the investment in more healthy and environmentally correct house building in Denmark are not more widespread.

The reason for the missing initiatives in this area are due to a number of facts. An important reason must be linked to the fact that there is no focus on the total economy in connection with the new building of houses, consequently the economic advantages, when building healthy and environmentally correct, are not part of the decision-making process. Another reason is that there are no guidelines for this kind of initiatives to further in the house building. Certainly there are a number of publications with guidelines and recommendations which can be used as means of inspiration.

However, often as not there is opened up for a wide range of possibilities for various urban environmental initiatives without information of priority and costs which may have an deterrent effect on builders who perhaps are interested in an urban environmental effort, but do not have the necessary funds or the required expertise at their disposal to make the necessary priorities.

2. Objectives

In order to further the initiative in the building of healthy and environmentally correct houses the company Hans Bjerregaard Raadgivning ApS in co-operation with Cenergia prepared a concept on healthy and environmentally correct house building which is meant to be a working tool for the builders interested in healthy and environmentally correct house building.

In the early stages the company PlanEnergi and the architect company Arkitema K/S together with the Housing Association Ringgaarden have made several useful comments to the concept.

The idea is to demonstrate this concept in connection with new building within the housing area.

The proposed new concept for healthy and environmentally correct building consist of two grades, levels A and B respectively, which show the two different levels of the initiative for health and environment in house building.

The contents of the levels A and B will consist of specific demands in the shape of:

- demands for reduction of heating, water and electricity consumption
- demands for specific initiatives as regards health and environment.

These demands have to be documented in order to secure that the level of initiatives as regards health and environment has been achieved.

When demands are made for the initiatives on health and environment in the house building it is important also to take the financial costs into consideration. It is imperative that the initiatives actually improve the health and reduce the environmental stress from the houses. However, of similar importance is it that the required initiative is exactly balanced off compared to the financial costs. So the basis for the concept on healthy and environmentally correct house building in the levels A & B is that it will be possible to carry out the building within the financial realisable frames.

The basis for the two levels is:

Level A specifies an ambitious effort for healthy and environmentally correct house building which is estimated to be realisable with an additional investment of up to 10% compared to present day standard building. This way of building results in savings in the operation phase, especially due to a lower consumption of heat, water and electricity. Thus if a total economic perspective is made (economy for construction and operation) the price for the building is only approximately 5% higher than for a standard building.

Level B specifies a less ambitious effort for healthy and environmentally correct house building compared to grade A, but nevertheless it differs fundamentally from standard building. Level B is estimated to be carried out with an additional investment of maximum 5% compared to present standard building. Savings in the operation phase will, based on the design, result in the fact that the building in a total economic perspective (construction and operation) is cheaper than a standard building.

The contents of the effort on health and environment for the levels A and B have been prepared in relation to the above financial frames. In the next section the demands contained in the levels A and B (section 3), are presented and further two examples of house building which meet the demands mentioned in the levels A and B, one of the reasons being the economy of the building as regards construction and operation (section 4).

3. Healthy and environmentally correct building – Using quality levels A and B

In order to secure a sufficient effort on health and environment, demands covering two areas are made on the levels A and B:

1) Reduction of heating, water and electricity use.
   The building design has to create the background to obtain a low resource use in the operation phase.

Background:

A reduction of the resource use of the buildings is necessary in order to make the building more sustainable. This also has priority in the Construction Management's action plan for sustainable development of the Danish building and construction sector. Focus is placed on reduction of resource use in the operational phase, as this constitutes the chief part of the building resource use in a life cycle perspective. At the same time as an environmental gain is achieved, a considerable financial advantage is gained because the expenses for heating, water and electricity in the life of the building are reduced considerably.

2) Specific measures for health and environment.
   In building a minimum of measures have to be adopted for grades A and B in order to secure health and environment.

