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## Sustainable refurbishment by public clients

*Innovation and procurement strategies and practices*

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# SUSTAINABLE REFURBISHMENT BY PUBLIC CLIENTS: INNOVATION AND PROCUREMENT STRATEGIES AND PRACTICES

SBI 2013:33





# Sustainable REfurbishment by public clients: Innovation and procurement strategies and practices

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# Preface

This report contains the lessons learned from the Nordic project *SURE: Sustainable Refurbishment – lifecycle procurement and management by public clients*.

The SURE project team covers four of the Nordic countries with participation from both research institutes and practitioners, namely SBI/AAU (Denmark), VTT (Finland), Multiconsult A/S (Norway) and Innovation Centre Iceland (Iceland).

The project has been managed by a steering committee consisting of the following persons:

- Kim Haugbølle, SBI/AAU, Denmark (project manager).
- Peter Vogelius, SBI/AAU, Denmark.
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- Marianne Matinlassi, ARA, Finland (chair of Finnish steering committee).
- Pekka Huovila, VTT, Finland.
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The publication has been peer-reviewed by Paula Femenias, Assistant Professor, Chalmers University of Technology, Sweden.

Danish Building Research Institute, Aalborg University  
Construction and health  
December 2013

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# Executive summary

The Nordic project *SURE: Sustainable Refurbishment – lifecycle procurement and management by public clients* was carried out in 2009-2012. The objectives of the SURE project were:

- Build a Nordic network among industry, authorities and researchers to improve knowledge exchange on sustainable procurement.
- Summarise state-of-the-art on the interplay between life-cycle costing, environmental assessment of buildings and sustainable procurement.
- Assess and classify various sustainable procurement strategies deployed by public clients on refurbishment of existing public buildings.
- Analyse the experiences of public clients acting as sustainable change agents on the implementation of sustainable refurbishment in construction and real estate.
- Develop guidelines for sustainable refurbishment of existing buildings by public clients.
- Disseminate the lessons learned, the developed classification of procurement strategies and the guidelines for implementing sustainable refurbishment.

Based on national state-of-the-art reports, the SURE project has summarised factors of interest from the four participating Nordic countries: Denmark, Finland, Iceland and Norway. For various reasons Sweden was not part of the study. The state-of-the-art addresses the following issues in the participating countries:

- Population and age distribution.
- Building stock and ownership.
- Impact of building stock on environment.
- Construction sector and the market.
- Maintenance and refurbishment of facilities.
- Sustainable procurement of maintenance and refurbishment.

The SURE project has carried out 11 case studies in the four Nordic countries: Denmark, Norway, Iceland and Finland. The case studies focus on the different interactions between the framework conditions for the client, the client organisation, development projects and the refurbishment project itself. These interactions have been investigated in order to support the development of a Nordic guideline for sustainable refurbishment. The individual case study will typically have a more specific focus, for example on the relationship between the refurbishment project and the client organisation.

The main conclusions of the project address how sustainable refurbishment is promoted through procurement and innovation. Based on the 11 case studies in Denmark, Norway, Finland and Iceland, the SURE project has identified three different strategies for driving sustainable refurbishment:

- Strategy 1: A procurement-oriented strategy towards sustainable refurbishment.
- Strategy 2: An innovation-oriented strategy towards sustainable refurbishment.
- Strategy 3: An ad-hoc strategy towards sustainable refurbishment.

The SURE project has developed a guideline for procuring sustainable refurbishment. This SURE Guideline contains a ten-step process (the guideline is available at <http://www.sustainableprocurement.wordpress.com>):

- 1 Awareness of the process and the time aspect.
- 2 Defining sustainability and strategy.
- 3 Ambition level and finances.
- 4 Creating a performance profile of the building(s).
- 5 Strategic analysis – what to do?
- 6 Requirement (target) setting – define a quality program.
- 7 Selecting teams.
- 8 Implement the sustainable quality program into the process.
- 9 Check and act.
- 10 Monitoring and user behaviour.

A tool of sustainable indicators – The SURE Indicator Tool - was developed as an integral part of the guideline. A wide range of indicators were identified, starting with approximately 200, which was later reduced to approximately 70 indicators. The indicators are sorted in five categories: Social, Environmental, Economic, Technical standard and Process.

A series of short introductory videos on how to use the guideline are embedded in the guideline and can be found at YouTube ([www.youtube.com](http://www.youtube.com)).

