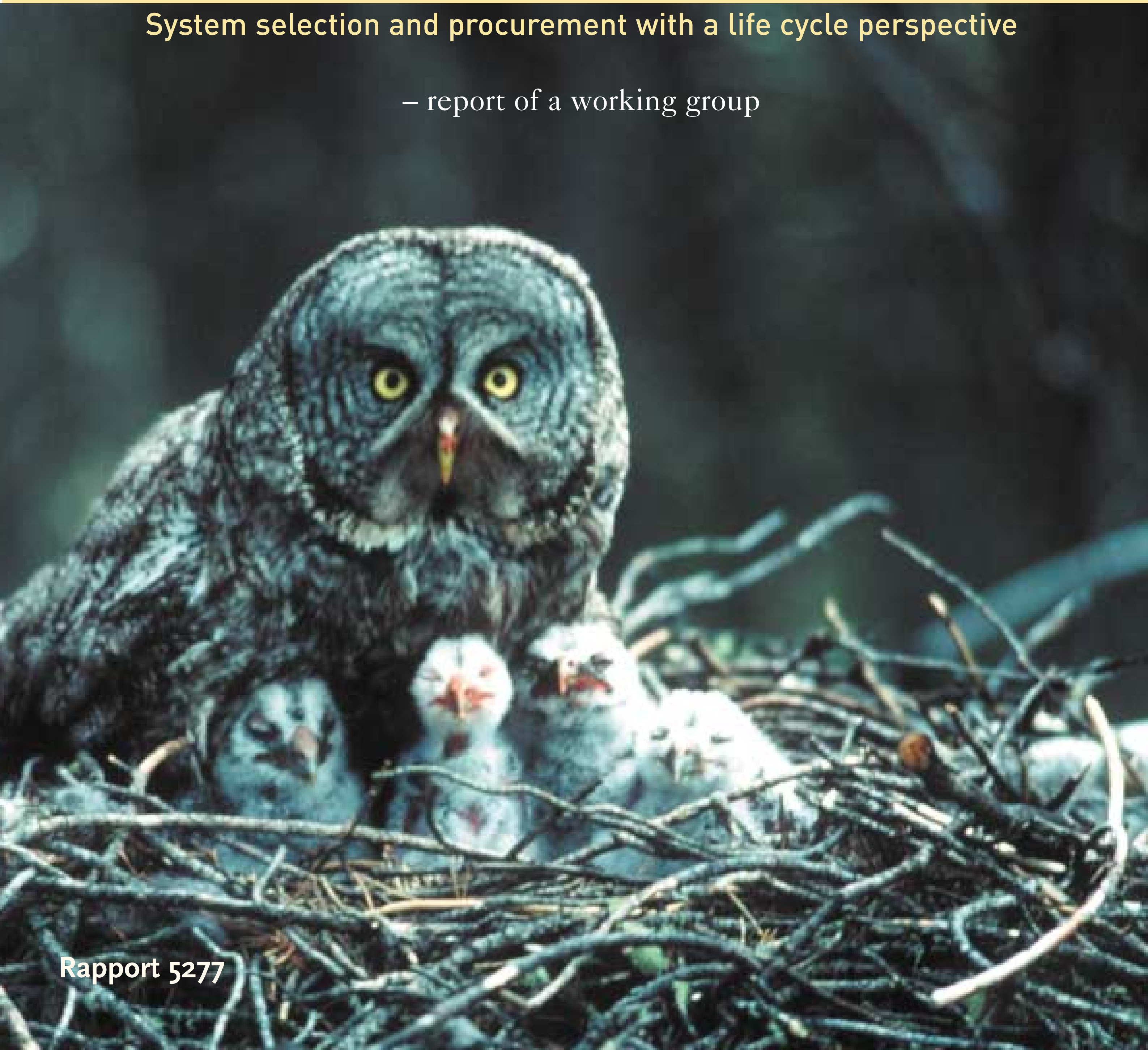
Building, Living and Property Management for the Future



Building, Living and Property Management for the Future

System selection and procurement with a life cycle perspective

– report of a working group

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Preface

Great efforts are required on the part of both state and local government and the business community if we are to achieve the goal of sustainable development. The building and property sector has a huge impact on the environment in Sweden. How should we build, manage and live in buildings in a way that minimizes the load on the environment and satisfies our need for comfort, light, warmth and a healthy indoor environment? And how should we plan our communities?

This is the subject of the broadly-conceived dialogue called Building/Living ("Bygga/Bo" in Swedish) that has been held between the state and the private business sector, with sights set on achieving a sustainable building and property sector 25 years from now. The method being used is called "backcasting" and involves first defining a vision for the future and then discussing what strategies and measures are needed to achieve the desired goal.

The dialogue has taken place in two phases. In the first phase, 20 companies, three municipalities and the Environmental Advisory Council came up with visions, goals and strategies. The results are presented in the report *Think new, think sustainable! _ building and managing properties for the future* (in Swedish only). In the second phase, six working groups with participants from companies and municipalities have pursued this dialogue in greater depth and formulated concrete proposals for measures and voluntary agreements to achieve a sustainable building and property sector. The work has been coordinated by an information group. The Ministry of the Environment has been in charge of this part of the dialogue. The results of the working group are presented in this report: "System selection and procurement with a life cycle perspective and a holistic view".

Building structures have a relatively long lifetime and are subject to periodic alteration and renovation. The long operating period accounts for approximately 85% of the lifetime environmental impact. This makes it important to design building structures, technical systems, materials etc. with a view towards their entire life cycle and not just the initial investment phase. If more consideration is given to the whole life cycle in planning and design, environmental impact can be substantially reduced. The working group has come up with proposals for measures to improve the selection of systems – design of building structures, technical installations and complements – and procurement based on a life cycle perspective and a holistic view.

All the members of the working group deserve credit for a job well done:

Anders Nilson, Bengt Dahlgren AB, Energy and Environment Dept., Gothenburg, *Chairman*

Kajsa Sundberg, Swedish Environmental Protection Agency, Stockholm, *secretary*

Carl-Erik Augustsson[1] , AB Svenska Bostäder, Stockholm, *through December 2001*

Kristina Gabrielii, NCC AB, Gothenburg

Eva Gabrielsson[2] , Ministry of the Environment, Stockholm, *through July 2001*

Jonas Gräslund, Skanska Fastigheter Stockholm AB, Solna

Gunilla Haglund, Vasakronan AB, Region West, Gothenburg

Bjarne Harved, Stadsfastigheter Malmö, Malmö

Jari Lalli[3] , National Property Board, Stockholm, *through September 2001*

Mikael Nutsos, Locum AB, Stockholm

Jan Sällström, Platzer Fastigheter AB, Gothenburg

In certain meetings of the working group, the following persons have also offered valuable viewpoints within their respective spheres of activity and competence:

Rolf Simón, Forum Fastighetsekonomi AB

Eva Sterner, Luleå University of Technology

Martin Bergdahl, Landstingsfastigheter, Dalarna

Stockholm, April 2003

Anders Nilson
Chairman

Kajsa Sundberg
Secretary

[1] Currently assigned elsewhere

[2] Currently assigned elsewhere

[3] Other duties relating to government-owned buildings, requiring changed priorities

Contents

1 *Summary*

1.1 Proposals for agreements and initiatives

The working group “system selection and procurement with a life cycle perspective and a holistic view” has come up with a number of initiatives which it proposes that the actors within the building and property sector undertake by voluntary agreement between the business community and the state.

A fundamental measure is that the participating companies and municipalities who select systems – design buildings and facilities and select and design technical installations – and purchase services and products lend their support to the following principles to achieve long-term sustainability:

- To comply with legislation and promote compliance with the rules of consideration of the Environmental Code,
- To establish a level of ambition for own environmental work and formulate simple and clear requirements,
- To prepare clear and consistent documents as a basis for tenders with regard to requirements, goals and other parameters of importance for environmental impact,
- To behave consistently and fairly in the evaluation of tenders against environmental requirements,
- To follow up and evaluate experience from contracts and projects entered into,
- To use procurement methodologies that ensure constant improvements,
- To work actively for progress in the sector towards achieving long-term sustainability, for example via collaboration with suppliers and customers.

Other proposals are that participating companies and municipalities undertake:

- To analyze functions, buildings, facilities and subsystems based on a holistic view and a life cycle perspective,
- To regularly carry out life cycle costing (LCC) when selecting systems (designing buildings and facilities and selection of technical installations) and to take life cycle costs and environmental impact into consideration when procuring major parts and components,
- To have managerial staff undergo training in life cycle thinking (LCA and LCC) during 2003/2004; the training should be co-funded with the state; this training should then be regularly repeated,
- To regularly formulate and use project-specific environmental programmes.

According to the group’s proposals, such an agreement between the state and the business community should also entail:

- That the state adopt similar measures with regard to its activities in the building and property sector,
- That the state furthermore undertake to develop standardized data to be used in life cycle assessment.

A more detailed description of the dialogue project – vision, goals, organization, participating companies, etc. – is provided in Chapters 2–3 and in appendices.

1.2 The dialogue project – whole and parts

The purpose of the dialogue project "Building, Living and Property Management for the Future" is to achieve a sustainable building and property sector by means of cooperation between the sector and local and state government.

In the first phase of the dialogue, twenty companies, three municipalities and the Environmental Advisory Council agreed on a vision of sustainable development – a desirable future in 25 years – and on seven prioritized goals for the future. In the second phase of the dialogue project, a number of working groups have then come up with proposals for concrete measures and voluntary agreements on initiatives to achieve these goals. The Ministry of the Environment has been in charge of this second phase. The six working groups have had responsibility for the strategic areas defined in the dialogue group:

1. Sustainable community planning
2. Use of best available technology (BAT) and need for research and development (R&D) for good environmental solutions,
3. System selection and procurement with a life cycle perspective and a holistic view
4. Quality and efficiency in the building and property management process
5. Classification of residential and commercial premises with regard to energy, environment and health,
6. Property management for a better built environment.

The working groups rank their proposals for measures and voluntary agreements in order of priority. The steering group for the dialogue project then makes a selection of the prioritized proposals. The state and the business community – the companies, municipalities and organizations participating in the dialogue project – then reach an agreement regarding these proposals for initiatives. Subsequently, other companies, municipalities and organizations are invited to conclude agreements.

A more detailed description of the dialogue project – vision, goals, organization, participating companies, etc. – is provided in Chapter 5, Background of the dialogue project.

2 *Voluntary agreements on initiatives*

2.1 Background

The design of a building structure (buildings and facilities), its complements and installations defines the premises for how it can be used and how great its environmental impact will be, but placement and siting are also of great importance, as well as how it is used. A building structure is a whole in which the parts interact and are of importance for how great the environmental effects and costs will be during the structure's entire life cycle.

In the case of existing development, many of these parameters are already fixed – siting and design of building structures that often last for over 100 years. Environmental requirements can then be imposed at different times and in different ways during the operating phase, not only in connection with procurement, but also in connection with renovation and alteration, demolition or rental. It is often easier to make substantial environmental gains when building new structures than when renovating and maintaining existing structures.

Different choices that must be made for new buildings concern their placement in the landscape and compass orientation, window size and orientation, heat transmission coefficient (k-value), exploitation of and shielding against incoming solar radiation, thermal insulation and air-tightness, materials including chemicals, heavy or light framework, heating and ventilation systems, floor plan (e.g. whether a house has a draught-proof vestibule) and how efficiently the areas can be used, technical solutions and installations for water (only drinking water or split water systems) and sewerage (separating or not), plus waste (garbage separation, composting plant, waste disposer unit, other) etc.

The building sector in Sweden accounts for about 40% of the energy use, 50% of the electricity use and 40% of the material flows in the country. This means it accounts for a substantial portion of the environmental impact as well. In addition, the indoor environment in many buildings is not satisfactory. Methods for designing building structures and selecting technical systems, as well as procurement with a life cycle perspective and a holistic view, are needed to reduce the sector's environmental impact. This applies to both existing and new building structures. The building stock is renewed at the rate of about 1% per annum, which means most of the buildings that will exist in 25 years exist today!

The environmental impact caused by a building structure in its entire life cycle derives mainly from the use of energy, materials and hazardous substances, extraction of raw materials, land use and noise. Today, the operating phase of existing buildings accounts for about 85% of its environmental impact, while construction accounts for about 15% in the case of new buildings, operation accounts for a smaller portion in many cases.

Life cycle assessment (LCA) and life cycle costing (LCC) are the primary means used to calculate a building structure's environmental impact and costs (see section 3.4.6 Environmental assessments and the examples in Appendix 1).

Installations for HVAC, electricity, and control and monitoring systems in buildings account for an increasing portion of the total construction cost and the operating costs. In 1950, these installations accounted for 10% of the total construction cost of residential and commercial premises. 40 years later, in 1990, these systems accounted for 20%

of the total construction cost of residences, more than 30% for offices and more than 40% for hospitals.

The technical installation systems'share of thetotal construction cost for new construction 1950 and 1990.

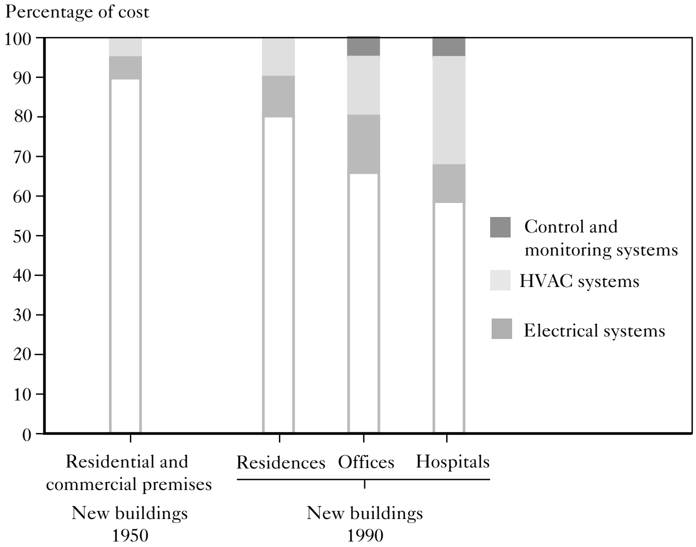

Figure 1
The technical installation systems' share of the total construction cost. Source: Byggnaden i focus. Byggnad och byggande i helhetsperspektiv. IVA's publication series Kompetensutveckling. IVA, March 1998 (IVA = Royal Academy of Engineering Sciences)

These installations are more or less energy-demanding in the operating phase, and different kinds of energy are used. To assess the environmental impact caused by this energy use, it is important to distinguish between electricity and heat, see Figure 2 below.

Energy use in the Swedish building stock...