Background:

The development within environmentally correct building has come so far that there exist environmental measures which must be considered standard for a building which we characterise as healthy and environmentally correct. There is provided a basis for the implementation of a number of the measures regarding valuable lessons and sound economy. The project group have chosen a number of measures for the levels A and B on basis of an estimate of the measures compared to effect and costs, at the same time it should be possible to set up operational demands for the fulfilment of the measures. This makes the classification a useful tool for the builder because it is indicated which solutions to implement taking the building's economy into account.

In connection with the preparation of the concept, calculations and estimations have been made of the savings and costs connected to the carrying out of the measures for level A and B. On basis of this "a total economic model" has been prepared where examples for building in grades A and B can be gone over.

In the previous phase these calculations have been a tool to adjust the present content of the levels A and B, so they correspond with the financial frames compared to the wish for effort on health and environment.

In this section a calculation example for house building in the levels A and B respectively is presented in order to illustrate the economy connected to the implementation.

4. Examples of housing projects according to the proposed A and B quality levels

4.1 House building in the level A – an example

Below is presented the principal results from a total economic calculation example for a house building which meets the demands for grade A.

QUALITY GRADE A		Investment	Savings	Maintenance
Heating		DKK/habitat	kWh/m²	DKK/year
Passive solar heat design	x	6.000	6,9	0
Heat savings through ventilation	x	10.000	16,4	250
Airtightness	x	2.500	9,7	0
Energy savings through water saving	x	0	2,3	0
Energy savings in view of tenant behaviour	x	1.000	7,7	
Super low-energy windows U-value=1,1	x	5.500	10,0	0
Cold bridges, 50% improvement	x	3.000	5,5	0
Additional insulation	x	6.500	6,3	0
Active solar heating	x	10.000	9,4	200
Sum of chosen initiatives		**44.500**	**56**	450
Water		kr.	%	
General water saving initiatives	x	1.500	15 %	0
Water saving through tenant behaviour	x	1.000	5 %	0
Collection of rainwater	x	10.000	32 %	30
Local bypass of rainwater	x	2.000	0	10
Sum of chosen initiatives		**14.500**	**52 %**	40
Electricity			%	
Low-energy lighting	x	2.000	5 %	0
Electricity savings through ventilation	x	5.000	10 %	0
Electricity savings through tenant behaviour	x	1.000	5 %	0
Hard white goods – Grade A	x	1.000	3 %	0
Roofed clothe drying areas	x	3.000	5 %	0
Daylight optimisation	x	1.000	2 %	0
Preparation for PV	x	1.000	0	0
Sum of chosen initiatives		**14.000**	**30 %**	0
Tenant behaviour				
Visible displays	x	2.000	Mentioned under heating, water and electricity	0
"Urban ecological guidance"	x	500		0
Green accounting	x	500		0
Further initiatives on health and environment				
Environmentally acceptable paint	x	2.000	0	0
PVC free building	x	3.000	0	0
Exclusive "self impregnated" wood	x	1.000	0	0
Alternative insulation materials	x	4.000	0	0
Indoor climate labelled surface materials	x	2.000	0	0
Waste handling	x	2.500	200	0
Composting	x	1.000	0	0
Initiatives for acquiring green areas etc.	x	2.000	0	0
Securing of project quality				
Control through independent consultant	x	5.000	0	0
Total		**95.500**		

Additional investment
The calculated example of a grade A building shows that an additional investment per dwelling is estimated at DKK 95.500,- shared out on DKK 44.500,- on heating measures, DKK 14.500,- on water measures, DKK 14.000,- on electrical measures, DKK 17.500,- on other measures covering health and environment, and finally DKK 5.000,- to secure the project quality. This equals DKK 995,-/m² calculating with dwellings of 96 m². If we assume a standard investment of DKK 10.000,-/m² an **additional investment of 9,95%** is necessary as compared to a standard building.

For this additional investment a building with a considerable effort on furthering of health and environment is obtained. For such a building a marked reduction of the consumption of heat, water and electricity can be expected.

Heating consumption reduced by 61% from 92 kWh/m²/year to 36 kWh/m²/year.

Water consumption reduced by 52% from 45 m³/person/year to 22 m³/person/year.