# Introduction

This chapter provides a short introduction to innovation and procurement with regard to sustainable refurbishment, presents the objectives of the SURE project, sets the Nordic context for the project and provides reading instructions to the full publication.

## Background

Great values are already fixed in the existing building stock. Planning and preparation for how this value can be utilised in an optimal way in the future, and the estimation of future needs are very important when considering sustainability of the built environment. It is important to evaluate and compare experiences from actors in each of the Nordic countries to be able to estimate needs and to specify guidelines based on best practice.

Most guidelines focus on the building process of new buildings and starts with the briefing, design and construction (Thuvander et al. 2012), rather than taking the existing building as the starting point. For example, the European Commission has launched an initiative on "Green Public Procurement". Two particularly relevant reports from this initiative are the handbook "Buying green!" (European Commission 2004) along with the toolkit "Green Public Procurement (GPP) Training Tool" (European Commission 2008). In the toolkit the emphasis is on the construction process of buildings and the impact of buildings as such, but needs for refurbishment and related actions on the existing building stock are not addressed specifically.

In recent years, global warming has become one of the main challenges for our future development of the society. The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (2007: 59-60) concludes that improving energy efficiency in buildings holds one of the greatest potentials and most cost-efficient actions to reduce climate change. The building stock counts for a high amount of the total energy use both in the Nordic countries and globally. Energy-efficient refurbishment of buildings is therefore extremely important both for reducing the amount of greenhouse gases and reducing the load on the energy distribution system. A number of public policies have been implemented in the European countries to reduce the environmental impact for example with respect to energy consumption (see e.g. AID-EE EU project 2006b & 2006c).

In the building sector, reducing energy demand and changing the energy sources from fossil fuel to renewable energy have been the main actions to reduce the environmental impact. This huge focus on energy reduction is important, but there are also a range of other sustainable measures that have to be taken into account when aiming for sustainable refurbishment of buildings. Drawing on the definition of the Brundtland Commission sustainability reaches further than just energy.

Sustainable development was defined in the Brundtland report (United Nations World Commission on Environment and Development, 1987) as what "meets the needs of the present without compromising the ability of future generations to meet their own needs." The field of sustainable development

is based on three pillars: environment, psychosocial, and economy. Issues like e.g. waste management, material properties, space efficiency, service life time, indoor climate, adaptability, building conservation, maintainability and building physics should not be forgotten. Furthermore, the measures must be done in the right way to avoid building defects and to ensure proper use of the building. The buildings also have to be refurbished according to the climate to come, not only the present climate.

Despite the importance of these guidelines, public policies etc., it has also become clear that further actions from the construction and real estate cluster itself are necessary to achieve the desired goal of sustainability. Thus, in recent years the construction clients and building owners have been called upon by policy makers, the industry and clients themselves to become change agents that can stimulate innovation. Despite these calls for action, little is known about *how* clients in practice can make a difference as sustainable change agents, in particular when it comes to refurbishment of the existing building stock.

If clients are to act as change agents towards a sustainable built environment, they will need to rest their policies and actions on firm ground rather than loose sand. In the major European project SUREURO (Sustainable Refurbishment Europe), the issue of developing sustainable procurement methods and strategies were addressed by a group of social housing companies. The project clearly illustrated the problems of developing and embedding new sustainable procurement practices in a client organisation (see e.g. Haugbølle & Engberg, 2005 and Engberg & Haugbølle, 2005).

Thus, sustainable refurbishment of the existing building stock requires new procurement strategies and methods in order to succeed. More specifically, two challenges needs to be addressed:

- From traditional refurbishment to sustainable procurement strategies – making a sustainable difference.
- From business-as-usual to change management – implementing new ideas and sustaining change etc.

## Objectives

The objectives of the SURE project are to:

- Build a Nordic network among industry, authorities and researchers to improve knowledge exchange on sustainable procurement.
- Summarise state-of-the-art on the interplay between life-cycle costing, environmental assessment of buildings and sustainable procurement.
- Assess and classify various sustainable procurement strategies already being deployed by public clients on refurbishment of existing public buildings.
- Analyse the experiences of public clients acting as sustainable change agents on the implementation of sustainable refurbishment in construction and real estate.
- Develop guidelines for sustainable refurbishment of existing buildings by public clients.
- Disseminate the lessons learned, the developed classification of procurement strategies and the guidelines for implementing sustainable refurbishment.