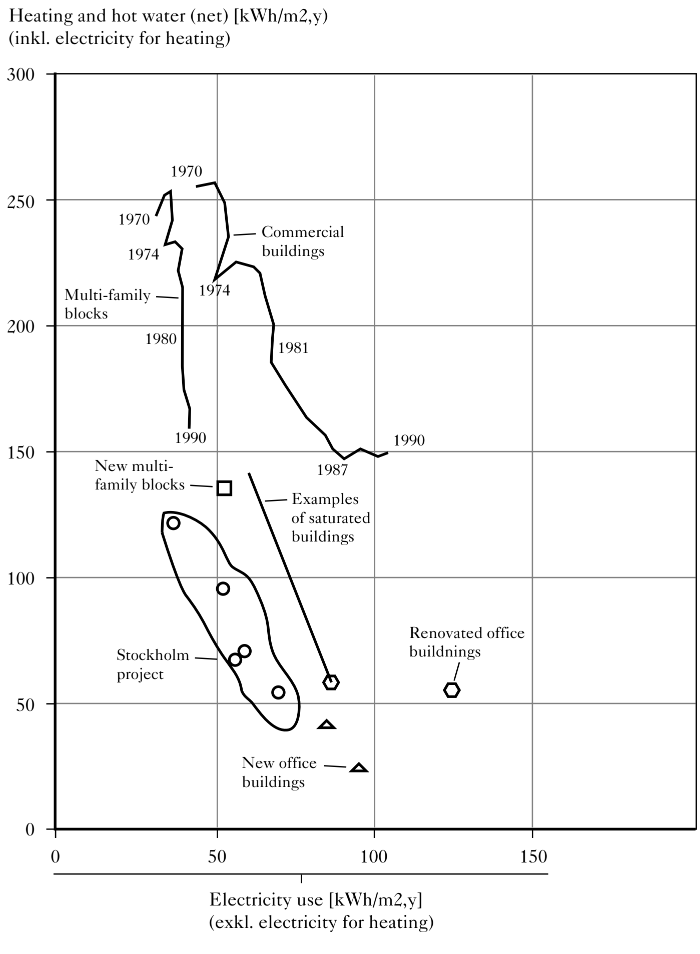

Figure 2
Energy use in the Swedish building stock .
Source: The Energy Book, Swedish Council for Building Research, T6:1996 and Bengt Dahlgren AB/CTH Installationsteknik

Energy use for multi-family blocks and commercial buildings is shown in the figure, broken down into electricity use (excluding electricity for heating) and energy for heating and hot water (including electricity for heating). The data in the figure have been taken from various studies. The Stockholm project is the name of six experimentally built residential buildings in Stockholm erected between 1982 and 1985 and designed to be energy-efficient. Figure 2 shows that energy for heating and hot water has declined, while electricity use has increased counted as kWh/m^2,y. This is most significant for commercial buildings. This means that the building and its installations must be viewed as a whole (holistically) and both heat and electricity use must be analyzed, not just energy use in general. This imposes corresponding requirements on how a building's key figures for energy use must be reported.

2.2 Problem description – relevant questions

A building structure has a relatively long life, usually more than 50 years and often more than 100 years. The operating period is long, and includes periodic alteration and renovation.

During the design phase, a structure's design, technical systems, materials, etc., are selected on the basis of a building programme, a room function programme, etc., for the particular property and its use. Far too often, the focus today is mainly on the investment cost. Far too little consideration is paid to how design, installations, local climate and use interact, and what the maintenance needs will be for different choices. This is true in spite of the fact that the environmental impact of the construction phase is currently approximately 15 % of the total impact for the entire life cycle, while the operating phase accounts for about 85%, see Figure 3. If greater consideration is given during planning to the operating phase than is the case today, environmental impact and even costs for the entire life cycle can often be reduced. The fact that this isn't done can be regarded as a serious "system fault". There are many reasons for this, and the following factors are involved:

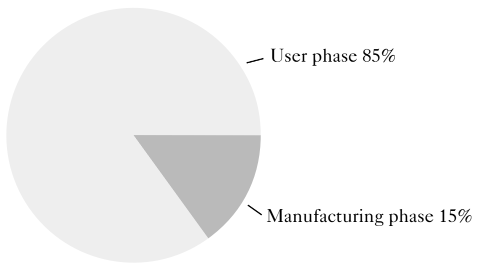

Figure 3
Current average percentages of environmental impact from construction and use of a building. The demolition phase is marginal and has therefore been omitted in the figure. Source: Bengt Dahlgren AB

Organization

- The building process is traditional and highly fragmented, with many steps between the client's intentions and the finished building.
- Different areas of responsibility and organizations within the companies. The documents are devised for production and are not focused mainly on management, even though these aspects are also considered.
- Short project times.

Economics

- The investment cost often increases. With different budgets for investment and operation and maintenance, it can be difficult to justify extra costs in the investment phase, even if it pays in the end.
- The tax assessment value increases, and with it the property tax.
- Unfortunately, customary principles for property valuation take only limited account of operating costs. Investments that give low environmental impact and operating costs over the entire life cycle do not usually affect the market value.

Knowledge

- Inadequate knowledge among management, staff and suppliers regarding system interrelationships and the connection between investment and operating cost. Unfortunately, the competence of owners has been undermined in recent years, as has been pointed out by the Royal Academy of Engineering Sciences (IVA).
- Inadequate awareness of existing knowledge.

Technology

- Complex systems may make it difficult to calculate life cycle costs and to keep track of them during the operating period.
- Advanced technology makes heavy demands on competence and organization, which can make it hard to foresee consequences in the future.
- Traditionally low level of technical development in the building sector.

Miscellaneous

- Political decisions on the national and EU level.
- Uncertainty regarding the development of e.g. rates and costs.

Problems of varying nature and origin exist when it comes to bringing about sustainable development in the building and property sector. The working group has identified and compiled obstacles and opportunities in Chapter 3, broken down into organization, economics, knowledge, technology and structure.

2.3 Proposals for commitments

Based on the problems and opportunities that have been identified (see Chapter 3), the working group "System selection and procurement with a life cycle perspective and a holistic view" has arrived at the following proposals for commitments:

Commitment 1:

Participating companies and municipalities support the principles presented below for system selection and procurement with long-term sustainability.

Commitment 2:

Participating companies and municipalities undertake to analyze functions, building structures and subsystems based on a holistic view and a life cycle perspective.

Comment: How this can be done is described in greater detail in Appendix 1, Work procedure and methods.

Commitment 3:

Participating companies and municipalities undertake to regularly carry out LCC analyses when selecting systems – design of buildings, technical installations and complements. Furthermore, procurement of major building parts and components shall be done with consideration given to LCC. Where necessary, the LCC analyses shall be supplemented with LCA limited to relevant parts.

Comment: How this can be done is described in greater detail in Appendix 1, Work procedure and methods. Tools that can help in this work are identified in 3.4.6 Environmental assessments and in Appendix 1.

Commitment 4:

Participating companies and municipalities undertake to have managerial staff undergo training in life cycle thinking, LCA and LCC, during 2003/2004. Such training shall be co-funded with the state. This training shall then be repeated at regular intervals.

Comment: Section 3.4.6 and Appendix 1 deal with topics related to this training.

Commitment 5:

Participating companies and municipalities undertake to regularly prepare and use project-specific environmental programmes.

Commitment by the state:

- That the state adopt similar measures with regard to its activities in the building and property sector;
- That the state furthermore undertake to develop standardized data to be used in life cycle assessment (LCA).

Principles for system selection and procurement with long-term sustainability:

In system selection and procurement work, participating companies and municipalities undertake:

- To comply with legislation and promote compliance with the rules of consideration of the Environmental Code,
- To establish a level of ambition for own environmental work and formulate simple and clear requirements,
- To prepare clear and consistent documents as a basis for tenders with regard to requirements, goals and other parameters of importance for environmental impact,
- To behave consistently and fairly in the evaluation of tenders against environmental requirements,
- To follow up and evaluate experience from contracts and projects entered into,
- To use procurement methodologies that ensure constant improvements,
- To work actively for progress in the sector towards achieving long-term sustainability, for example via collaboration with suppliers and customers.

2.4 Concerned parties

In the initial phase, the proposals for measures within the building and property sector that have been arrived at by the working group concern the state and the companies and municipalities included in the dialogue. All actors in the sector (clients and property-owners, consultants, contractors and material manufacturers) who do not participate in the dialogue can thereafter commit themselves to adopt measures included in the agreement.

The client/property-owner is the key actor for creating a working integration between the long management period and the shorter design and construction period so that all parts of the project are implemented with a life cycle perspective and a holistic view. The client or his agent sets the tone for the collaboration and the mutual respect within and between the consultancy group and the contractor. The choice of architect and technical consultants and the formulation of conditions for their work are strategic for ensuring good quality – architectural, technical and environmental – in construction and management.

Consultants – architects and others – work with building projects in their early phases, both new construction and alteration projects, and their work and knowledge is of great importance for the structure during its life cycle.

The contractors execute the building projects, and it is in this phase that the intentions of the project are turned into practical action.

The material manufacturers deliver parts and components that are used in the buildings. Selection and handling of raw materials is of importance throughout the life cycle for both sustainability and environmental impact.

More detailed requirements on various actors involved in building projects to permit work towards sustainable development are presented in section 3.4.3.

3 *Work of the working group*

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
Brundtland Commission, 1988

3.1 Tasks and goals

The goal of the group's work has been to contribute to sustainable development within the building and property sector. The group's task has been to present methods for both system selection and procurement based on a holistic view and consideration of the entire life cycle of a building.

The goal is that total environmental impact should be lower in the future. In the building sector, this may entail that construction accounts for a larger portion of the environmental impact, as well as for a greater absolute environmental impact, while operation accounts for both a smaller portion and less total impact. Today, environmental impact from the use phase of the existing building stock accounts for about 85% of the total, with 15% coming from construction. Operation often accounts for a smaller portion of the environmental impact of new buildings.

In order to achieve long-term sustainable development in the building sector, the environmental work should be concentrated on:

- Minimizing the environmental impact caused by the building's energy use, i.e. with respect to local conditions, primary energy, conversion losses for heating, cooling and electricity, etc. Choice of location of buildings, design, technical systems and installations also has an influence. The lowest environmental impact often coincides with the lowest life cycle cost. The lowest investment cost often gives both higher life cycle costs and greater environmental impact.
- Detoxifying building materials (getting rid of the worst ones) both in connection with new construction and for existing buildings.
- Choosing materials and products that are of good quality, long-lived, and easy to maintain or replace.

3.2 Priority areas

The work of the group has focused on designing building structures, including subsystems, and procurement with a life cycle perspective and a holistic view. The structure's subsystems consist of technical installations, materials and building parts. The design of a building structure is determined early. The client has a central role in seeing to it that design and procurement are done in an environmentally correct manner. Methods and tools for selection, design and procurement with a view towards environmental impact (life cycle assessments, LCA) and life cycle costs (LCC) are important aids, see description of LCA and LCC in section 3.4.6, as well as Appendix 1, Work procedure, and the examples there.

The work is mainly focused on buildings, but the described approach can also be applied to other structures. An important element in the process outlined is naturally experience feedback from completed projects (Cf. ISO 14001's requirements on "continual improvement").

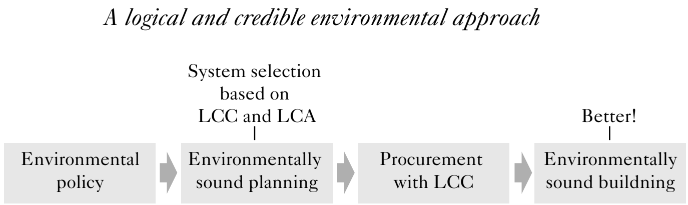

Figure 3
A logical and credible environmental approach.
Source: Bengt Dahlgren AB

In the early phase and planning, it is necessary to study reference projects and to have time for brainstorming. When architects and other consultants are selected, the reference projects and their actual performance should influence the choice. It is important that both the architect and technical consultants adopt a holistic view and a life cycle perspective in their work and have high general competence.

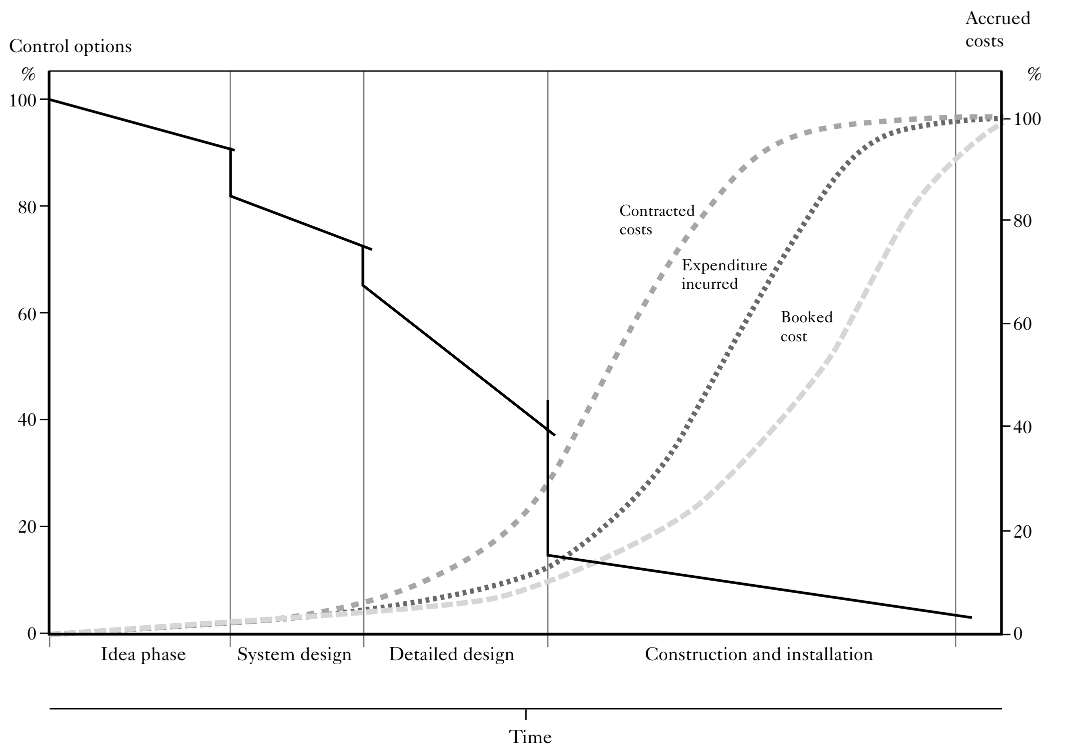

Figure 4
Control options diminish as decisions are made.
Source: Käll, Gunnar and Genberg, Håkan. El- och VVS-installationer 1.
Projektering, redovisning, upphandling och uppföljning.
Svensk Byggtjänst, Stockholm 2000

In property companies, the building and management units need to collaborate and exchange experience when embarking on new construction and alteration projects. If this is not done, management cannot be integrated with design and construction, which will then greatly impede the introduction of better resource management in the entire building sector. It is important that environmental management be included from the beginning, cf. Figure 4.

A life cycle perspective and a holistic view of environmental impact and costs are important in the design of buildings and facilities, as well as in the selection of technical systems and procurement. Investing in and designing a building for e.g. a low energy requirement, with energy-efficient technology, longer maintenance intervals for different installations, and materials with known content and known properties, can permit considerable savings during the utilization period. This leads to both lower energy use and lower environmental impact in the end. At the same time, the construction or investing phase will account for a greater portion of the environmental impact and cost, while the operating phase accounts for a smaller portion, viewed in a life cycle perspective. When different actors are in charge of the investment and operating phases, as is common, incentives for these kinds of changes are lacking. Many real estate companies have "different pocketbooks" for construction and for operation. Unfortunately, the project manager often sees it as his most important duty to keep the investment costs down, without giving much consideration to future energy and maintenance costs or environmental impact. This obviously does not contribute to long-term sustainable development!

The vision in *"Think new, think sustainable! – building and managing properties for the future"* states:

"2025 – In offices, consumption of purchased electricity has been reduced by more than half. Only low-energy lighting and office equipment is used."

In office buildings, the office equipment, lighting, etc., that is in use today sometimes generates surplus heat. This requires the installation of cooling equipment or district cooling. With better products, this "unnecessary" heat output could be avoided. It is assumed that such environmentally sound, heat-efficient products will be developed. Work is being pursued internationally to design products and services so that their environmental impact on human health and the environment during their entire life cycle is reduced. This is known as Integrated Product Policy, IPP.

Efficient Use of Natural Resources, report by the Resource Efficiency Committee (in Swedish), SOU 2001:2:
Page 135: *"Along with chemicals use, energy use and conversion emerges as one of the most significant components of the environmentally degrading impact of production and consumption."*

Page 68: *"With a one-sided focus on material use, there is a risk of missing small material flows with large negative environmental effects, such as chemicals."*

Comment: Instructions for preparing building product declarations state that additives in excess of 2.0 percent by weight shall be specified. If the material contains substances included on the National Chemicals Inspectorate's Observation List, List of Restricted Substances or the like, this limit has been set at 0.2 percent by weight. Since building materials comprise a large portion of the material flows in society, these restrictions entail the very kind of risk referred to in the report.