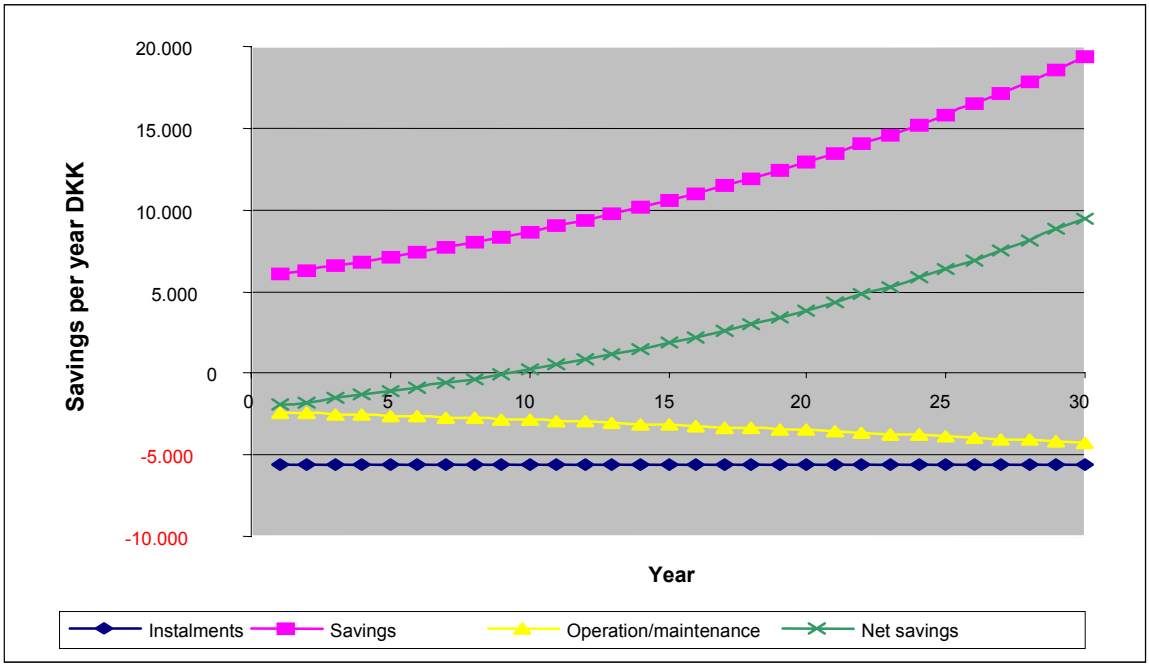
El-consumption reduced by 30% from 1300 kWh/person/year to 915 kWh/person/year.

This totals a CO_2 reduction of 45%.

Total economy – construction/operation
The calculation example for house building in grade A shows an additional investment of about 10% compared to a standard building. In return one gets a house building with a marked lower consumption of heating, water and electricity which result in considerably lower consumer costs compared to a standard building. With the expected rise in prices in mind on heating, water and electricity this lower consumption rate will be of great importance for the total economy of the building over a 30-year-period. Here total economic calculations show that the additional investment corresponds to savings which make the building, in a total economic perspective, a little cheaper than a standard building.

In order to illustrate this, the economy for a 30-year-period is shown on the graph below. Here the expenses in connection with the additional investment shared out on the capital costs (4%), on an annuity loan inclusive the expenses in connection with maintenance (2% for deposit) and operation. Further the yearly savings as a result of a lower consumption of heating, water and electricity are shown. The difference between the expenses and savings show the net saving, also shown on a graph.

The savings involved in level A (summed up per dwelling)



From the figure it appears that the expenses, i.e. capital costs and operation/maintenance, are more or less constant, while the savings increase concurrently with the expected rise of prices on heating, water and electricity. Therefore, the net savings keep rising.