## SURE – a Nordic research cooperation with different contexts

The SURE research project has been a close cooperation between building researchers and practitioners from Denmark, Norway, Finland and Iceland. To gain insight into what type of needs to address and what kind of problems the market is struggling with, case studies are of great importance as a basis for developing a guideline for sustainable refurbishment.

The building or project owner is here defined as the client, and the main objectives in the SURE project have been to investigate both technical challenges for a sustainable refurbishment and processes/barriers in the client organisation and environment to find out how a successful sustainable refurbishment can be fulfilled. The results of the analysis, combined with the researcher's former experiences and knowledge in this field, have given a solid basis for developing a Nordic guideline on sustainable refurbishment.

Although the ambition has been to develop a common Nordic guideline, the authors are fully aware of the need for local adaptation to suit specific national requirements. Thus, the guideline should be viewed as a principal framework, which is flexible and adaptable.

In Norway, Finland and Denmark, energy reduction is of very high importance both for new and existing buildings. Stricter requirements in building codes, implementation of passive house standard and a high focus on increasing the amount of renewable energy sources combined with reducing the electricity consumption is of high priority. In Iceland, though, due to the extensive use of renewable geothermal heating, the focus of energy is much lower. Here, the standard of the building and low maintenance costs are seen as more important qualities for a sustainable development. The energy issue described is one of the major differences between the Nordic countries when talking about sustainable refurbishment. But there are also other differences in the priorities among the countries, mostly related to building codes, weighting of performance indicators, building stock, population, culture and market changes.

## Reading instructions

The SURE project is reported in two main parts: a summary of the main conclusions and 15 appendices divided in four national volumes of state-of-the-art and 11 case studies from the four Nordic countries participating in SURE.

The summary of the SURE project contains the lessons learned and main conclusions across the national case studies and the four core technical work packages. The outline of the summary part looks like this:

- Introduction to innovation and procurement of sustainable refurbishment.
- Research design.
- State-of-the-art in the Nordic countries
- Procurement and innovation strategies.
- Guideline on sustainable refurbishment.
- Conclusion.

Each of the four national state-of-the-art contributions addresses the following issues:

- Population and age distribution.
- Building stock and ownership.
- Impact of building stock on environment.
- Construction sector and the market.



- Maintenance and refurbishment of facilities.
- Sustainable procurement of maintenance and refurbishment.

Each of the case studies follows the same general template:

- Introduction.
- Contextual description of the case.
- Procurement strategies.
- Client as change agent.
- Guidelines.

# Research design

This chapter introduces the theoretical framework and methodology of the SURE project. The theoretical framework is set within a systemic innovation perspective and business strategic perspective. The applied methodology includes a documentary analysis of state-of-the-art and case study design based on 11 case studies in four involved Nordic countries, which informed the design process of the guideline developed as part of the SURE project.

## Theoretical framework

### A systemic innovation perspective

Porter's (1990) diamond model for the competitive advantage of nations has been widely applied as a systemic perspective on various industries. However, Gann & Salter (2000) provides a stronger analytical framework for understanding innovation in service-enhanced project-based industries like the construction industry. First, every construction organisation is embedded in a context of markets as well as politics (regulatory and institutional framework) and knowledge institutions (technical support infrastructure), which shape the boundaries of possible action of the firm (see Figure 1).

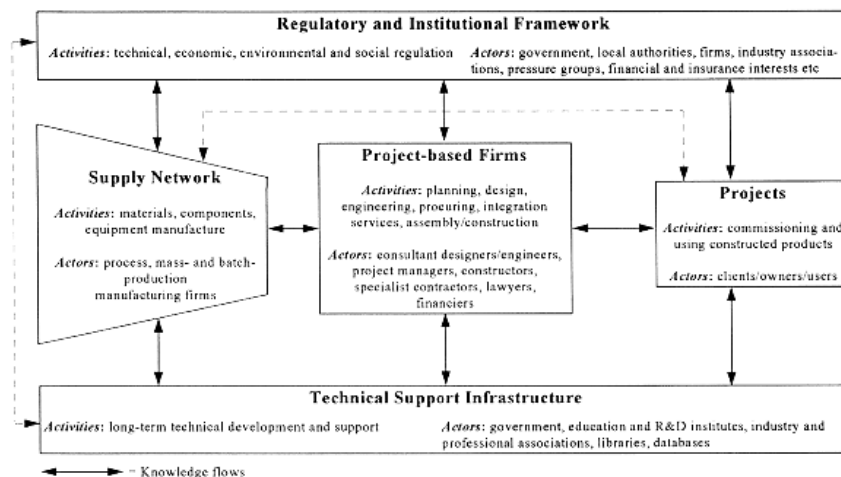


Figure 1. Knowledge, information flows and actors in project-based processes. Source: Gann & Salter (2000: 960).