3.3 Boundaries

Boundaries against other groups

The building process is not included in the group's work. Management – operation and maintenance – of buildings is only included when it comes to planning and procurement. Research and development and best available technology (BAT) only enter in because procedures are needed to incorporate knowledge from these areas in early phases, design and procurement. The working group for Classification of Residential and Commercial Premises – Energy, Environment and Health is working to identify relevant parameters for environment, health and energy. Methods for assessment of the environmental impact of buildings have therefore only been dealt with cursorily here. Planning, rate-setting, etc. have not been included in the group's work.

System boundaries

ISO 14040: *"System boundary is the interface between a product system and the environment or other product systems"*

As far as physical conditions are concerned, the work of the group has mainly been focused on properties – a building structure and its lot – but the point of view also applies to other building structures such as roads and railways.

The system boundary comprises the boundaries for the design of a local project/building based on a given need description. The need may for example be:

- 150 housing units including x 1-room, 2-room, 3-room units, etc.;
- offices with 200 workplaces plus conference room and 60 parking spaces;
- footpath from a housing area to a green area, separated by a motorway.

Regarding resource use, energy and chemicals (including hazardous substances) are of central importance for the building sector, but use of land and extraction of natural gravel are also essential.

The operating phase of property management has the greatest environmental impact, and it is largely the decisions made at early phases that determine how great this impact will be. Other management, maintenance of buildings, is only included when it comes to various choices, planning and procurement within management.

The environmental impact from the erection, operation and maintenance of a building structure spans a range from local effects (e.g. noise from a fan on a building to the surroundings) to global effects (e.g. climatic impact caused by the use of fossil fuels). Based on the environmental impact caused by erection, operation and maintenance of a structure, the work of the group has mainly been focused on energy use in a life cycle perspective and "detoxification". The environmental impact of energy production for building operation – electricity, heating and cooling – is included.

The environmental impact from the use of a given quantity of energy will vary in terms of emissions of acidifying substances, particles, volatile organic compounds (VOCs) and carbon dioxide equivalent etc., depending on which energy carrier and which production method is used. The environmental impact from 1 kWh of district heating based on e.g. biofuel is considerably less than that from 1 kWh of electricity produced in a condensing power plant fired with lignite and with limited flue gas cleaning. It is therefore important that all accounts clearly show how environmental impact has been calculated.

How the environmental impact of electricity production and use is to be calculated is being discussed in many contexts. In some cases the calculation is based on the "average mix in Sweden", i.e. the average production of electricity, in others on the marginal production or yet other methods of calculation, giving different results, see example 2 in Appendix 1. Today, electricity is distributed in a common grid that covers large parts of Europe. Electricity in this grid mainly comes from fossil-fired power plants (mainly coal), nuclear power plants, hydropower, and, to a small extent, from renewable energy sources. Imports of electricity to Sweden generally take place in the wintertime during peak-load periods. The opposite occurs during the summer, when there is normally surplus capacity in the Swedish power plants, see "Electricity market 2001, ET 31:2001" from the Swedish Energy Agency (in English). Marginal electricity production and CO^2 emissions in Sweden are discussed in report ER 14:2002, also from the Swedish Energy Agency (in Swedish).

Work on the environmental impact of energy use is being pursued by researchers and government agencies. Different emission figures for greenhouse gases, depending on how the electricity has been generated, are reported in e.g. the Swedish Energy Agency's "Climate report 2001, ER 6 2002" (in English). In "Key figures for energy use in buildings, Government commission M2001/226Hs”, ISBN: 91-7147-684-9 (in Swedish), the National Board of Housing, Building and Planning proposes key figures that can describe energy use and environmental loads in buildings. The indicators take into account what energy carrier is used, which is of the utmost importance in line with what has been said above.

According to the National Board of Housing, Building and Planning’s proposed key figures, the amount of energy used for space heating, hot water heating, cooling and operation of buildings is measured for each energy category and divided by the number of square metres of heated utility area (UTA(t)):

$$kWh_{index}/m^2 \text{ UTA(t) and year}$$

kWh_{index}/yr = *total energy supplied to building during one year per energy category*

index = *electricity, district heating, oil, gas, coal, peat, wood, woodchips, pellets or other*

m^2 = *temperature-controlled utility area (UTA(t)) according to Swedish Standard 02 10 53*

Key figures for energy use in buildings should be specified per building category.

3.4 How the work has been conducted

The group’s work is based on existing knowledge. No new research or studies have been done within the framework of the commission. The members of the working group mainly represent property-owners, but also building companies and consultants.

In order to collect data, the companies participating in the work have described how they work with procurement matters and value long-term sustainability, why they don’t always comply with their own requirements, and how credible their own work is. The companies have also described how knowledge concerning the environment and sustainability is disseminated within the companies.

Subgroups of 3–4 persons have also gathered data which the group has discussed and evaluated:

- Analysis of obstacles and opportunities
- Requirements on system know-how and analysis of functions and solutions based on a life cycle perspective that should be met by architects, consultants, contractors/suppliers and real estate appraisers
- Guidelines for application of ecologically sustainable procurement within the building and property sectors
- “Environmental programmes” for energy efficiency improvements, a healthy indoor environment, and efficient resource use, where requirements on limited LCA and procurement based on LCC play a central role.

The working group has also discussed what the work procedure and methods should look like and how they should be used in different phases.

The working group has submitted proposals on work forms, tools, etc., and identified obstacles and incentives for achieving within one generation a well-functioning and at the same time environmentally sound building and property sector that gives rise to smaller environmental effects than today and that contributes to sustainable development.

A brief review of work in other countries, the status of research, etc., has also been conducted.

3.4.1 Current situation – how participating companies work today

There are approximately 700 million m^2 of heated buildings in Sweden, which is equivalent to about 80 m2 per person, of which 47 m^2 is residential and 35 m^2 is commercial space, hospitals, schools, etc. There are more than 10,000 process plants for electricity, heating, water supply and waste management and 1 million km of roads, streets and utility lines. In addition there are industrial premises and unheated farm buildings.

The companies that participate in the working group together own properties with a surface area of more than 12 x 10^6 m^2. The properties are of different kinds, mainly residential, offices, hospitals and service buildings which the companies also manage.

The working group has conducted a survey of how the companies represented in the group work:

- How is long-term sustainability valued?
- Why don't they always comply with their own requirements?
- How credible is the work in the company?
- How is new knowledge disseminated in the company?
- How does the client work with procurement?

How is long-term sustainability valued?

To a great extent, the companies have written documents stipulating clear goals for their own work and requirements on their cooperation partners when it comes to a life cycle perspective and a holistic view. But work methods for making choices in the early phases that contribute to sustainable development are not so well developed in all companies. More knowledge and better developed work methods are needed to shed light on the connection between different choices of systems and environmental impact. When it comes to buildings, such factors as siting, placement on the lot, compass orientation, choice and design of technical installations, and activities in the building influence the environmental impact to which the building gives rise. The siting of an activity is of importance for the transport requirement and the environmental impact of transport activities. The route chosen for a road is also of importance for the environmental impact of the vehicles that use the road.

The companies have prepared documents with questions of relevance for sustainable development in the sector. These documents are given to all actors engaged by the companies, and they are expected to comply fully with them. Some companies have also produced documents for tenants. The principle for the companies is that the total cost is crucial in the project planning and that special emphasis is given to the costs of the management phase (life cycle costs).

There are various procedures for keeping the procurement documents up to date. At one company, for example, 15 administrators have been given responsibility for maintaining the status of the documents. Each administrator is responsible for one subarea/chapter of which he has experience. The material is updated once a year to keep it in compliance with current requirements. Experience feedback obtained during the year is also incorporated.

The static building and system parts are assumed to have a long life. How other building parts and installations are valued is usually determined by technical life, but not infrequently by how long a product's market life or regulatory life is considered to be. Another important factor is how flexible a property is for different uses and tenants.

Why don't they always comply with their own requirements?

The causes may undoubtedly vary. Most building projects – whether new construction, alteration, demolition – are carried out under great stress and with many actors involved. Large quantities of materials and products are procured, transported, built in, installed or torn out. Certain phases of the building process are also influenced by the weather. Many problems that crop up need to be solved quickly and are then often solved ad hoc without complying with the company's own environmental and quality policies. Special circumstances can also lead to a collision between different requirements. Stress, ignorance, financial requirements on profitability at the time of investment, lack of communication within the organization on decisions made, or misguided thrift are other influencing factors.

It isn't unusual that building projects start with far too little time for planning and design. As a result, they may not have time to incorporate environmental aspects into their documents. "We don't have time now, we'll do it in the next project."

Many different documents serve as a basis for the different phases in the building project. These documents are not always in agreement, which contributes to confusion. Sometimes a single document may even contain contradictory information. In such cases, it is common practice to "do as we've always done", which often means following old procedures that do not embody environmental considerations.

The quality work and the environmental work are related. There are many examples of how quality failings lead to environmental problems. An important part of the management system is experience feedback.

When new projects are costed, consideration is often given to e.g. future energy costs, but when the project is procured and the incoming tenders exceed the budgeted cost, it is common practice to start haggling. It is then easy to fall for the temptation of choosing cheaper options. This often leads to short-sighted choices that do not take the life cycle perspective into consideration.

Credible?

In order for the companies' environmental protection work to be credible, and for the environmental requirements made by the companies to be enforced, environmental audits have to be performed. Some companies have carried out a large number of environmental audits in both the design and the building phases. This has produced very good results by giving the environmental requirements a clearer status. Another purpose of environmental audits is to reveal deficiencies in the company's organization, for example a lack of important environmental requirements.

An important incentive for the companies will be the desire to be perceived as credible builders and property managers in connection with future environmental classification of properties.

Instructions and requirements must be marketed in a modern way via relationships. It is difficult to market a message without functioning communications. The work with a life cycle perspective and a holistic view must not be just a paper product. The long view must be adopted and a preventive approach taken in all parts of the organization. Cooperation with consultants to achieve stipulated goals is important. Cooperation promotes not only a holistic view but also good relations.

Everyone in the organization must feel like a participant in the environmental work based a life cycle perspective and a holistic view, even though different individuals may vary in their enthusiasm.

How is new knowledge disseminated in the company?

The companies have different systems for disseminating and integrating knowledge of environmental impact in their rules and procedures. This is done in several different ways:

- The companies participate in external R&D projects and collaborate with universities etc., for example by employing doctoral candidates.
- The companies use intranets to post news, information on ongoing R&D projects, and results.
- The companies build up their own knowledge banks with links to universities and research institutes.
- The companies arrange seminars for production personnel, for example on new technology, new research results or other themes with both internal and external speakers. The companies also hold annual conferences where they explain how the results of research and development have been applied in building projects and what lessons they have learned from this.

- Many companies have specialist services that act as a link between production and R&D.
- The companies make use of the evaluations they or their consultants have performed to draw their own conclusions, which are incorporated as relevant requirements in own framework documents.

How does the client work with procurement?

The companies that are represented in the working group all have an environmental policy, and some are environmentally certified. Several of the companies have systems for tender evaluation where special consideration is given to environmental aspects. However, procurement procedures are different in the different companies, partly depending on what kinds of activities are conducted or what type of property is managed. Some of the companies in the working group have to comply with the Public Procurement Act (LOU).

Some companies have framework agreements for the provision of goods and services, and purchases are made in a highly decentralized organization by call-off under blanket purchase agreements. A central unit with specialist competencies is responsible for follow-up, experience feedback and improvements, and documentation for new agreements, as well as for information to and training of company employees.

The procurement of consultants is of central importance for the companies for both alteration and new construction projects, since the decisions made in the early phases determine the premises of the project, particularly for the energy requirement and the possibility of finding energy-efficient solutions. The results are highly dependent on the competence of the consultants.

It is common for companies to have a policy of procurement taking into account life cycle costs and a goal of selecting materials, products and methods for construction, management, operation and maintenance in a purposeful manner. This includes insisting that the contents of all materials and products that are used be known, along with the energy requirement during the whole life cycle.

Due to shorter lease periods and a high turnover of tenants, offices and other premises are altered, materials are replaced, and technical installations are modified long before they have served out their useful life. Surface layers often have a "fashion life" rather than a service life. To reduce the environmental impact of these frequent changes, the companies try to use more flexible or robust systems, for example walls that can be moved without having to change the floor covering, or ventilation ducts with some overcapacity.

The companies have somewhat different purchasing policies, but the following purposes apply:

- Lower costs; products and materials with the most favourable price overall for the company, taking into account quality and life cycle costs, are chosen; flexible and simple solutions are favoured.
- Higher quality; the properties of goods and services are constantly being improved, or delivery reliability is increasing.
- Better environment through active and committed environmental efforts.
- Uniform conduct within the organization.
- It is important to adopt a holistic view, which means all requirements must be taken into consideration!

Some companies have begun to energy-declare their properties with the goal of reducing energy use. This work includes determining the status and quality of the building stock with regard to energy balance, identifying and documenting technical shortcomings, and suggesting improvements, replacements or modifications of technical equipment. This also includes performing an LCC for each proposed change. In many cases, procurement has taken into account the life cycle costs of the tenders.

	Company								
	Stadsfastigheter Malmö	Svenska Bostäder, Sthlm	Vasa -kronan National	National Property Board	NCC	Skanska Fastighet Sthlm	Platzer Fastigheter AB	Bengt Dahlgren AB	Locum
Type of properties	Mixed	Mixed	Commercial	Public	Commercial	Commercial	Commercial	-	Hospital Commercial
Managed floor area 10^3 m^2 2001	1,400	3,800	1,970	1,750	400	600 [1]	440	-	2,200
Has environmental policy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Environmentally certified ISO 14001	No	No	Yes	Yes[2]	Yes	Yes	No	Yes	No
Must comply with LOU	Yes	Yes	No	Yes	No	No	No	No	Yes
Has environmentally considerate rules of procurement	Yes	Yes	Yes	Yes	Yes	Yes	To some extent	Yes	Yes
Procurement takes into account LCC	To some extent	To some extent	To some extent	To some extent	To somet extent	To some extent	To some extent	To some extent	To some extent
Imposes environmental requirements on sub-suppliers	Yes	Yes	Yes	Yes	Yes	Yes	In some cases	Yes	Yes
Evaluates Projects	To some extent	Yes	To some extent	Yes	To some extent	To some extent	To some extent	Yes	Yes
Has system for integrating new environmental knowledge in rules and procedures	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] Total Skanska in Sweden 1,000 x 10^3 m^2 managed floor area

[2] The National Property Board (SFV) is also EMAS-registered

The above table is a compilation of the companies' types of real estate holdings and how they take into account some different factors of importance for long-term sustainability and system selection and procurement with a life cycle perspective and a holistic view. Comment: The companies have come far, but there is still room for improvement.

3.4.2 Analysis of obstacles and opportunities

Obstacles to and opportunities for achieving long-term sustainable development in the building and property sector which the working group has identified in regard to organization, economics, knowledge, technology and structure are listed below.

Organization

Obstacles

- The traditional structure of the building process – the process is highly fragmented and there are many steps between the client's wishes and the finished building.
- Different areas of responsibility and organizations in different parts of the company.
- Lack of commitment on the part of the management – the people who make the investment decisions don't have the complete picture regarding economics and technology.

- Inadequate documentation and quality system – leads to disorder in the documentation and lack of continuity.
- The documents are designed for construction – not oriented enough towards the management phase.
- Short project times.
- That's the way we've always done it before.
- Nature of the company: large or small, properties intended for sale or rental.

Opportunities

- Formulate overall objectives and strategies in the management (environmental policy, expected value increase).
- Create continuity between the decision, construction and operating phases as regards LCC/LCA work, quality system, documentation, etc.
- Adapt the decision-making documents to emphasize and clarify the LCC aspects.
- Influence trade organizations, SABO (Swedish Public Utility Housing Enterprises), the Swedish Federation of Property Owners, etc.
- Get the many small companies involved.

Economics

Obstacles

- The investment cost is increasing – leads to a threshold effect at the time of investment, in the light of traditional principles for real estate investments.
- The risk that the actual outcome will not be as projected.
- The companies have "different pocketbooks" for investment and for operation and maintenance
- It can be difficult to justify new investments, even if they are profitable in the long term.
- Environmental investments do not affect the market value, see also section 3.4.3.