However, from the figure it appears that there is an extra charge (- net saving) the first 9 years (from DKK 1.856,- the first year declining to DKK 83,-, year 9). Whereupon the costs of savings are evened out so that from year 9 a steadily increasing saving (DKK 210,- year 10 to DKK 9.194,- year 30). Looked upon over the whole period of 30 years the building has a profitable economy as compared to a standard building.

Compared to the financial frames shown for level A at the beginning of the document, this calculation example for grade A shows a much improved total economy. So, the financial frames are a conservative estimate where the single buildings, shown in this example, can be total economic favourable.

4.2 House building in the level B – an example

Below is presented the principal results from a total economic calculation example for a house building which meets the demands for grade B.

QUALITY GRADE B		**Investment**	**Savings**	**Running**
Heating		DKK/habitat	kWh/m²	DKK/year
Passive solar heat design	x	6.000	6,9	0
Heat savings through ventilation	x	5.000	5,0	50
Energy savings through water saving	x	0	2,3	0
Energy savings through tenant behaviour	x	1.000	7,7	
Energy windows, U-value=1,4	x	1.500	5,7	0
Cold bridges, 50 % improvement	x	3.000	5,5	0
Additional insulation	x	6.500	6,3	0
Sum of chosen initiatives		**23.000**	**31**	50
Water		Kr.	%	
General water saving initiatives	x	1.500	15 %	0
Water saving through tenant behaviour	x	1.000	5 %	0
Improved collection of rainwater	x	1.000	0 %	0
Sum of chosen initiatives		**3.500**	**20 %**	0
Electricity			%	
Low-energy lighting	x	2.000	5 %	0
Electricity savings through tenant behaviour	x	1.000	5 %	0
Hard white goods – Grade A	x	1.000	3 %	0
Daylight optimisation	x	1.000	2 %	0
Sum of chosen initiatives		**5.000**	**15 %**	0
Tenant behaviour				
Displays in sight	x	2.000	Mentioned under heating, water and electricity	0
”Urban ecological guidance”	x	500		0
Green accounting	x	500		0
Further initiatives on health and environment				
Environmentally acceptable paint	x	2.000	0	0
Exclusive “self impregnated” wood	x	1.000	0	0
Indoor climate labelled surface materials	x	2.000	0	0
Waste handling	x	2.500	200	0
Initiatives for acquiring green areas etc.	x	2.000	0	0
Securing of project quality				
Control through independent consultant	x	5.000	0	0
Total		**46.000**		

Additional investment
The calculated example of a grade B building show that an additional investment per dwelling is estimated at DKK 46.000,- shared out on DKK 23.000,- on heating measures, DKK 3.500,- on water measures, DKK 5.000,- on electrical measures, DKK 9.500,- on other measures covering health and environment, and finally DKK 5.000,- to secure the project quality. This equals DKK 479,-/m² calculating with dwellings of 96 m². If we assume a standard investment of DKK 10.000,-/m² an **additional investment of 4,79%** is necessary as compared to a standard building.

For this additional investment a building with a considerable effort on furthering of health and environment is obtained. For such a building a marked reduction of the consumption of heating, water and electricity can be expected.

Heating consumption reduced by 34% from 92 kWh/m²/year to 61 kWh/m²/year.

Water consumption reduced by 20% from 45 m³/person/year to 35 m³/person/year.