Second, construction in general operates in a context of project-based services. As noted by Gann & Salter (2000), a major impediment for innovation in project-based service-enhanced firms is the gap between the project-based processes and the business processes of the firm. The project-based nature of construction implies that the interdependencies are primarily linked to the rather fluently, changing and ad-hoc patterns of cooperation with a rather great number of external firms.

The strength of this framework (Gann & Salter 2000) is its strong emphasis on putting construction in to its context – a context of both knowledge and politics. Another feature of the model is its recognition of both actors and activities taking place. Further, the model acknowledges not only the construction industry in a traditional sense – consultants and contracting firms – but extends the perspective to include the manufacturing industry that deliver most of its output to construction.

Despite the strengths of this perspective, it is rather weak on transformative business strategies. Thus this systemic and network-based perspective on construction may benefit from being supplemented with an additional perspective with a stronger focus on firms and strategy. Similarly, business strategy perspectives tend to lack sufficient conceptualization of and emphasis on the systemic and network-based character of construction business.

### A business strategic perspective

Several frameworks have been developed for business strategy analysis like the balanced scorecard (Kaplan & Norton, 1992). Hambrick & Fredrickson (2005: 51) argue that despite the range of frameworks for analysing strategy processes guidance is missing on what the product of these frameworks should be – and more fundamental, what actually constitutes a strategy. The main point of critique is that the use of specific strategic tools tends to draw the strategist toward:

*"...narrow, piecemeal conceptions of strategy that match the narrow scope of the tools themselves. For example, strategists who are drawn to Porter's five-forces analysis tend to think of strategy as a matter of selecting industries and segments within them. Executives who dwell on "co-opetition" or other game-theoretic frameworks see their world as a set of choices about dealing with adversaries and allies."*

Strategy is concerned with how a business intends to engage its environment, so choices about internal organisational arrangements are not part of strategy and neither are well-known concepts such as *mission* and *objectives*. These should rather be viewed as standing apart from and guiding the strategy. Thus, Hambrick & Fredrickson (2005) provide us with the following illustration to put strategy in place (see Figure 2), which will form the basis for the subsequent analysis of the construction client.

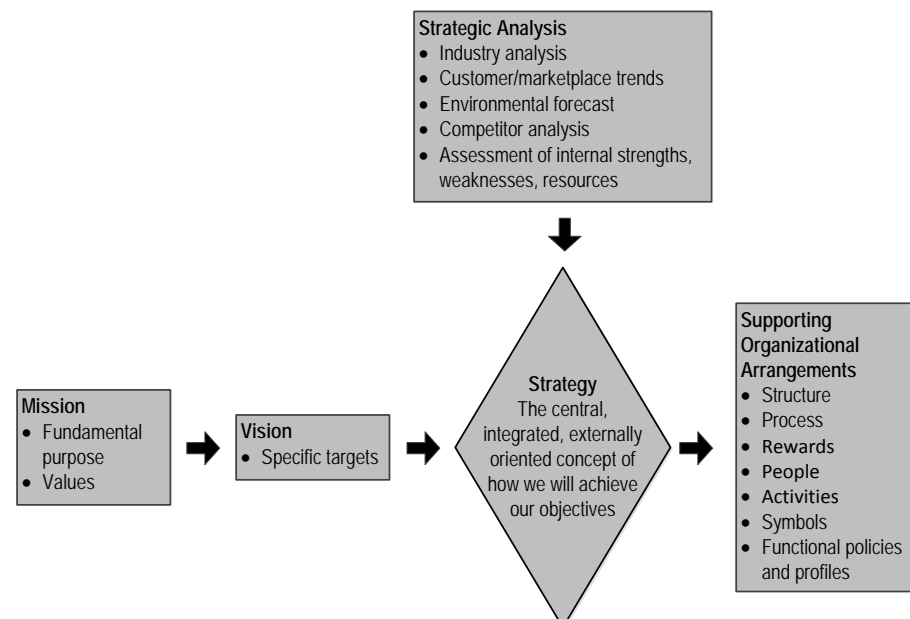


Figure 2. Putting strategy in its place. Source: Adapted after (Hambrick & Fredrickson, 2005: 53).