Opportunities

- Use of LCC and LCA and identified relationships between them as a basis for investment decisions. This can also lead to better economics. In the case of simple technical systems, there is a great likelihood that the outcome will be as expected.
- Evaluate the outcomes for LCC-based choices to get a better basis for future decisions.
- Increased knowledge of relationship between operating cost throughout the life cycle and value.
- Relief/incentives for environmental improvements, such as lower insurance premiums, lower property tax, etc.

Knowledge

Obstacles

- Lack of insight about future values in society and the business world.
- Management, employees and suppliers have insufficient knowledge of the relationships between investment and operating cost.

- Poor knowledge of tools – e.g. the ENEU® concept is a relatively new phenomenon, except within certain specific sectors in the installation field and within the Swedish engineering industry; the Committee for Ecologically Sustainable Procurement's tools for procurement of certain simple products are completely new.
- The information about LCA has mainly been aimed at engineers and not at accountants.
- Lack of awareness of existing knowledge.

Opportunities

- Knowledge and insight about changes and trends in society and business makes it possible to meet future customer demands.
- Skills enhancement of employees in companies and organizations via collaboration between consultants, suppliers and clients.
- Dissemination and development of knowledge concerning work methods, procedures and tools.

Technology

Obstacles

- Complex systems – according to some it is difficult to perform LCC calculations and to follow up during the operating period (probably has more to do with being unaccustomed to the concept and what it involves).
- Advanced technology makes great demands on competence and organization, which leads to high costs for the future and unforeseeable consequences.
- Systems and components do not always perform as promised.
- Lack of a uniform standard for measurement and accounting in the building sector.
- Low level of technological development in the building sector.
- Conflicting requirements, e.g. regarding function (accessibility etc.) and energy use.
- Consideration for existing installations and the whole is overlooked.

Opportunities

- In early phases, optimize the building design and the installations for existing conditions (e.g. climate, user demands), thereby achieving good harmony between them.
- Analyze whether climate and functional requirements can be modified in order to obtain a more environmentally friendly plant.
- Guide the design engineers towards simple systems. This makes it possible to use relatively simple analytical procedures in the design and procurement phase. This provides simpler and more reliable operation.
- Development of more efficient components and systems, which are more user-friendly and reliable.
- Guide and influence manufacturers towards standardized measurement and accounting methods to obtain better and more comparable data for LCC calculations (Cf. the standardization in the ENEU® concept).

Miscellaneous

Obstacles

- National political decisions.
- National versus EU political direction and decisions.
- Uncertainty regarding the development of e.g. rates and costs.
- A lack of environmentally friendly infrastructure alternatives.
- Companies that are supposed to cooperate have completely different structures.

Opportunities

- Influence the energy suppliers by means of requirements and dialogue regarding a future energy mix based on different raw materials.
- Make use of business intelligence to predict cost trends as a basis for strategic decisions.
- Influence authorities to create incentives, for example environmental certification, for tax relief, etc.

The analysis shows that both obstacles and opportunities exist within all three areas that are important for long-term sustainable development – the social, the economic and the ecological area. Measures therefore need to be taken and methods etc. developed with this in mind.

3.4.3 Property valuation

Valuation (appraisal) is done today by appraisers based on market value, not by construction engineers. The market value of real estate is obtained by analysis of recent sales, local price analysis, or simulation of sales. In practice, a blend of these two methods is used. A valuation takes into account the following factors:

- What rents can be expected in the future?
- What operating and maintenance costs need to be figured in? Operation and maintenance (O&M) includes energy, running maintenance, snow clearance, and water.
- What cost of capital – including what risks – must be reckoned with?

Real estate appraisers consider operating costs to be of secondary importance and say that for relatively ordinary properties, the discrepancy between the valuation and the market value is normally within ± 5–10%, while the discrepancy for unusual properties can amount to ± 20–25%.

The group's work has revealed that:

- Figures for operating and maintenance costs in various sources used in the sector are often unreliable. The figures often come directly from accounting departments without any engineering assessment having been made of the building or its installations.
- Short-term market requirements on yield can lead to problems when it comes to making long-term profitable investments.
- The environmental debt of a property is not very well understood. However, the appraisers try to get information on the risks of future cleanup costs by e.g. inquiring about previous activities in the property.
- Foreign companies are in the forefront when it comes to demanding environmental declarations for properties.
- The results of the different methods that exist for assessing properties from an environmental standpoint are only used by real estate appraisers to a limited extent.
- The real estate sector needs developed valuation models where environmental factors are included.

More contact is needed between real estate appraisers and advocates of long-term sustainable development. The appraisers need better knowledge of e.g. the relationship between investments in energy efficiency and operating costs. Course on this topic should be required for certified real estate appraisers. The property companies could contribute by providing databases with up-to-date data on operating costs etc.

The OECD's Sustainable Building Project (cf. 3.4.9) observes that buildings often change owners and that it is therefore difficult for the initial owners to recoup the gains of their investments unless they can incorporate a premium for this into the sales price. In theory, it is said, buildings with a longer service life and better performance should be valued by the market. In reality, it is uncertain whether this is taken into account in valuation. Future changes in such conditions as climate, energy taxes, etc., are perceived as uncertain factors.

3.4.4 Requirements on builder, architects, other consultants, contractors and suppliers

In order to be able to work towards sustainable development, those who participate in a building project must have the appropriate knowledge. Everyone has to be informed on some topics, while on others it is enough if certain actors are informed. Who needs to know what is explained below. Topics on which *all builders, architects, other consultants, contractors and suppliers* must be informed:

- LCC/LCA
- Operation and maintenance of buildings and installations
- Overall economic consequences of measures
- Holistic view with regard to environment and energy in selection of products and purchasing
- Scheduling, hiring of persons with right competence, and follow-up
- Environmental training – general and project-specific
- Follow-up (environmental inspection rounds, audits, inspection schemes)
- Environmental management systems – planning, execution, follow-up, improvement)
- General knowledge of relationship between building and installations and between energy and indoor environment.

	Topics on which certain actors require knowledge, X, or familiarity, (X):				
Requirement	Builder	Architect	Other technical consultants	Contractor	Supplier
Perform LCC/LCA			X	X	X
Relationship architectural design/geometry and energy efficiency/indoor environment	(X)	X	X	(X)	
Perform climate and energy simulations		(X)	X[1]		
Formulation of requirements early in the process and when preparing descriptions in different phases	X	X	X	X	
Environmental valuation – related to economic consequences	X	(X)	(X)	X	
Perform environmental valuation of building		(X)	X		

[1] Chiefly installation consultants (HVAC, energy and environment) when it comes to simulations etc.

Real estate appraisers need knowledge of:

- LCC and LCA on a general level (introductory)
- Overall economic consequences of measures
- General environmental training
- Environmental valuation – linked to economic consequences
- Environmental valuation of building (introductory)
- Environmental management systems – planning, execution, follow-up, improvement)
- Relationship between building and installations and between energy and indoor environment on a general level.

3.4.5 Work procedure and methods in different phases.

The construction and management process consists of several phases, and it is important that a holistic view and a life cycle perspective on environmental aspects and costs should accompany the entire process, not least the initial phases. This is also vital in connection with renovations and alterations.

Appendix 1 describes how this work can be conducted. Good examples are also given there of LCA and LCC calculations.

3.4.6 Environmental assessments

Overall assessments

Environmental impact assessments (EIAs) and environmental impact statements (EISs) are mainly used in connection with the siting and establishment of various kinds of activities. Instructions on how to conduct an EIA can be found in the Swedish Environmental Protection Agency's (EPA) general recommendations on environmental impact assessments (pursuant to Chapter 6 of the Environmental Code and the Ordinance (1998:905) on environmental impact statements; NFS 2001:9).

Strategic environmental assessments (SEAs) focus on the strategic level where the questions why, if and where are of principal interest. On the project level, the assessment mainly has to do with how an area or a property should be designed to fulfil environmental objectives and requirements. The ideal model for SEA in a region is that SEA be integrated with regional and comprehensive planning to include environmental effects in a long time perspective with great breadth but not so much depth. A comprehensive set of documentation is created for EIA on a detailed development plan and project level. SEA can be done in the work with the comprehensive plan in order to shed light on the consequences of e.g. integration of working, living and services in a neighbourhood. This is no clear boundary between SEA and EIA.

Life cycle assessment (LCA) and life cycle costing (LCC)

LCA is a methodology for describing the environment- and resource-related consequences that can be related to a human activity in a holistic perspective. An LCA is a simplified model of a very complex reality. The methodology has a structure established by ISO that divides LCA into four main phases:

- Goal and scope of study
- Inventory analysis
- Impact assessment
- Interpretation of results

The ISO 14000 series contains different standards in the environmental field – a kind of toolbox with all the necessary tools for the environmental work in companies. The standards having to do with LCA are found in ISO 14040 – 14049. The method is constantly being developed. The results from LCA provide guidance, but are not an "absolute truth" and cannot comprise the sole basis for decision. They give an indication of what direction to go.

The way LCA is normally used in the building sector is limited to studying environmental impact in the operating phase, which dominates today. This means that the environmental impact from the erection of a building and from the manufacture of materials is not always included. Environmental impacts of various kinds are included in LCA. The impact from energy use is an important area that is included for the building sector. The use of chemicals and hazardous substances is not included to the same extent, but is instead dealt with in project-specific environmental programmes.

LCC describes all costs that are currently associated with a given activity throughout its life cycle, for example the costs of waste disposal. But it should be observed that at present, no price has been set on environmental impact. This means that societal costs for environmental impact are not included in the life cycle cost. In other words, the total actual cost entailed by different kinds of environmental impact is not obtained. Societal costs may eventually be charged, however, so there is some uncertainty in the assessment of life cycle costs.

There is no standard for calculation of LCC (life cycle cost) at the present time, but the work can be structured in a similar fashion to LCA. LCC can be divided into four main phases:

- Goal and scope of study
- Inventory analysis
- Calculation of costs
- Interpretation of results

Theoretical models have been developed to shed light on both the environmental load of a building during its entire life cycle or parts of it, as well as on the life cycle costs, but no simple standard exists yet for the whole package. Roughly the same basic data are needed – the inventory analysis – to make a holistic assessment from a life cycle perspective of the environmental load of a building and its costs. A development of the methodology to make LCA and LCC calculations "fit together" would be valuable. Research has begun for this purpose.

It is of great importance how the boundaries are set in an LCA or LCC calculation. The results are greatly affected by whether the calculation includes a building, the activities pursued there and the transport entailed by its siting, or whether the calculation only includes the building or even just one technical installation. Depending on where the boundaries are set, the results can vary widely. Too narrow boundaries can result in a sub-optimization from a holistic view and a life cycle perspective. Very wide boundaries can, on the other hand, be very difficult to handle and assess due to too many uncertainties.

Examples of LCA and LCC are presented in Appendix 1.

Standardization work concerning life cycle costs in the building sector

"Buildings and constructed assets – Service life planning", ISO 15686

The International Organization for Standardization (ISO) is working on a standard, ISO 15686, that deals with "Buildings and constructed assets – Service life planning". The work is being pursued within ISO's Technical Committee ISO/TC 59. The standard is intended to comprise five parts:

- Part 1: General principles
- Part 2: Service life prediction procedures
- Part 3: Performance audits and reviews
- Part 4: Data requirements
- Part 5: Life cycle costing

Ecocycle and lifetime planning , SIS/TK 98

A technical committee, TK 98, within the Swedish Standards Institute (SIS) is working with “Ecocycle and lifetime planning”. The work in the committee has included an exchange with the work in ISO 15686.

Energy Management CEN/BT/WG129

AFNOR (the French standardization organization in charge of the WG 129 secretariat) has requested that CEN start a new project to arrive at a standard for Energy Management, to which the CEN/Technical Board has assented. The work is in an initial phase, and living and the “third sector” are mentioned in AFNOR’s discussion paper.

There are a number of aids for design, calculation of energy requirement, and procurement with a life cycle perspective and a holistic view. Some of them are mentioned in Appendix 1.

3.4.7 Guidelines for procurement to achieve long-term sustainability

In order to achieve long-term sustainability, actors within the building and property sector need to commit themselves to the following guidelines and applications:

- Comply with legislation with a special emphasis on the Environmental Code’s rules of consideration. The general rules of consideration entail that persons who pursue an activity shall
  - Acquire the necessary knowledge
  - Take the necessary precautions
  - Employ the best possible techniques (BAT)
  - Select a suitable site for the activity
  - Conserve energy and natural resources
  - Exploit all possibilities for reuse and recycling
  - Avoid using chemical products for which less dangerous substitutes are available
  - Take responsibility for rectifying or compensating for damage caused by the activity
- Determine the level of ambition for the internal environmental work
  - Comply with legislation
  - Stipulate simple environmental requirements
  - Use a well-thought-out methodology with a focus on evaluation criteria and incentives (bonus/penalty)
  - Stipulate requirements based on optimization from an LCC and LCA perspective.
- Far-reaching integration of sustainability and resource aspects
  - Work actively to promote the trend towards more sustainable policies
  - Besides stipulating requirements in connection with procurement, the major actors have an opportunity to influence the trend in the sector in a more sustainable direction, for example by showing more environmental consideration and by stipulating requirements in connection with property development and municipal planning, as well as by pursuing well-though-out programmes
  - Raise the level of competence among clients by e.g. certification
- Use methodologies for procurement that ensure constant improvement
  - Exploit the opportunities provided by the sector’s standard conditions and templates to prescribe environmental consideration and thereby stipulate environmental requirements
  - Life cycle thinking (LCC and LCA) should be developed and encouraged in the selection of sustainable technical solutions and materials.

3.4.8 Environmental programme/plan for efficient use of resources – energy, land, materials – and a healthy indoor environment

The working group finds that project-specific environmental programmes are an important tool in efforts to achieve sustainable development in the building sector. In preparing and following such programmes, various questions must be addressed.

Detailed material choices are not specified in the early phases of a project, but questions that have a more concrete bearing on material selection and the presence and phasing-out of hazardous substances are addressed in the environmental programme. An active use of project-specific environmental programmes is an important instrument for detoxifying the building sector.

Appendix 2 presents an example of a template for environmental programmes that can be used in the preparation of project-specific environmental programmes.

3.4.9 Current state of research

Construction-related LCA and LCC research is being conducted at the institutes of technology and at SP (the Swedish Testing and Research Institute) and IVL (the Swedish Environmental Research Institute), and funders are MISTRA (the Swedish Foundation for Strategic Environmental Research), FORMAS (the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning), and others. When it comes to the environmental impact of energy use, work is being conducted by numerous research bodies and government authorities.

Several LCA-based methods exist for assessing the environmental impact of a building structure. Research and development is under way, but there is still not any one method that is comprehensive, easy to use and sufficiently takes into account the maintenance need and its effects. Questions concerning methods for assessing the environmental load of buildings are being dealt with in the working group for “Classification of Residential and Commercial Premises – Energy, Environment and Health”. Interest in research on LCC methods for the building sector is also great.

In 1998 the OECD started the project “Sustainable Building” with the goal of providing guidance on the design of national policies for dealing with environmental impacts from the building sector. The project is aiming at reducing CO^2 emissions, waste minimization and prevention of indoor air pollution. The work is expected to be completed in 2002.

3.5 Need for measures and future work

In order to achieve long-term sustainable development, the total environmental impact of the building sector must be reduced in the future. Achieving this goal requires knowledge, awareness and a willingness to change behaviour on the part of all concerned actors. Clients in particular must be clear and impose requirements on consultants and contractors. Existing knowledge must be disseminated and used, and stipulated requirements must be enforced.