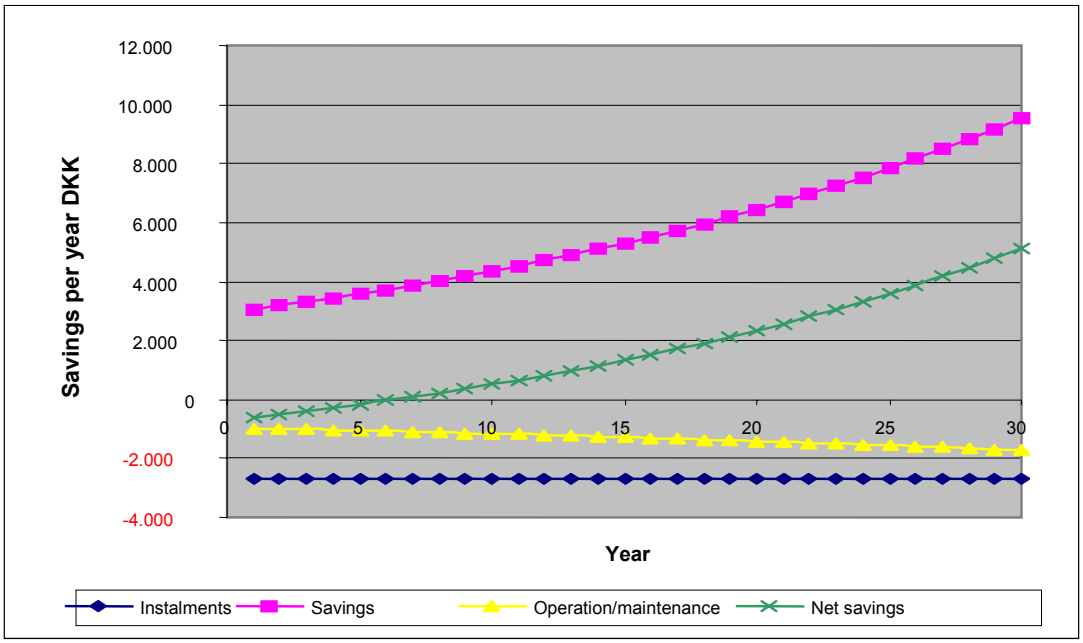
El-consumption reduced by 15% from 1300 kWh/person/year to 1100 kWh/person/year.

This totals a CO_2 reduction of 24%.

Total economy – construction/operation
The calculation example for house building in grade B shows an additional investment of about 5% compared to a standard building. In return one gets a house building with a marked lower consumption of heating, water and electricity which result in considerably lower consumer costs compared to a standard building. With the expected rise in prices in mind on heating, water and electricity this lower consumption rate will be of great importance for the total economy of the building over a 30-year-period. Here total economic calculations show that the additional investment corresponds to savings which make the building, in a total economic perspective, a little cheaper than a standard building.

In order to illustrate this, the economy for a 30-year-period is shown on the graph below. Here the expenses in connection with the additional investment shared out on the capital costs (4%), on an annuity loan inclusive the expenses in connection with maintenance (2% for deposit) and operation. Further the yearly savings as a result of a lower consumption of heating, water and electricity are shown. The difference between the expenses and savings show the net saving, also shown on a graph.

Savings in connection with level B (summed up per dewelling)



From the figure it appears that the expenses, in the shape of capital costs and operation/maintenance, are more or less constant, while the savings increase concurrently with the expected rise of prices on heating, water and electricity. Therefore, the net savings keep rising.

However, from the figure it appears that, similar to grade A, there is an extra charge (- net saving) at the beginning (DKK 600,- the first year declining to DKK 38,-, year 6). But from year 7 the costs of savings are evened out so that there is a steadily increasing saving (DKK 90,- year 7 to DKK 5.134,- year 30). Looked upon over the whole period of 30 years the building has a profitable economy as compared to a standard building.

4.3 Background for savings and additional investment – Level-A

Below the background for savings per dwelling and additional price per dwelling in connection with a diagram on page 18.

Heating
The energy consumption for heating is estimated at 7370 kWh equal to an end-of-terrace house in two floors with a gross floor area of 96 m², and which meets the demands mentioned in the directive for buildings. Energy consumption for heating the domestic hot water is estimated on the basis of a total yearly water consumption for heating the hot domestic water is calculated on the basis of a total yearly water consumption of 1,1 m³/m², 30% of this is domestic hot water. If we assume a heating from 10-50°C, the yearly calculated energy consumption will be 1478 kWh for heating of the domestic hot water. The total yearly net energy consumption is 8850 kWh equal to a standard consumption of 92,2 kWh/m². The standard consumption is converted into energy per heated floor area. The standard consumption also applies to other buildings within the same category – terrace houses and linked houses. Compared to the above standard consumption the energy consumption can be reduced by introducing the economic measures mentioned below.