Consequently, Hambrick & Fredrickson (2005) provide a framework for strategy processes that provides answers to the following five core questions (see Figure 3):

- Arenas: Where will we be active?
- Vehicles: How will we get there?
- Differentiators: How will we win in the marketplace?
- Staging: What will be our speed and sequence of moves?
- Economic logic: How will we obtain our returns?

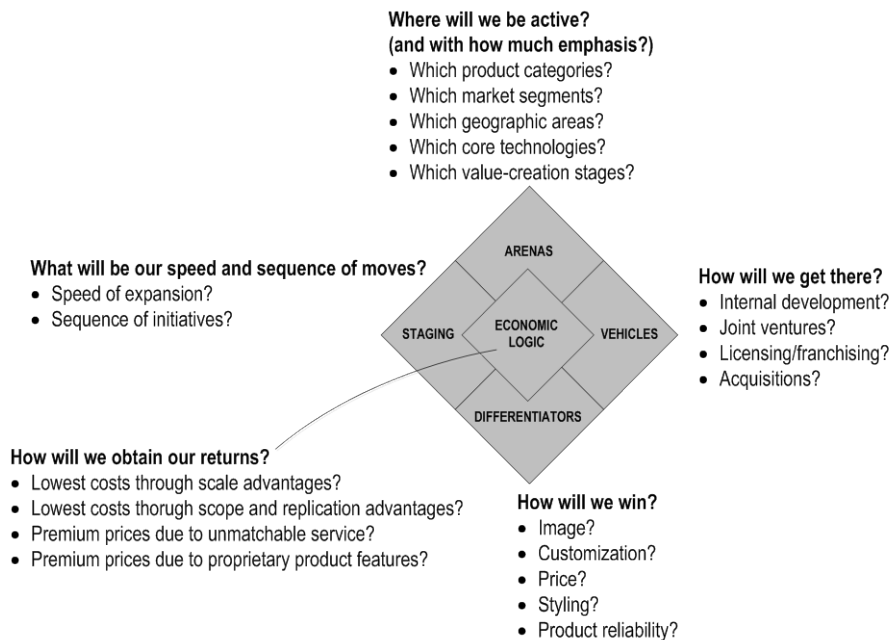


Figure 3. Five major elements of strategy. Source: Adapted after (Hambrick & Frederickson, 2005: 54).

The overall criteria for the evaluation of the strategy of the public client are consistency and adequateness. Consequently, Hambrick & Fredrickson (2005) proposes that it is insufficient to simply make five sets of choices regarding arenas, vehicles, differentiators, staging and economic logic. Thus, some strategies are clearly better than others, and to test the quality of the strategy the following key evaluation questions can be applied:

- Does your strategy fit with what's going on in the environment?
- Does your strategy exploit your key resources?
- Will your envisioned differentiators be sustainable?
- Are the elements of your strategy internally consistent?
- Do you have enough resources to pursue this strategy?
- Is your strategy implementable?

## Methodology

### Documentary analysis

The need for and the execution of refurbishment of public buildings is dependent on a multitude of factors. Some of these factors are dependent on the local context, others may be cross-national. In the following discussion on state of the art in the Nordic countries, the factors of interest are mainly considered to be as follows:

- Population and age distribution:
  - The actual situation and foreseen changes that will affect the need for public buildings of different types.
- Building stock and ownership:
  - The need for refurbishments and maintenance is dependent on the number and age distribution of existing buildings along with the type and number of buildings needed in the future.

- The ownership of public buildings sets the frame for decisions about refurbishment and how these are financed.
- Impact of building stock on the environment:
  - The impact of the building stock on the environment depends on the present and future functional performance of the buildings.
  - The impact on the environment depends on performance of the existing building stock and how it may be refurbished.
  - Energy demand is an important factor, but energy production and environmental effects differ widely between countries.
  - Health and indoor air quality in older buildings may be an important driving factor for refurbishment.
  - Material use, production and transport needs (domestic or imported) affect the amount of embodied energy and generally impact from different material use on environment.
  - Waste handling is a factor of increasing importance as the building industry is a heavy producer of waste.
- Construction sector and the market:
  - Information regarding how well the sector does fulfil market needs, and what can be done better is of interest.
- Maintenance and refurbishment of facilities:
  - Information regarding estimated needs, which methodology has been used and experiences gathered will give an idea about what the market needs to prepare for.
- Sustainable procurement of maintenance and refurbishment:
  - Mapping of the public aims regarding sustainable procurement provide information on what counts as sustainable, especially if described explicitly in public documents together with success criteria.
  - Decision-making processes, methodologies and tools shape what may be procured by public clients.