The following is observed in the publication *“How good houses are built and managed”* (in Swedish), published by the National Property Board in 2000:

- Primary responsibility for quality in all construction and property management rests with the client (sometimes the property-owner).
- The client or his agent sets the tone for the collaboration and the mutual respect within and between the consultancy group and the contractor.
- The choice of architect and technical consultants and the formulation of conditions for their work are some of the most strategic factors for ensuring good quality – architectural, technical and environmental – in construction and management

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Among the measures that are needed, the following have been identified:

- The first step in training is to "train" leading individuals at builders (and investors) in a life cycle perspective regarding environmental impact and costs (LCA and LCC).
- In order to achieve sustainable development in the building sector, concrete guidelines must exist.
- Evaluate and study methods for developing environmental indexes for proposing suitable methods. This includes how the environmental impact of electricity is to be assessed with regard to e.g. a European perspective.
- Study completed evaluations of different energy and climate simulation programs and the performance of "more recent" programs.
- The impact of tenants on environmental load, with a focus on energy use.
- Go further with the formulation of requirements in connection with demolition, for example that an inventory shall always be performed before demolition and by competent personnel.
- Requirements on the production process, where the contractor's chief coordinator has a very important role.
- More contact is needed between real estate appraisers and advocates of long-term sustainable development. The appraisers need better knowledge of e.g. the relationship between investments in energy efficiency and operating costs. Course on this topic should be required for certified real estate appraisers. The property companies could contribute by providing databases with current data on operating costs etc.
- Develop and "standardize" methods for "limited" LCA, i.e. LCA for the operating phase.
- Collaborate internationally, within the EU and the Nordic countries, for standardization of methods for LCC.
- Use new methods where appropriate, e.g. function selling. This involves selling a function instead of a product, for example that telecom operators sell voicemail, energy companies sell a given room temperature, landlords sell access to passenger transport or food delivery, etc. Function selling does not automatically reduce environmental impacts, but by quickly making use of new technology and thereby reducing the life cycle of energy-consuming products, it can contribute towards reduced energy use; this has been done in, for example, the laundry sector. The rules in the Code of Land Laws, however, entail that all that is "affixed" to a building belongs to the building, which prevents certain types of function selling for buildings.

3.6 Work in other countries – international comparisons

Extensive international work is being pursued on the design of buildings and other products with consideration for environmental impact and life cycle costs. Appendix 3 presents a summary of some current projects in the Nordic countries.

Appendix 1
Work procedure and methods in different phases

General

The construction and management process consists of several phases. It is important that a holistic view and a life cycle perspective on environmental aspects and costs accompany the entire process. This is particularly true in the initial phases, in connection with both new construction and alterations and renovations.

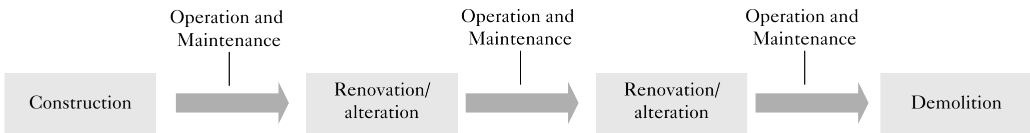


Figure 1.
The total lifetime of a building and recurrent periods of "inventory of needs, investigation, product determination and product manufacture" as steps in building management.

The working group "Quality and efficiency in the construction and management process" has identified the following phases or "processes", which are described in greater detail in the working group's report:

- Inventory of needs – activity, location, cost frame, time frame, regulatory contacts
- Investigation – description of activity, description of function, risk analysis with respect to technology, economics, environment, and preparatory plan process
- Product determination – programme, programme outlines, local programme, functional requirements, cost-revenue analysis, environmental programme
- Product manufacture by various forms of contracting
- Product use – utilization, operation and maintenance
- (Decommissioning – demolition (sale))

Figure 2 shows the phase where the needs are determined as well as the actual construction process and its sub-processes. What is new in this scheme is the "traffic lights" that follow each phase in the process. A "green light" is needed before proceeding to the next phase in the process. This means that the builder has to decide whether the next stage can be started or whether further information is needed. The builder must then give a clear go-ahead for proceeding to the next stage.

Analysis of needs and product determination in Figure 2 can also be regarded as recurrent phases in the total life of a building, which may be a hundred years or more before it is demolished. Examples of how these phases recur as "construction", "renovation" and "alteration" are shown in Figure 1.

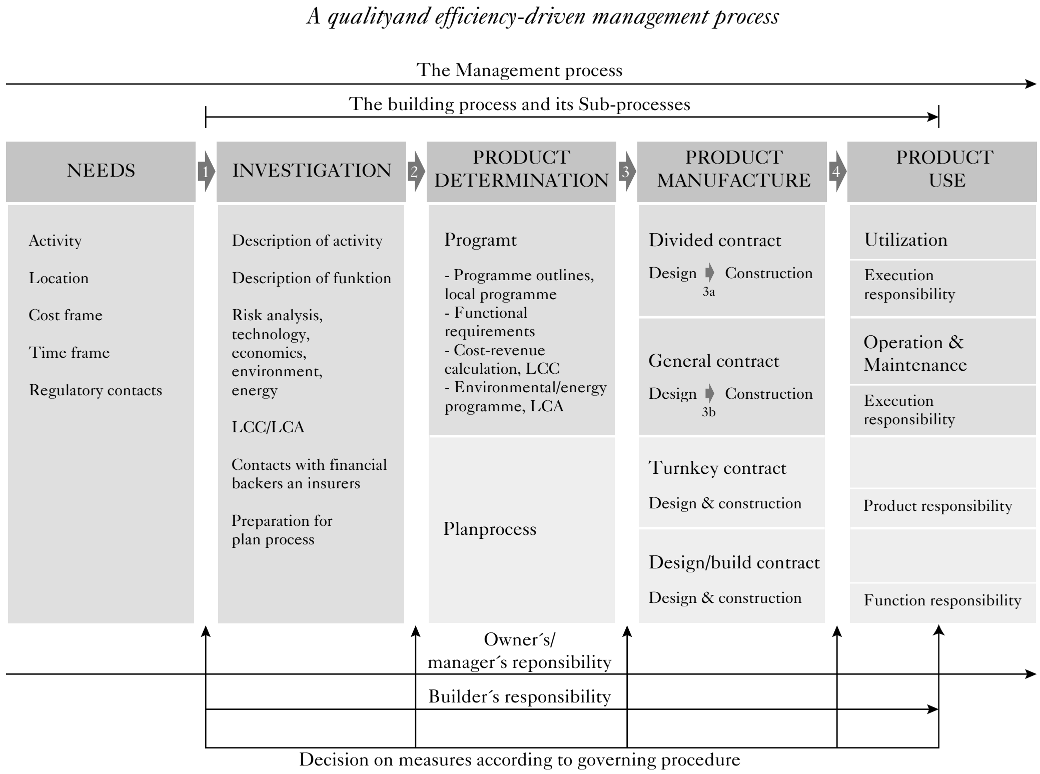


Figure 2.
Detail consisting of a reworked version of "A quality- and efficiency-driven management process", according to the working group for "Quality and efficiency in the construction and management process".

The different phases/processes shown in Figure 2

Needs

With a view towards the environment and resource management, there is reason to ask:

- Do we need this new construction, alteration or addition, or can we meet the need in an environmentally preferable way, for example with the existing street network or building stock through more efficient use of areas, co-utilization of premises, or use of buildings located elsewhere?
- Does new construction or alteration entail the use of new and better technology in such a way that environmental impact is reduced?

The work with the inventory of needs should include the company's environmental policy.

Investigation

In the investigation phase, activities and functions are described and technical and economic aspects are analyzed, along with environmental aspects and risks of various kinds. The risks may be of a technical, economic or environmental nature.

It is in the investigation phase that the plan process is commenced in cases where the plan has not already been adopted and changes are not needed.

In the investigation phase, facts are gathered regarding environmental issues and the needs of the client/user. There are many questions to ask in this phase, e.g. is there a risk of flooding or landslide, has any activity been conducted on the site that may have contaminated the soil, is there any activity in the vicinity that could cause disturbance due to noise or air pollution?

A general environmental programme is prepared for the project. It covers energy issues, chemical issues such as phasing-out of hazardous substances, and various general requirements on the indoor climate if it is a building that is to be erected. Note that chemical issues including phasing-out of hazardous substances are not likely to come up in early phases, but not until product determination and product manufacture.

Product determination

Product determination is based on the preceding phases. Programme and functional requirements are determined and the environmental programme is developed. It is primarily in this phase that decisions are taken that will determine the life-cycle environmental impact and costs of the building.

In order to obtain a product that meets stringent requirements with respect to life-cycle environmental impact and costs, there is reason to

- Decide which parameters should be design premises for the project and which can be varied,
- Perform computer simulations with respect to energy use and thereby associated environmental impact and life cycle costs, LCA and LCC, for various alternative project designs, see examples in this appendix. Such computer simulations can be based on energy calculations with the aid of generally accepted calculation tools such as BRIS, IDA, ABB Ventac, TRANSYS, DOE2, etc. (see e.g. Bengt Bergsten, "Energy calculation program for buildings – a comparison based on functional and user aspects", published by EFFEKTIV, Gothenburg 2001). For simpler projects such as residential buildings (except in cases where passive solar energy is utilized), the tool Enorm or the equivalent can be used. Svensk Byggtjänst and the Swedish Council for Building Research (BFR) have conducted work to integrate building cost calculations with project-oriented databases, where the point of departure is the management phase. In Sweden there is a positive attitude towards establishing a common database, but also a realization that difficulties may arise due to national peculiarities and national and regional differences in climate and building traditions.
- Develop environmental programmes with clear requirements, e.g. regarding selection of materials and products that may contain hazardous substances, see the sample template for an environmental programme in Appendix 2.
- Develop and define and enlist support for your goals, including the environmental programme for the project in question and its management, among all participating actors such as consultants, contractors and suppliers.

By, for example, carrying out life-cycle-based financial calculations and estimates of the environmental load for different alternative solutions, a foundation is obtained for determining design and construction method for a building.

The needs and the functional requirements are determined when the project is formulated. Normally the need description in a project is detailed based on the user/owner's demands on different functions, for example indoor climate, etc. In general investigation phases and sensitivity analyses, the need description could also be subject to unbiased reassessment, perhaps above all in vision studies and in R&D contexts.

Which parameters should comprise design premises for the project and which can vary

Building height, placement on the lot (orientation) and building area, as well as development rights, are usually a part of the need description. These design premises, related to the detailed development plan, may, however, be included in and determined during the investigation phase in consultation with the authorities in the detailed development plan phase.

Needs and functional requirements for e.g. offices include number of workplaces, floor area per workplace, floor thickness, building area, gross floor area (GFA), indoor climate requirements regarding operating temperature, air temperature, draughts, CO^2

level, air volume per m^2, illuminance, and possible internal loads from workplaces, etc. These requirements must be specified so that different design solutions with regard to orientation, framework and façades and different technical solutions can be devised that give equivalent conditions. For example, the interaction between the framework and the air treatment system is of great importance.

Computer simulations with respect to environmental impact and life cycle costs for different alternative designs of the project

Computer simulations can be run for:

- The whole building or construction works
- Alternative technical installation solutions
- Choice of components with regard to pressure drop, efficiency, U-value, heat capacity, etc.

Glazing, floor thicknesses, façade and static structure can normally be designed "freely" in the building permit phase.

All development on the land should be included, e.g. parking, communal facilities, etc. Energy use for operation, heating and the like is included. It is important to distinguish the use of electricity and other energy. An attempt should be made to include in the analysis activities where the boundary between landlord and tenant is not clear-cut, e.g. electricity for lighting (lighting control, daylight use, etc.), hot water use, etc. The needs of the tenant can be generalized in the analysis (need for light, electricity for computers, hot water, etc.). Transport to and from the building by the user/tenant is usually not included, nor is consumption etc., but attention should be given to these matters.

It is difficult to estimate the resource use caused by the tenant's activities and investment costs for "tenant adaptations" in early phases. These must therefore be handled separately in a later phase of the project. The tenant chooses and pays for both installation and operating costs for e.g. choice of light fixtures, control of lighting, etc.

An LCA can be limited so that only the operating phase is included. Environmental impacts from manufacture, erection, demolition, or recycling and waste management of the building are not included. This greatly simplifies the work and is reasonable in the majority of cases, since these parts currently have much less environmental impact than the operation of the building, see the report in section 2.2. The costs for these parts are included, however. But in the long run, these parts will also fall within the system boundary as regards environmental impact. It is important that materials, chemicals and hazardous substances are included in this work.

The various solutions that are arrived at provide input data for simulation calculations. The simulations in turn provide information on both indoor climate and energy requirement broken down into heating, building electricity, cooling and tenant electricity per hour and per month and year.

A work procedure that can be used for simulation calculation is described in example 1 below.

Product manufacture

There are different types of construction contracts: divided contract, general contract, turnkey contract, and design-build contract. In order to foster a trend towards longer building life and lower property management costs, the clients (property-owners) must clearly stipulate requirements to this effect. In this way, builder, contractors, architects, etc. will be given a clearer responsibility. Control and follow-up are important in this phase. An example of a tool that can be used is *Miljöanpassad projektering från AI-Företagen* ("Environmentally sound design from AI-Företagen", in Swedish only). AI-Företagen is now called STD Svensk Teknik & Design (the Swedish Federation of Consulting Engineers and Architects).

Product use

In order to foster a trend towards longer building life and lower property management costs, the clients (property-owners) must make their demands to this effect clear to the consultants, builders, contractors and service companies they engage. In this way they are given a clearer responsibility.

Decommissioning – demolition

When a building or parts of it are demolished or torn out, procurement of the inventory and demolition work must be done with environmental consideration, i.e. inventory must be done by certified inspectors and the demolition work must be done correctly with respect to hazardous substances that are encountered but have not been identified in the inventory.

Example 1 – Work procedure for computer simulation

Calculation for an entire building or construction works, for example an office building

In the early phases, all parameters that are not needs or functional requirements can be allowed to vary. Such parameters include *façade design*, i.e. number of m^2 and orientation of windows, sun screening and glass data (U-values, direct solar transmittance, total transmitted solar energy).

Each of the different combinations provides input data for a computer simulation. The results pertain to energy need and can in turn be combined with a production cost calculation that gives the life cycle cost. In combination with data on environmental impact, the simulation also gives the results of a life cycle assessment (LCA). Allowing all parameters to vary is, however, a laborious and costly process. To keep the amount of labour in the project manageable, the number of variable parameters should be limited to a few. This gives a few alternatives to be compared with regard to LCC and environmental impact. Environmental impact can be obtained from an LCA, which can usually be limited to the operating phase. Experience from other similar calculations naturally provides good guidance on what the most important factors are and what does not need to be analyzed in greater depth.

The same air conditioning system should be selected in all cases, but it may have different cooling capacities. The selected air conditioning system is a premise in the simulations. It should preferably be selected based on experience or studies of system solutions in previous projects.

Even a limited study with several parameters that vary is complex. The results influence different types of demand, such as electricity demand for lighting, heating demand, cooling demand, and electricity demand for fans.

It is appropriate to include a *reference building* in the parameter study that has normal glazing, climate control system, etc. The design premises of the project are applied to this reference building, i.e. geometry, internal loads, etc. This gives a comparison value for LCC and for environmental impact and can be used as an indication of where in the range the optimization has brought us.

This work should be carried out in cooperation between the programme architect, the client, and consultants with construction and installation engineering expertise and documented knowledge and experience of similar calculations. Limiting the number of variables makes the LCC/LCA manageable and one of the factors the architect can use for final building design.

This work requires that the client furnish information on which parameters should not be varied and on the standard building, data on environmental impact, and particulars on the financial assumptions for present value calculations.

Calculation for technical solutions

When choosing technical solutions and installations, the orientation and design of the building, including façade and windows, are given. In early phases, however (see above), they are parameters.

In order to get as good a solution as possible for indoor climate control, different technical solutions are studied. By means of iteration, it is possible to arrive at the capacity levels of installations for heating and cooling and the air volumes that are needed for the same indoor climate in the different alternatives. The results of the different simulations give energy costs in the form of a present value. Together with installation costs and possible building costs, the life cycle costs for the alternative solutions studied are then obtained. The annual energy needs can be used as a limited LCA.