Passive solar heating: Saving of 6,9 kWh/m²/year, estimated additional price DKK 6.000,-.
In this example a solution has been chosen where passive solar heating is made use of by using a structural engineering with a large thermal mass as well as a distribution of windows facing south. Using a technical method of calculation a large thermal mass and distribution of windows with 10 m² facing south and 4 m² facing north have been defined. In the standard building the windows are placed evenly in the south and north aspect of the building.

Heat saving through ventilation: Saving of 26,1 kWh/m²/year, estimated additional price DKK 17.500,- (DKK 10.000,- heating savings through ventilation + DKK 2.500,- through airtightness + DKK 5.000,- through electrical savings through ventilation).
Ventilation with heat recovery is implemented with a mechanical ventilation system with inlet and outlet air flow and heat recovery between the inlet and outlet air. The volume of air is estimated at 126 m³/h and the temperature actual efficiency of 80% together with an average infiltration of 0,25 times per hour. The standard consumption is calculated for natural ventilation with an average ventilation of 126 m³/h equal to an air change of 0,61 times per hour. The yearly saving estimated at 16,4 kWh/m².
Furthermore the tightness is improved so that the infiltration is reduced from 0,25 to 0,10 times per hour giving a yearly saving of 9,7 kWh/m².

Additional insulation: Saving of 6,3 kWh/m²/year, estimated additional price of DKK 6.500,-. Concerning additional insulation 50 mm is allowed for.

Low-energy windows: Saving of 10,0 kWh/m²/year, estimated additional price of DKK 5.500,-. If super low-energy windows, with a heat loss of 1,1 W/m²K, is used, the yearly heat consumption is reduced with 10,0 kWh/m² compared to windows with a heat loss of 1,8 W/m²K.

Cold bridges: Saving of 5,5 kWh/m²/year, estimated additional price DKK 3.000,-.
If the heat loss from the cold bridges is reduced by 50% the yearly heat consumption is reduced by 5,5 kWh/m². For the standard consumption is estimated a heat loss from cold bridges which just meets the demands of the building directive.

Solar collector: Saving of 9,4 kWh/m²/year, estimated additional price DKK 10.000,-.
If the solar heating is used as supplementary heat source for the DHW a yearly saving of 900 kWh is obtained equal to a yield from a 2 m² solar collector. This gives a saving of 9,4 kWh/m² for the standard housing.

Hot water saving: Saving of 2,3 kWh/m²/year.
By implementing a water saving a reduced amount of DHW can be obtained and energy is saved.

Heat saving through user behaviour: Saving of 7,7 kWh/m²/year.
By lowering the indoor temperature 1°C a yearly heat saving of 7.7 kWh/m² is obtained.

By implementing a single of the above mentioned suggestions an energy saving as described can be obtained. When implementing several of the suggestions the energy savings cannot be found simply by adding the saving of each suggestion. A correction factor has been implemented which reduces the contribution of the single suggestion to the total heat saving when more than one measure is chosen.

Water use

Standard water saving measures: Saving of 15%, estimated additional price DKK 1.500,-.
In households the consumption of water for baths and personal hygiene total 36% and lavatory flushing 27% and the households' total consumption (63%) (Copenhagen Energy). If we assume that 25% of this consumption can be saved by installation of water saving fittings and toilets compared to standard installations, a saving of 15% is obtained.

Re-use of rainwater: Saving of 32%, estimated additional price DK 10.000,-.
In a household washing amounts to 13% and lavatory flushing 27% of the total household consumption (40%) (Copenhagen Energy). If we assume that it is only technical and economic attractive to cover 80% of this consumption with rainwater a saving of 32% will be achieved. (Appendix from the report on Teglmosegrunden). The price for a rainwater reception facility for clothes washing as well as for lavatory flushing will vary somewhat in price depending on the single project. Figures based on experience (published by Nyrup Plast) show that these facilities can be installed in new building for a price of 5.000-10.000,- per dwelling.