Assessments of environmental impacts of materials and chemicals are essential in this phase, as is phase-out of hazardous substances.

Data from the client stipulating design premises are required here as well.

Comment: It is naturally possible to allow both climate system and building/façade design to be parameters, but then a multiple of the number of alternative climate control systems and building/façade designs is obtained. The costs of product determination increase, however, for which there is seldom margin in an individual project, even though it may be profitable in a life cycle perspective.

Calculation for components and individual parts

Selection of components includes taking into consideration materials and material combinations, their content of hazardous substances, etc. The standard templates included in the ENEU® concept (cf. example 3 below) can be used in assessing energy needs, as long as the proportionate distribution of energy use (e.g. between heating and electricity) does not vary widely in the different alternatives. If it does, a limited LCA is also required (cf. example 2 below).

Particulars from the client that define design premises are required here as well.

Examples of results are given below:

- From LCA and LCC calculations and a comparison between these is done (Example 2)
- From analyses of LCC for procurement of different building and installation parts with the aid of the ENEU® concept (“Calculate with LCCenergy”)

Example 2 – Climate system for an office building

The example relates to a climate system for an office building, Room temperatures, operating times, internal loads, etc., have been assumed to be equal for all climate systems studied.

The example includes relevant installation costs for:

- “Cooling baffle” – Refrigeration plant including piping system and cooling baffles plus air treatment plant
- "CAV system" (Constant Air Volume) – Refrigeration plant including piping system and air treatment plant, no cooling baffles
- "VAV system" (Variable Air Volume) – Refrigeration plant including piping system and air treatment plant and VAV terminal device, no cooling baffles

I Life cycle costing (LCC)

The energy costs are calculated at their present value with a factor of SEK 7/kWh for heating and electricity, SEK 5/kWh for cooling. The costs are in SEK/m^2.

	Annual investment	*Heating Cost*	*Cooling Cost*	*Fan electricity cost*	*Total (SEK/m^2)*
Cooling baffles	945	320	50	73	1388
CAV	680	475	20	153	1328
VAV	1200	368	20	121	1709

II Limited life cycle assessment (LCA)

The examples II a and II b include energy use during one year of operation for district heating, district cooling and electricity. The CO_2 generation is calculated with a factor of 0.095 kg/kWh for district heating, a factor of 0.0033 kg/kWh for district cooling, and a factor of 0.05 kg/kWh (mean value) for electricity. The table gives CO_2 in kg per m^2.

II a	*The calculation is based on a mean electricity value for Sweden:*			
Alternative	Heating	Cooling	Fan electricity	Total
Cooling baffles	4.34	0.03	0.52	4.9
CAV	6.45	0.01	1.09	7.6
VAV	5.00	0.01	0.87	5.9

II b	*The calculation is based on a marginal electricity value for Europe: The marginal value for electricity is 0.6 kg/kWh and for district cooling 0.04 kg/kWh.*			
Alternative	Heating	Cooling	Fan electricity	Total
Cooling baffles	4.34	0.40	9.16	13.9
CAV	6.45	0.16	13.1	19.7
VAV	5.00	0.16	10.4	15.6

Figure 3 below shows the results of the different calculation methods in a bar graph. In the chosen example, CAV is found to be slightly more advantageous than the other two systems if the calculations are only done with LCC (*not generally!*), while cooling baffle is found to be most advantageous when LCA is applied, regardless of which input data are chosen. However, it must be borne in mind that the results of similar analyses may differ from what has been found in this particular case, which means that a critical analysis of results obtained must always be done.

The present example is only intended to demonstrate one methodology that could be employed.

A qualityand efficiency-driven management process

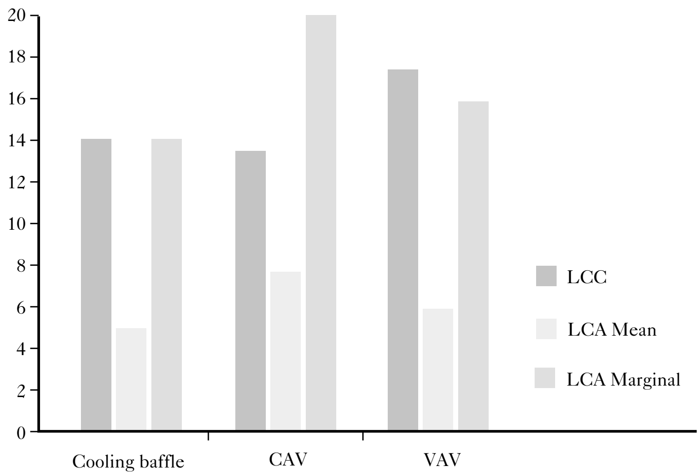


Figure 3
Example of ranking of environmental load for different climate systems in an office building calculated by LCC and LCA, where the environmental load is calculated with the mean load for Sweden and the marginal load for Europe. Note the units, LCC is given in SEK 100/m² and LCA in kg CO2/m² and year.
Source: Skanska Fastigheter Stockholm AB

Example 3 – Analyses of LCC with the aid of the ENEU® concept

The tool "Costing with LCC_{energy}. Economically sustainable procurement of energy-consuming equipment based on the ENEU® concept" has been developed by Bengt Dahlgren AB for the Association of Swedish Engineering Industries (VI). The Swedish Energy Agency (STEM) has also sponsored the project under an agreement with VI. The method was presented for the first time in 1994 in a version intended for procurement in industry (ENEU94). A first version intended for procurement in municipalities, county councils and private real estate companies (ENEU94K) also came out during 1995. A new, revised version that is partially web-based has been available since the autumn of 2001.

"Costing with LCC_{energy}" can be said to be a model for selection, evaluation and procurement of energy-consuming equipment where the life cycle cost (LCC) enters into the assessment of different investment alternatives and comparisons between tenders. The distinguishing characteristics of the method are:

- Technical functional requirements or guidelines for technical systems and components are made that ensure the desired function and minimal environmental load.
- The evaluation of different tenders is based on the life cycle cost.
- Post-measurement is included to verify that the installation meets the stipulated requirements. The possibility of a performance bonus or penalty in the event the actual result is better or worse than the projected result is also described in the ENEU® concept.

"Costing with LCCenergy" includes Handbook, Legal Module, Guidelines for the different technical areas and Forms for the different technical areas. The components and major parts of technical systems that are dealt with are:

- Air treatment system with fans and heat exchangers (refined calculation methodology)
- Refrigeration and heat pump plants
- Pumps
- Air compressors

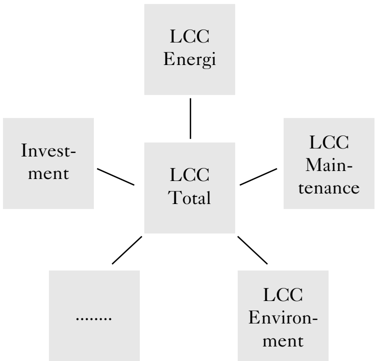
- Motors and electronic frequency converters for speed control
- Lighting for workshop premises, offices, healthcare premises, multi-family blocks and sports centres
- Power transformers
- Catering equipment, and in particular electric dishwashing equipment
- General electric-powered equipment (conveyor belts, etc.)

The ENEU® concept has become a kind of de-facto standard in the building and property sector as well and is supported by most trade organizations in the installation area and related areas. It has become increasingly widespread in Sweden and beyond (the Nordic countries and the EU).

Some typical results taken from various system analyses and calculations for individual building and installation engineering system parts and procurements carried out since 1994 are presented below (*Source of the figures: Bengt Dahlgren AB*).

Components of life cycle cost

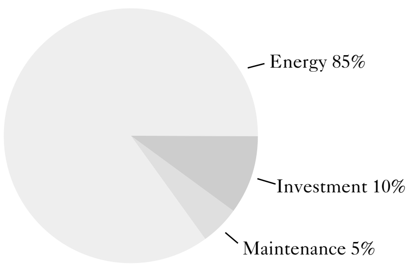
Components of life cycle cost



Cost allocation for LCC – Air treatment unit

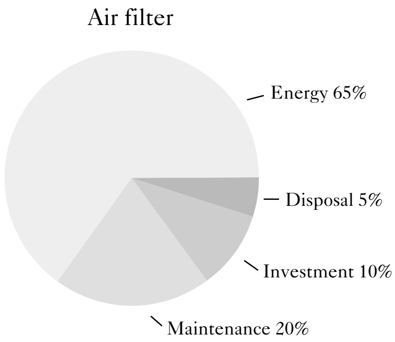
Cost allocation for LCC [1]

Air treatment unit (15 years)



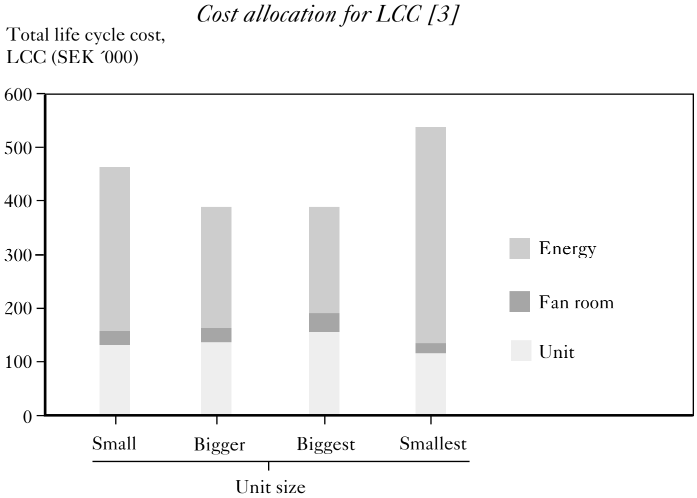
Cost allocation for LCC – Air filter

Cost allocation for LCC [2]



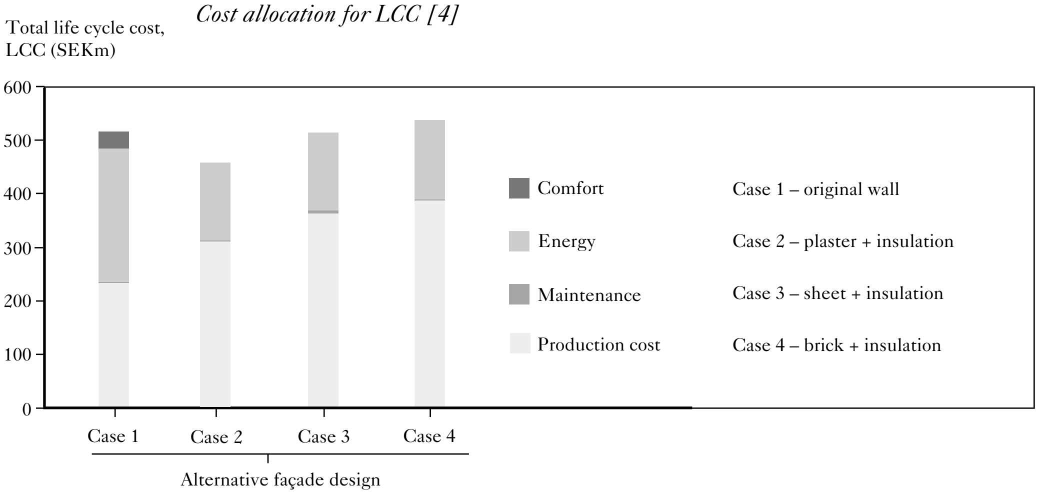
Cost allocation for LCC – Influence of unit size on LCC

Cost allocation for LCC [3]



Cost allocation for LCC – Choice of different façade designs for major energy conversion (Taking into account requirement of same operating temperature– increased energy use to achieve this – "Comfort cost")

Cost allocation for LCC [4]



Appendix 2
Example of template for environmental programme[4]

(Text in italics *represents* comments and examples)

1 Overall environmental requirements and objectives

1.1 Laws and regulations

Swedish law

The Environmental Code is the framework law that embodies current environmental legislation in Sweden. The most important requirements from the Environmental Code that influence design and construction are in brief:

- Precautionary principle: The mere risk of adverse effects on health and environment entails an obligation to take measures.
- Polluter Pays Principle (PPP): The party who causes or risks causing pollution should pay for whatever measures are needed to comply with the general rules of consideration in the Environmental Code.
- Best available technology: For professional activities, the best available technology shall be used to prevent environmental detriment and damage.
- Substitution principle (product selection principle): Wherever it is possible to replace a chemical product with a less harmful product, this shall be done.
- Resource management principle: Raw materials and energy shall be used as efficiently as possible.
- Ecocycle principle: Everything extracted from nature shall be used in a sustainable manner with minimum resource consumption.

The National Board of Housing, Building and Planning's building regulations – BBR

Chapter 6 of BBR contains general regulations on hygiene, health and the environment: "Buildings shall be designed so that the quality of air, light and water, moisture and temperature conditions, and hygienic conditions, are satisfactory with respect to public health requirements."

1.2 Anticipated environmental requirements

SFS 1998:902

As from 2005, organic waste may not be landfilled.

[4] It is very important that the environmental programme is adapted to the current project. If not, there is a risk that the reability of the environmental work will decrease

1.3 Investigations

Investigations and inspections carried out before the start of the project are listed here. Examples of such investigations are EIA, occurrence of ground radon, traffic noise, etc.

1.4 New investigations

The additional investigations to be carried out during the pre-production design process are listed here. These surveys are specified in environmental plans for each consultant and contractor.

2 Environmental objectives of the project

2.1 Overall environmental objectives

Outdoor environment

The outdoor environment shall not be adversely affected by the building's activities with regard to air quality, sound, light, electrical environment, and choice of work methods.

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……

Indoor environment

The building's indoor environment shall provide a climate free of problems with moisture, mould, radon, chemicals, dust/particles or similar nuisances.

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Ecologically sound practices and natural resources

Consultants and contractors shall choose processes, structures and materials that minimize material consumption and energy use and that contribute towards achieving the environmental objective of a "Non-toxic environment", cf. the detailed environmental goals. The life cycle perspective shall provide guidance (service life, maintenance, etc.). Requirements shall be made on consultants, contractors and subcontractor in connection with procurement and purchasing so that the total adverse environmental effects are minimized with regard to design solutions, goods and services. The precautionary principle shall be observed, i.e. the mere suspicion that a product, technique or process is polluting is sufficient to abstain from it. Renewable raw materials shall be used wherever possible.

The building shall be designed to enable the customers to practice source separation of waste.

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……

2.2 Detailed environmental goals

Outdoor environment

The consultancy group shall obtain information on the flora and fauna in the natural land area by referring to the municipal inventory, if there is one. The presence of interesting plant species, plant populations or solitary plants is marked in the plan and, if necessary, on the site as well. If rare animal species occur, they are taken into account in the planning of the area. In the absence of an inventory, a discussion shall be held with the client to decide on suitable measures.

When alterations are made in the terrain, the greatest possible consideration shall be given to those parts that are to be spared. No heavy machinery or material heaps may occur within the natural land area.

Particular consideration shall be given to the choice of work methods and machinery for construction so that nearby aquatic environments and surrounding environments are not harmed.

The size of paved surfaces shall be minimized so that stormwater can be managed by natural infiltration to as great an extent as possible.

Local stormwater management shall be prioritized.

The outdoor environment shall be planned so that residents suffer minimal nuisance due to odour, air pollution (exhaust gases, particulates) and the like.

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Indoor environment

Thermal climate

Guidance – Requirements shall be made on the indoor thermal environment with regard to the type of activity. Consideration shall be given to impacts on energy use and other resource consumption. TQ classes in accordance with the Swedish Society of Heating and Ventilation Engineers' (Inneklimatinstitutet) Guidelines R1 (revised version) can serve as the basis.

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Air quality

Guidance – Requirements shall be made here on e.g. AQ class in accordance with the Swedish Society of Heating and Ventilation Engineers' (Inneklimatinstitutet) Guidelines R1 (revised version), i.e. CO2 concentrations, volatile organic compounds (VOCs), dust, radon concentration, etc.

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Critical structures shall be designed for moisture effects.

Time shall be provided for drying of concrete floor structures in accordance with the manufacturers' instructions for the selected floor covering.

Avoid materials that emit, or in combination with moisture or alkalinity form, substances which are classified in the National Chemicals Inspectorate's list KIFS 1994:12, with addendum 1999:3, as carcinogenic, reproduction-toxic, allergenic or irritating to mucous membranes.

The production method shall be chosen so that a moisture-proof structure is erected.

Water supply systems shall be designed and rated so that the risk of contaminating the room air with legionella bacteria is minimized.

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Materials

Design surface layers and fittings for easy cleaning (radiators, cable runs, cabinetry, water closets, wash basins, floor coverings, etc.).

Surfaces shall have durable and easily cleaned finishes.

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Sound

Guidance – Requirements shall be made on the desirable sound climate with regard to the type of activity. New standards can serve as the basis.

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Light

Guidance – Requirements shall be made on the desirable light climate with regard to the type of activity.

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Electrical environment

Guidance – Requirements shall be made on the electrical environment which regard to the type of activity.

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Ecologically sound practices and natural resources

Materials and structures

Structures and materials shall be selected with a holistic view and from a life cycle perspective.

Structures and systems shall be selected so that the quantity of residual products is minimized (e.g. choose prefabricated structures). *Choose structural solutions that permit dismantling and replacement to as great an extent as possible. Prescribe resource-efficient building structures.*

Recommend renewable raw materials for structures and surface layers to as great an extent as possible. Avoid using metals and vinyl if other materials are available.

Recommend low-emission paint systems based on renewable raw materials. Paints, like other chemicals, shall be thoroughly examined for environmental and health impacts.

FSC-labelled wood products shall be used. The FSC – the Forest Stewardship Council – is an international voluntary system for eco-labelling of forest products agreed on by forest products companies, WWF, the Swedish Society for Nature Conservation and the trade-union organizations. The FSC takes biological diversity into consideration.

Prescribed products shall be environmentally examined by experts. Building product declarations and, where applicable, material safety data sheets and emissions reports as well, shall be appended to the examination document for prescribed products. Building product declarations shall essentially be prepared in accordance with the template issued by the Ecocycle Council for the Building Sector, then reviewed and approved in accordance with established criteria.

Avoid building materials that contain, or require for their use and care, substances which are classified in the National Chemicals Inspectorate's list KIFS 1994:12, with addendum 1999:3, as carcinogenic, reproduction-toxic, and bioaccumulative, combined with high toxicity. Substances with these properties are included in various lists of chemicals such as the National Chemicals Inspectorate's Observation List and Restricted Substances Database, as well as the "Kemikalielista över relevanta ämnen i byggvaror" ("List of relevant chemical substances in building products", in Swedish only) issued by the Swedish Construction Federation.

Collected building product declarations, material safety data sheets and emissions reports are gathered in a logbook for the particular property, which is handed over to the client for updating in conjunction with future alterations.

Prescribed products shall be environmentally examined and approved by the client. Substitution may therefore not occur without the client's approval. If substitutions are made in the production phase, equivalency shall be ensured. Aside from technical performance, environmental performance and estimated life cycle cost shall also be evaluated. Evidence of environmental equivalency shall be furnished in the form of building product declarations, emissions reports and material safety data sheets. In cases where products are not prescribed, they shall be selected on the basis of environmental requirements and verified against building product declarations, emissions reports, lists of chemicals, etc.

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Energy

Life cycle cost (LCC) and life cycle assessment (LCA) (limited to relevant parts) shall guide the selection of systems for the building.

Procurement of major installation components and subsystems shall be based on life cycle costs, e.g. in accordance with the ENEU® concept, wherever possible.

Select building envelopes and installation systems with low energy needs. Consideration shall be given to the heat storage capacity of the building framework (light/heavy building).

Make use of daylight as a light source in spaces that are not sensitive to the influence of daylight, e.g. stairways and other circulation areas.

Need-adapted systems for e.g. ventilation and lighting shall be prescribed.

An energy budget shall be prepared for the project with the objective that the environmental load shall be as low as possible. The total share of purchased energy (heating and building electricity, including general lighting, cooling, etc.) may not exceed XX kWh/m2 and year, of which electricity use may not exceed YY kWh/m^2,yr.

Energy balance calculations shall be done in early phases and be gradually refined in subsequent phases to check that the energy budget can be met.

Alternative, environmentally appropriate energy sources shall be prioritized. Valuation shall be done on the basis of an LCC analysis and an LCA, limited to relevant parts where warranted.

Surplus heat from insolation and from technical equipment shall be minimized in order to minimize the use of comfort cooling. Consideration shall be given to all heat loads of importance such as lighting, computers and other heat-generating equipment that contribute to this cooling demand. Switching to less heat-generating products should be considered. Any remaining cooling demand should preferably be met with free cooling and otherwise with mechanical cooling. Environmentally friendly refrigerants shall be chosen.

Environmentally friendly brines with low ecotoxicity and human toxicity shall be chosen. Consideration shall be given to the tendency of any brines to leak.

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Waste

Structures and systems shall be selected so that the quantity of residual products is minimized, e.g. choose prefabricated structures rather than cast-on-site ones, if possible. Choose design solutions that permit dismantling.

Esthetic and functional equipment for management of the user's waste products shall be devised for the property. The logistics shall be carefully thought out. The number of fractions shall meet the requirements and possibilities of today, and provision shall be made to increase the number of fractions in the future.

Source separation of waste during the construction period shall be clearly specified in the construction documents. The supporting material for the layout document shall clearly indicate dismantlability (simplify future dismantling). Building waste shall preferably be reused, otherwise recycled or as a last choice energy-recovered. Only waste for which one of the aforementioned alternatives is not possible may be landfilled.

Local mass balance shall be applied where possible. The exception is contaminated soil, which shall be disposed of in an environmentally safe manner. (*Cf. Environmental Code Chapter 10, Chapter 20, Chapter 26, Chapter 29, Chapter 32, and EIS, if any*).

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3 Environmental plan for design and production

Every consultant, contractor and subcontractor prepares an environmental plan for his specialty field with activities and commitments to fulfil the client's environmental programme.

The outline for the specific project's environmental plan is:

- Introduction to project
- Organization
- Timetable
- Activities and commitments (trackable/measurable)
- Follow-up of environmental plan activities
- Experience feedback

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4 Follow-up

The client will conduct environmental audits by examination of the documents **prior to** distribution. The following documents will serve as a basis for the audit:

- Environmental programme
- Environmental plan for particular consultant (also applies to contractor in the production phase)
- Current technical descriptions and drawings and similar documents

During the course of the work, **self inspection** shall take place with the aid of checklists prepared by each consultant, contractor and subcontractor. Prior to the audit, any non-conformances with the environmental programme shall be reported according to the client's instructions. Procedures for non-conformance reporting regarding deviations from the client's environmental programme and material selection etc. shall thus exist.

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5 Experience feedback

A summary and evaluation of the execution of the project shall be carried out to the extent that valuable information can be obtained for use in future projects. This can be done at a final meeting where all persons involved in the project gather to exchange experience on, for example, new methods, materials and machines, critical operations, results of inspection and testing, non-conformances, etc. This ensures constant improvement.

Experience feedback should also include the client's environmental requirements.

Appendix 3
Work in other countries

Following is a summary of what is being done in the Nordic countries. It is primarily focused on LCC, but not on early phases, LCA or chemicals.

1 Denmark

In Denmark, energy labelling of all buildings of less than 1,500 square metres prior to sale has been obligatory since 1996, when a law to this effect was passed. This is a part of the work to reduce costs and energy consumption. Buildings larger than 5,000 square metres also have to be labelled with an expiration date. These buildings must therefore be regularly measured and re-labelled.

In Denmark, calculation of life cycle economy (LCE) is tied to certain state housing subsidies. Since 1 January 1998, the Danish Ministry of Housing and Urban Affairs has required that applications for state subsidies be accompanied by an LCE of projects involving public construction and properties with private condominiums. For this a calculation model was needed, which the Danish state devised. The engineering company of Birch og Krogboe A/S developed a PC-based calculation tool for life cycle economy assessment called Trambolin for the Danish Ministry of Housing and Urban Affairs.

Certain information activities at energy companies and suppliers have taken place centred around the ENEU® concept (see below) in Denmark as well back in 1994. This has probably also influenced developments in Denmark.

Trambolin is aimed at builders and public officials who make decisions in subsidy matters. It is, however, up to the builder if he wants to use Trambolin or another calculation tool. According to a decision by the Danish Ministry of Housing and Urban Affairs, the tool shall be regularly re-evaluated and revised.

In the autumn of 1998, the Danish Ministry of Housing and Urban Affairs therefore created a working group consisting of representatives from the Ministry, the Danish Association of Housing Companies (Boligselskabernes Landsforening), Local Government Denmark (Kommunernes Landsforening), i-68, Birch och Krogboe A/S, Danish Building and Urban Research (By og Byg, formerly Statens Byggeforskningsinstitut) and BUR. An initial evaluation entitled *Totaløkonomi – erfaringer og anbefalinger* ("Total economy – experience and recommendations", in Danish) was done in 1999 (Willendrup, Annelise & Ejvind Løgberg 2000, Copenhagen, Danish Ministry of Housing and Urban Affairs). The conclusions were that:

- Municipalities, resident associations and the construction industry are positively disposed, but dubious as to the practical usefulness of the tool.
- It has been found to be tricky to carry out life cycle economy assessments when subsidies are granted, since the project in question then only exists as a set of objectives.
- Freedom of choice as to method is exercised in most applications, while Trambolin has been used in relatively few. Trambolin has the most desirable evaluation parameters, but has proved to be difficult to use.
- The construction industry, and in particular the consultants, often lack the necessary data for an LCE assessment.

- Municipalities, resident associations and consultant have different experience of encountering political and economic obstacles. Many also lack an understanding of how to use an LCE assessment for planning and design.

The working group has also put forth a number of proposals of how to proceed:

- There is an acute need for in-depth information on the virtues of LCE, including information on successful projects.
- Incentives for adopting an LCE approach should be strengthened.
- Freedom of choice of method should be preserved, but augmented with guides and practical aids. LCE assessments shall be adapted to the multi-tiered decision-making process and at the same time be adjusted to schedule A, B, C, BOSSINF and operating plans (note: pertains to Danish procedure in grant matters).
- There is a need to devise method descriptions and requirement specifications for new tools. Trambolin should be revised if this can be done in a reasonably economical manner. The task of devising new tools should be left to the free market.
- The Ministry of Housing and Urban Affairs' work of collecting key figures should not only continue, but also be strengthened. The Ministry should in particular collect a number of supplementary data from concluded projects, determine standard values and arrive at key figures as well as overviews of solutions that are advantageous from the viewpoint of total economy.

Note 1: BOSSINF= Ministry of Housing and Urban Affairs' information and administration system

2 Finland

The introduction of life cycle costing in Finland has been and is still incomplete, partly because the information has been poor and the tools have not been user-friendly. Today there is no standardized structure for total evaluation of buildings, and since the state does not impose any requirements there is low demand from e.g. companies and municipalities.

With support from TEKES (the National Technology Agency) and RAKLI (The Finnish Association of Building Owners and Construction Clients), TAKE (Development Centre for Finnish Building Services) has established cooperation with more than 40 different companies and major clients. The goal is to promote the commercialization of new innovations in LCA and LCC. During 1997 a number of projects were started by TAKE to try to find a common way of working against a standard. During the first phase, pilot calculations were performed on the product level only. During the second phase, in the spring of 1999, pilot projects were carried out on fully equipped technical installation systems (HVAC systems).

The results showed that a variety of different methods are available, but no reliable information on evaluation and limitations of the different systems. A methodology has been developed to be able to evaluate both the environmental impact and the life cycle cost of heating and ventilation systems. On the product level, a standard methodology for describing the factors that influence the calculation has still not been attained.

The development work is continuing in ongoing projects in TAKE. Some of the main areas are:

- Database for material used in conjunction with maintenance of buildings (widely accepted and examined).
- Database for emissions from energy production (widely accepted and examined).
- Finding and developing criteria for durable LCA/LCC tools.
- Continued development of the building systems' design tools and the work of increasing the proportion of ecological buildings and improving them.

The work is progressing with a growing number of partners on the national and international level.

Finland has good technical expertise in the field of life cycle costing and has developed good LCC models for technical installations. There is also a program developed by property-owners that deals with the valuation of property portfolios.

There is also a database of key figures for property management and a benchmarking service in which 50 major property-owners participate.

To spread the LCC culture in Finland, examples are needed where the benefits of LCC can be demonstrated. They are also interested in Nordic cooperation with exchange of experience in the field. Here there should be great opportunities, since Sweden, thanks to e.g. the ENEU® concept, has come very far and the methodology has in a way become a de-facto standard.

Great efforts have been made to find out about different projects in the area in Finland. Unfortunately, very little has been published in Swedish or English, which has so far prevented such an analysis.

According to the OECD project "Sustainable Building", the Finns use a series of unique tools to extend the service life of buildings, for example a property-owner is required to keep a service log of all maintenance and renovation work.

3 Norway

The *Grønn Stats* ("Green State") working group for buildings and energy use has compiled a list of the kinds of measures that can be effective in reducing energy use in government buildings.

The compilation is divided into

- Administrative measures for property-owners and managers
- Practical measures for property-owners and managers
- Administrative measures for tenants/users
- Practical measures for tenants/users

The compilation states the measure, describes it and what material is available, and proposes what should be done. When it comes to energy and power budgets, annual costings and selection of heating systems, reference is made to the Norwegian Standard *NS 3454 Livsykluskostnader* ("Life cycle costs"), and it is also stated that one-time builders can obtain help from the "regionale enøksentret" to draw up an energy and power budget for the new building. This standard contains requirements on how the calculations are to be done, what items should be included in the analysis, etc.

The *Bygningsnettverket* ("Building Network") was started by NVE (the Norwegian Water Resources and Energy Directorate) to assist large property-owners in organizing the energy conservation work in their buildings in order to improve energy efficiency and save money. The network consists today of several hundred property-owners – private, state, county and municipal. The members' buildings, currently about 1,200, comprise the foundation for the Energy Statistics kept on Norwegian buildings. Property-owners who wish to become members receive financial support from NVE to carry out a so-called network process, either on their own (large organizations or companies) or in cooperation with other property-owners (network group). Membership provides access to up-to-date information and statistics and contributes to increased energy awareness in the organization.

Calculations of *life cycle costs* (LCC) in Norway underlie investment decisions and rent-setting in the buildings owned by the Norwegian state that are let for public purposes. As from 1 September 1998, Statsbygg (the Norwegian state building company) introduced compulsory annual costing for all projects in the preparatory design phase. This means that design engineers are contractually required to deliver an annual cost calculation together with other preparatory design documents. The calculation, which must include a detailed description and evaluation of selected solutions, must be approved before the main design work can proceed. To facilitate this, Statsbygg has devised a costing model, a calculation example, and a description of reported key figures. The IT tool is called "Annual cost analysis", and Statsbygg developed it in cooperation with the Institute of Technology in Norway. The tool is free of cost to use.

When the cost frame for a project is presented in Statsbygg, the life cycle costs are included, i.e. the costs for both erection and use of the building during its service life are included. The calculations are carried out in accordance with Norwegian Standard NS 3454. The programme also takes revenues into account, and could therefore more appropriately be called a life cycle economy (LCE) calculation.

The calculation method is used in several contexts in Statsbygg:

- For evaluating alternatives, for example whether to rent, build or buy?
- For choosing solutions during the design phase
- For operation and maintenance (O&M) budgeting
- As a basis for rent calculations according to Statsbygg's rental model

Design can then be commenced with the purchasing of consultants. Design premises must be followed up. This is important for being able to report whether the O&M budget and the rent are right, and also provides good experience feedback for new evaluations of alternatives. Follow-up is also supposed to show whether the chosen quality level is realistic or needs to be changed. Furthermore, the LCC method provides an opportunity to reveal design and construction faults that result in abnormally high O&M costs during the three-year warranty period. In other words, economic data can be used to check the chosen technology.