Local use of rainwater: No saving, estimated additional price DKK 2.000,-.

User behaviour: Saving: 5%, estimated additional price DKK 1.000-1.500,-.
A 5% saving of the water consumption is estimated when influencing the behaviour of the user through visible displays, tenants' instructions and green accounts. These measures are expected to be implemented for DKK 2.000-3.000,-per dwelling (expenses equally distributed on electricity and water).

Electricity use

Low-energy lighting: Saving 5%, estimated additional price DKK 1.000-1.500,-.
I housing: Estimate of 2-3%, lighting makes up 16% of the electricity consumption in households and low-energy bulbs save 75% as compared to standard filament bulbs (Elsparefonden) which gives a potential of 12% when changing to low-energy bulbs. Only a small part of the consumption is due to lighting in hall, lavatory and cooker hood (installed by builder), probably only 2-3%. But a somewhat larger potential through user behaviour (low-energy bulbs).
Communal areas: If we assume that joint electricity consumption (lighting, communal laundry, pumps, ventilation etc.) make up 20% of the total consumption where lighting makes up 25% of this (5% of the total consumption) (low-energy electricals) and DKK 500,- for effort on common consumption (low-energy electricals, control of lighting etc.).

Hard white goods energy label A: Saving of 3%, estimated additional price of DKK 1.000,-.
Washing, cooling, freeze ~ 30% of households. (Elsparefonden) if a 20% saving is estimated (as per www.a-klubben.dk a 10-30% saving can be obtained (cooling/freeze) as compared to mark B) 6% saving can be obtained. If we assume that refrigerator / freezer locker make up half, 3% is obtained. It is estimated that A marked refrigerator / freezer locker can be purchased at an additional price of DKK 1.000,-.

Roofed clothes yards: Saving of 5%, estimated additional price of DKK 3.000,-.
Electricity consumption for washing and clothes drying make up 10-12% of the household consumption (Elsparefonden). If we assume that electricity consumption for using a drying drum make up half we will get a saving potentiale og 5-6%.

Prepared for PV integration: No saving, estimated additional price DKK 1.000,-.
Expenses primarily in connection with planning as to space for PV etc., however, some expenses for el-tomrør? etc.

Daylight optimisation: Saving of 2%, estimated additional price of DKK 1.000,-.
Lighting makes up 16% of the electricity use (Elsparefonden). If the requirement for electricity for lightning is reduced with 33% due to daylight optimisation 5% can be obtained, however, if A bulbs are installed the electrical consumption will be reduced by 75%, so actually only 1-3%. Large window areas will increase the price the building, but the expense for this is covered by the expenses for utilization of passiv solar heat thus the additional price here should be seen as compared to design and planning.

User behaviour: Saving of 5%, estimated additional price DKK 1.000-1.500,-.
It is estimated that a 5% saving on the electrical consumption is possible by influencing user behaviour using visible displays, tenants' instructions and green accounting.This is expected carried out for DKK 2.000-3.000,- per housing (expense distributed on electricity and water).

Measures to further health and environment
"Healthy" and environmentally acceptable paint: Estimated additional price of DKK 2.000,-.
The Environmentally acceptable paint do not necessarily be more expensive than a standard paint of good quality (Pierre, Green Guide, Hjortshøj). However, actually it might be more expensive than standard painting. Samtidig med at sandsynligvis er ekstra arbejde forbundet med krav om miljøvenlig maling?

PVC-free building: Estimated additional price DKK 3.000,-.
PVC-free conduits for electrical wiring: The price for conduits for electrical wiring is approximately double which per housing equals about DKK 1.000-2.000,- per housing (VMC elteknik, www.vmc.dk) Other PVC-free installations (drains, water installations, windows etc.), estimate DKK 2.000,-. Quality and availability of PVC-free alternative installations have gone up and at the same time the prices are falling. For example the Daimler Chrysler concern (1999) is located in a PVC-free building where the additional building price actually was limited. The Engineering House is also a PVC-free house (1998).