The design group is allotted two contact persons from Statsbygg to answer questions about the calculation. They should mainly come from the building economics section and from the operation and maintenance section.

There is no requirement that Statsbygg's costing model must be followed, but regardless of the model it should be done according to NS 3454 and be set up and presented as prescribed there. The first page should provide all necessary information and graphics to show the final results.

During the past year, an increased Norwegian interest has been manifested in the many inquiries that have come to Sweden regarding the ENEU® concept as well (see below).

Energy budget

An energy budget should be done according to NS 3032 and submitted along with the calculation for the chosen heating system. The standard NS 3032 determines which items are to be included in an energy and power budget and specifies methods for checking the energy and power demand in buildings.

Follow-up on project completion

Statsbygg requires that the LCC calculation done during the preparatory design stage be updated and submitted to Statsbygg on completion of the project. The calculation will then show the building "as built" and form the basis for the first few years' operating budgets.

Follow-up during warranty period

It should also be in the interest of all users to check whether the finished building performs as it has been described (or ordered). It is therefore important for Statsbygg to obtain knowledge about all operating costs – including those for which the user is liable. Here, errors in the technical fine-adjustment of plants or abnormal/faulty operating plans can be detected and remedied.

When the lease is signed with the tenant, the way in which the major cost items – for example energy and waste collection – are to be reported to Statsbygg is also decided. The only costs not of interest to analyze during the warranty period are maintenance costs that arise later in the management phase.

For rental properties, Statsbygg checks the LCC costings against the accounts after the second year of operation and when the warranty period expires. Discrepancies are reported to the project design group.

4 Sweden

Sweden is probably the Nordic country that was first to develop good theoretical models for LCC. There is a good theoretical background in the subject and a professional approach here. However, Sweden has not yet been able to structure the theories and devise a total costing model in the building and property sector, but has instead focused on LCA (Life Cycle Assessment or Life Cycle Analysis) and LCP (Life Cycle Profit) for the individual element. This can in part be blamed on the cost allocation between property-owner and tenant that makes the investment cost the most focused. The private ownership structure is dominated by financial investors, who are most interested in their return on invested capital. The difference between LCP and LCC is in brief that in LCP, the revenue level is governed by the market, and expenses must be adapted to this in order to achieve the desired profitability in the life cycle. In an LCC calculation, the revenue level is determined by costs and must cover costs.

A general problem in Sweden is that even though useful data are available on LCC, they are spread among many sources in the construction sector and are not available and verifiable for others.

Sweden works actively with ISO, and development of LCP has taken place within projects more oriented towards real estate economics. For example, KTH (the Royal Institute of Technology) collaborated with the Swedish Construction Federation during the period 1992–94. This project had to do with developing conceptual and costing models for profitable construction and management of buildings. These models have been used in a joint project with Skanska (1996) and the Swedish Construction Federation (1999) to find a profitable combination between the rent and the project cost. A simplified model was used by the Building Cost Delegation (SOU 2000:20) in its analysis of tenders based on life cycle costs. Otherwise, experience of LCC analyses and calculations is most common in industry and the public sector. Historically, Sweden has had many different computer tools in the field.

A project has been conducted within Svensk Byggtjänst and the Swedish Council for Building Research (BFR) to integrate building cost calculations with object-oriented databases with the management phase as a point of departure. Researchers in Sweden are positive towards establishing a joint database, but believe that difficulties may arise due to national peculiarities and national and regional differences in climate and building traditions.

5 Iceland

The construction industry on Iceland has expanded vigorously and has been fully occupied with new construction. This area has therefore been given priority up until a year or so ago, and very little work has been done on the operation and maintenance phase. Operating costs have not been investigated systematically on Iceland, and there is no available information on this.

Today there are two IT programs on the Icelandic market, but they are only used by a few property-owners. Nor is there any contact network for maintenance, and financial problems have prevented one from being set up.

Iceland is very attentive to the problems surrounding LCC and LCA and is interested in participating in further work in this area.

Appendix 4
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Appendix 5
Background of the dialogue project

Representatives of a large number of countries met at the UN Conference on Environment in Rio de Janeiro in 1992 to discuss ways to achieve sustainable development. The action programme *Agenda 21* was adopted. The countries also agreed on the recommendation that all countries should develop a national strategy for sustainable development. In Sweden, the Riksdag (parliament) has decided to adopt 15 national environmental quality objectives that describe the quality or state of the environment that is required for ecologically sustainable development. One of these objectives is a Good Built Environment.

Achieving sustainable development is a great challenge for the whole of society. It will probably require revolutionary changes in many areas. In Sweden, the building and property sector accounts for roughly half of the environmental load in society, with 40 percent of the total energy use. The effect of environmental improvements in this sector is therefore great and is important in the ongoing work of achieving a sustainable society.

The Environmental Advisory Council, the Government's council on environmental issues, was commissioned by the Government to "formulate strategies for the development of an ecologically sustainable industrial sector by preparing and initiating a dialogue with parts of the business community" (Dir 1998:65 *Strategies for development of an economically sustainable business*, in Swedish). The purpose has been to initiate, support and influence the trend in the industrial sector, and to gather material as a basis for political decisions and positions on guidelines and instruments in environmental policy.

Two parallel dialogues have been conducted with participants from companies, municipalities and organizations: *Building, Living and Property Management for the Future and Future Trade in Convenience Goods*. The participants have discussed visions for 2025, goals, strategies and measures. The visions are based on the so-called generation objective and factor 10, which entails that resource use in the industrialized world needs to become on average ten times more efficient during the next one to two generations to enable the earth's ecosystems to cope.

Developed building – visions and goals

The dialogue group for Building/Living has agreed on a vision for a sustainable building and property sector and sustainable development of society up to 2025. The vision is described in the Environmental Advisory Council's report *Think new, think sustainable! – building and managing properties for the future* (in Swedish and a broschure in English). It is not a forecast of how the future will be, but the group's vision of how they want the future to be. The future vision is used to define goals and strategies for a sustainable building and property sector. Three themes and seven goals have been prioritized based on the vision. The focus in the vision is on the factors which the building and property sector can influence. People's need for comfort, light, warmth and healthy environments is also paramount in the vision. The vision is described from the perspective of five areas:

- A successful Swedish building and property sector
- A changing society – and one that we can influence

- Efficient use of resources
- A carefully planned building environment
- Resource-efficient property management

Prioritized themes:

- efficient energy use
- efficient resource use and
- a healthy indoor environment

Seven goals for the future:

1 By not later than 2025, space heating and hot-water heating will take place with only a limited use of fossil fuels. By not later than 2015, more than half of the annual energy need will obtained from renewable energy sources.

2 The use of purchased energy in the sector will decline by at least 30% by 2025 compared with 2000.

3 By not later than 2005, sector-specific information will be available that makes it possible to exclude building products and structures that give rise to substances known to be hazardous to human health or the environment.

4 By not later than 2010, all new buildings and 30% of existing buildings will have been declared and classified with regard to building-related health and environmental impact.

5 By not later than 2008, the building sector will have phased out the use of substances and metals covered by the Government's guidelines for chemicals use.

6 By not later than 2010, not more than 25% of the waste from new construction and alteration will be landfilled, compared with the 1994 level. Not more than 10% will be landfilled in 2025.

7 By not later than 2005, extraction of natural gravel will have been limited to a few specific purposes, amounting to not more than 3 million tonnes per annum by 2020.

These goals were adopted by the dialogue group and are included in the report Think new, think sustainable! – building and managing properties for the future (in Swedish). The goals have since been updated. The revised goals are published in the final report from Building, Living and Property Management for the Future.

Common platform

The visions, strategies and goals for a sustainable building and property sector that have been developed in the Building/Living group comprise the common platform on which the continued in-depth work with the dialogue is based. This common platform also includes the initiatives on the part of the state and the sector that were proposed by the dialogue group in the first phase of the dialogue project:

State initiatives

- Together with the sector, develop a system for the environmental classification of buildings.
- Examine the prospects of tax differentiation with regard to environmental class.
- Invest in research, development and innovations plus training, compe-

Sector initiatives

- Contribute towards fulfilment of goals.
- Plans for sustainable community planning.
- Use best available technology (BAT) and promote development of new technology and innovations e.g. by pilot projects and technology procurement.

tence development and experience feedback.

- In its roles as client and property manager, take the lead by stipulating requirements (indoor environment, energy, water, resource use) that lead to the goals.
- Incentives and resources for dissemination of the results of the dialogue and other general information on energy and environment.
- Energy taxes and charges that contribute to fulfilment of the goals.
- Regard the building as a system and procure with a view to life cycle cost.
- Develop a coordinated building process for improved quality and efficiency.
- Develop an efficient management process.
- Quality-assure buildings and develop extended warranties.
- Develop criteria for environmental classification of buildings and classify residential and commercial premises according to a suitable system.
- Examine the potential for differentiating premium systems and terms of credit.
- Invest in research, development and innovations (e.g. co-fund the Swedish Construction Sector Innovation Centre, BIC).
- Inform customers of environmentally sound solutions for environmentally aware choices in conjunction with purchase and use.

The results of the first phase of the dialogue, the agreed-on vision, and the areas the group decided are strategic are described thoroughly in the report Think new, think sustainable! – building and managing properties for the future.

Strategic areas

Seven action areas have been judged to be strategic and to contribute towards stimulating development in the desired direction for the three priority themes: efficient energy use, a good indoor environment and efficient resource use:

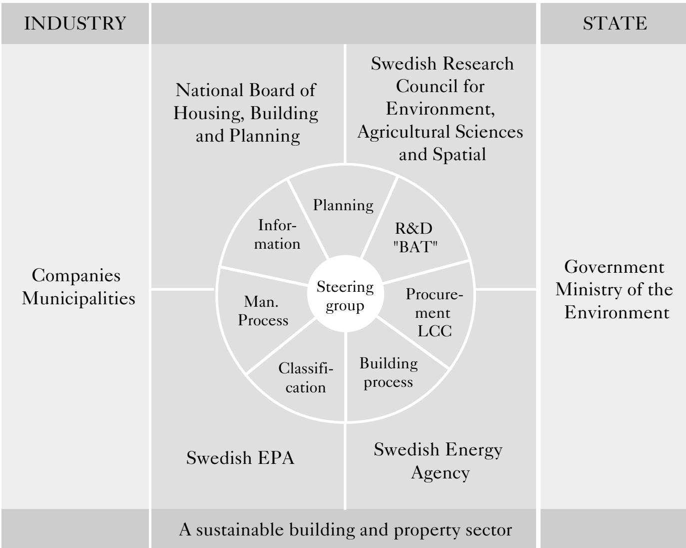
- Sustainable community planning
- Use of best available technology (BAT) and need for research and development for good environmental and energy solutions
- System selection and procurement with a life cycle perspective and a holistic view
- Quality and efficiency in the building and property management processes
- Classification of residential and commercial premises with regard to energy, environment and health
- Property management for a better built environment
- Information/implementation of sustainable solutions

Organization and timetable

Representatives of the companies, organizations and municipalities who developed the visions and the goals for sustainable development in the building and property sector in the first phase of the dialogue project have served as a steering group for the continued work during the second phase of the dialogue. This work has been pursued in six working groups with participants from companies, municipalities and organizations.

Companies, organizations and authorities who are not represented in the steering group have also participated in the work. The purpose has been to arrive at and agree on concrete measures and voluntary commitments aimed at achieving the goals for sustainable development. An information group has been in charge of coordination. The breakdown into working groups corresponds to the seven strategic areas that have been defined.

Building, Living and Property Management for the Future



The first phase of the dialogue project Building/Living was concluded in December 2000 with the report Think new, think sustainable! – building and managing properties for the future. Since then the work has continued, resulting during 2002 in proposals for agreements and concrete measures. A final agreement, contract or letter of intent is planned to be ready for the signature of the participants in the dialogue in early 2003. Then other companies, organizations and municipalities will be invited to conclude agreements.

Participants in the dialogue

Companies from the building and property sector, companies outside the sector but of great importance for the development of the sector, and several municipalities and Government representatives have participated in the Building/Living dialogue. Several persons who were not associated with any company or municipality but were included to further broaden the group’s perspective also participated in the first phase. A list of all participants in the first phase is included in the report Think new, think sustainable! – building and managing properties for the future.

Steering group

Bernt Johansson	Chairman of the steering group
Malte Hult/Per Wadstein	AB Electrolux
Sven Belfrage	AB Svenska Bostäder
Anders Möller/Nicklas Walldàn	AP Fastigheter AB
Håkan Gabrielsson	Asplunds Bygg AB
Anders Nilson	Bengt Dahlgren AB
Hanna Roberts	Bo 01 Framtidsstaden until May 2001
Mats Olov Hedblom	Ericsson Sverige AB until Oct 2002

Karl Erik Larsson/Jan Snaar	Folksam
Hans Pörner	FöreningsSparbanken
Peter Larsen/Mia Torpe	HSB Sverige AB/HSB Riksförbund
Lars Bergman	LB-Hus AB/Bridgemill AB
Lennart Eriksson/Ola Karlsson	NCC AB
Kjell Wedin	Riksbyggen
Ulrika Francke/Ingvar Johansson	SBC Bostad AB
Hans Wallström	Skanska i Sverige
Britt Hernell/Christer Herrström	Telia AB
Olof Sjöberg	Vasakronan
Martin Normark	Vattenfall AB until March 2002
Magnus Borglund	White arkitekter AB
Jerker Skarelius	Wirsbo Bruks AB
Leif Holmqvist	Municipality of Hofors
Martin Storm	Municipality of Kalmar
Göran Åberg	Municipality of Karlstad
Mats Olsson	City of Malmö

Co-opted members
Bengt Nyman from Oct 2001
Claes-Göran Stadler, Swedisol from August 2002

The Government's preparatory committee for the dialogue projects Building, Living and Property Management for the Future and Future Trade in Convenience Goods

Bertil Pettersson	Chairman, Ministry of Environment
Yogesh Kumar	Secretary, Ministry of Environment
Bernt Johansson	Chariman of Building, Living and Property Management for the Future
Bo Kjellén	Chairman of Future Trade in Convenience Goods
Björn Wellhagen	Ministry of Finance
Kerstin Grönman	Ministry of Environment
Åsa Holmgren	Ministry of Environment
Stefan Andersson	Ministry for Industry, Employment and Communications
Lars Guldbrand	Ministry for Industry, Employment and Communications
Erik Thornström	Ministry for Industry, Employment and Communications
Jakob Smith/Boa Drammeh	Ministry of Education and Science

Representatives of the Ministry of the Environment

Bertil Pettersson	Head of Building/Living in second phase
Yogesh Kumar	Secretary of Steering Group

Reference group with government agencies in first phase of the dialogue project

National Board of Housing, Building and Planning
Swedish Council for Building Research
Swedish Energy Agency
National Institute of Public Health
National Chemicals Inspectorate

Swedish EPA
NUTEK (Swedish Business Development Agency)
National Heritage Board
National Board of Health and Welfare

Building, Living and Property Management for the Future

In order to achieve sustainability in the building and property sector, it is necessary consider the building's environmental impact during its entire life cycle, not just during the manufacturing phase. The goal must be to analyze functions, buildings, installations and subsystems with a holistic view and a life cycle perspective. Procurement of major parts and components must take into account costs and environmental impact during the entire life cycle. Training in life cycle thinking is of very great importance here.

The working group "System selection and procurement with a life cycle perspective and a holistic view" offers proposals for concrete measures in this area which companies, municipalities and the Government can commit themselves to implement. The report also contains examples of work procedures and work methods in the various phases of the building and property management process, and how an environmental programme can be designed.

The work has been carried out within the project Building, Living and Property Management for the Future, a dialogue between the Government, twenty companies and four municipalities. The goal is to achieve a sustainable building and property sector 25 years from now.

The report is also available at www.naturvardsverket.se/bokhandeln

The working group "System selection and procurement with a life cycle perspective and a holistic view" within the dialogue project Building, Living and Property Management for the Future is responsible for the contents of the report.

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