Exclusive of pressure treated wood: Estimated additional price DKK 1.000,-.
The replacement of pressure treated wood by a real type of wood do not necessarily result in actual additional investment. For example the use of larch on the facade of the house building in Hjortshøj did not resulted in additional investment.

Alternative insulation materials: Estimated additional price DKK 4.000,-.
A new building in Randers (8 dwellings) was insulated using paper wool which resulted in an additional price of DKK 34.104,- (Environmental insulation in Kvarterløft in Randers-part report 1) which equals DKK 4.250,- per housing. The additional expense is more related to the design change, increase in the cost of subcontractors than to an actual additional price for paper wool.

Indoor air-climate surface materials with indoor air-climate labels: Estimated additional price DKK 2.000,-.
Danish Indoor Climate Labels estimate that articles, with indoor climate label, only cost a little more and the additional price is mainly due to planning etc.

Waste handling: Estimated additional price DKK 2.000,-, saving of DKK 200,- per year.
Experiences from refuse projects in Nørrebro, Copenhagen, show an approximate investment of DKK 220.000,- for the establishing of local waste handling unit for 60 apartments equal to DKK 3.666,- per apartment. The actual additional investment as compared to the establishing of a standard waste disposal is considered to be somewhat lower. The various municipalities do not agree whether to collect a fixed yearly refuse charge or to collect a differientiated refuse charge (for example depending on the size of container, number of strippings, weight). The yearly waste collection expences are between DKK 1.000-3.000,- per household (www.affaldsinfo.dk). A minimum of a saving of DKK 200, - per year per household is estimated.

Composting: Estimated additional price DKK 1.000,-.
Facilities for compost preparation using, for example, a compost roller. Estimated at DKK 100.000,- for the Teglmosegrunden in Albertslund (129 apartments).

Measures for green areas: Estimated additional price DKK 5.000,-.
An effort is required when planning (minimize belagte? areas, construction sites etc.) and the laying out of green commons which differ from standard.

Securing of project quality
Securing of project quality: Estimated additional price DKK 5.000,-.
It is estimated that an independant specialist consultant can make a securing of project quality for DKK 5.000,- per building.

4.4 Background for saving and additional investment – class B

As starting point the same calculations as for A. There are a couple of changes and observations.

Heating

Passive solar heat: Similar to A.
For the sake of simplicity the same calculations as used in A.

Heat saving through ventilation: Saving of 5 kWh/m²/year, estimated additional price DKK 5.000,-.
Natural ventilation with preheating in *solbrystninger?* which is estimated to save 5 kWh/m²/year compared to traditional solutions.

Low energy efficient windows: Saving of 5,7 kWh/m²/year, estimated additional price DKK 1.500,-.
Energy efficient windows with a heatloss of 1,4 W/m²K reduces the yearly heat consumption with 5,7 kWh/m² compared to windows with a heat loss of 1,8 W/m²K.

Additional insulation: The same as A
For the sake of simplicity the same calculations as used for A.

Water

Catching of rainwater: No savings, estimated additional price DKK 1.000,-.
Here catching of rainwater is prepared.

4.5 Design basis

Dwelling size (unit)	m²	96
Price for heating inclusive VAT	DKK/kWh	0,48
Price for water inclusive VAT	DKK/m³	29,75
Price for electricity inclusive VAT	DKK/kWh	1,75
Heating used for domestic hot water (DHW)	kWh/m²	15,4
Standard consumption for heating	MJ/m²	76,8
Standard consumption, heating + DHW	kWh/m²	92,2
Standard consumption, electricity	kWh/m²	32,0
Standard consumption, water incl. DHW	m³/m²	1,1
Standard consumption DHW		30 %
Set aside (maintenance)	%	2 %
Expected economic life	år	30
Nominal costing interest	rn	4 %
Rate of taxation on interest yield	s	0 %
Expected cost escalation rate for energy	ie	4 %
Expected cost escalation rate for current expenses	iu	2 %

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