In each of the national state-of-the-art reports in Appendix 1-4, the above listed items are discussed for the four contributing countries Denmark, Finland, Iceland and Norway. Unfortunately, Sweden was not able to participate. The available information differs some from country to country, and the emphasis therefore varies somewhat between the national contributions. Consequently, a comparison on a one-to-one basis between the countries has not been fully achievable.

### Case study design

The research perspective applied has broadly speaking encompassed two different approaches – an action-oriented approach and an analytical approach (for an overview of different types of research, see Launsø & Rieper 2005). The first approach is most clearly represented in the Norwegian and Finnish case studies. These have been based on an action-oriented approach in which the researchers have engaged in dialogue and consultancy processes with clients to shape the outcome of the actual refurbishment projects. The second approach is most profoundly expressed in the Danish and Icelandic case studies in which the researchers have adopted a more analytical perspective and have had a more distanced relation to the client organisations and refurbishment projects.

The overall research design of the project is based on case studies. The case studies have been selected as either paradigmatic cases (e.g. converting a building to new use) or as critical cases (e.g. refurbishing a listed building) in line with the case study methodology developed by Flyvbjerg (1991 and 2006).

Each of the case studies has applied a variety of different methods to collect data e.g. documentary methods and qualitative research interviews. Most



cases have included both qualitative and quantitative data e.g. client policy documents, procurement documents, drawings and descriptions, calculations and measurements of e.g. energy and so on. The description of each case study in the appendices provides more details on the data collection methods being applied.

The SURE project has carried out 11 case studies. The 11 case studies focus on the interactions between the client organisation on one hand and the framework conditions for the client, development projects and the refurbishment project itself (see Figure 4). The particular analytical focus, empirical details and comprehensive unfolding of the context of each case study can be found in the appendices (see Appendix 5-15).

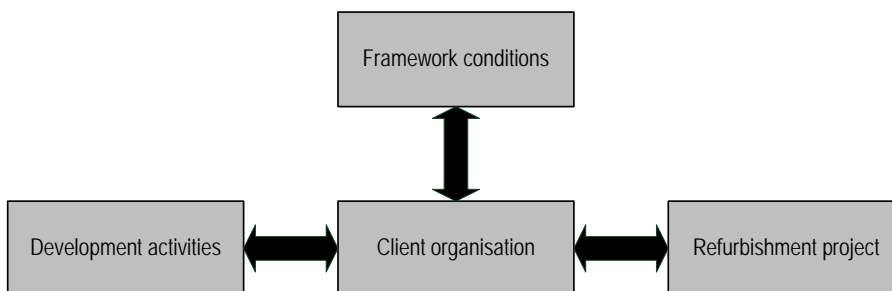


Figure 4. The relationship between the client organisation and the refurbishment project, development activities and framework conditions.

### Description of 11 case studies

The SURE case studies include 11 case studies from the four countries: Denmark, Norway, Iceland and Finland. Table 1 gives an overview over the SURE case studies.

Table 1. Overview over the SURE case studies.

Country	Client	Building	Theme	Listed
Denmark	City of Copenhagen	Sports arena Cultural facility	Politics and practice	YES
Denmark	Danish Palace and Properties Agency	Office	Health and safety	NO
Denmark	Social housing company AKB	Housing, Taastrupgaard	Development (EU FP5)	NO
Norway	Drammen Eiendom	Strømsø School	Conversion of use, energy savings	YES
Norway	Drammen Eiendom	Housing	Energy savings	NO
Norway	Entra Eiendom	School, Ringstabekkveien 105, Bærum	Conversion of use	YES
Norway	KruseSmith	Housing, Kristiansand	Energy and facade	NO
Iceland	Félagsbústaðir hf	Housing, Meistaravellir 19-23	Sewage and accessibility	NO
Finland	Social housing company VAV	Housing, Sahatie 2, Vantaa	Industrialised methods for energy refurbishment	NO
Finland	Domus Arctica Foundation	Student housing, DAS III, Rovaniemi	Change of layout, ventilation	NO
Finland	Helsinki Parish Union	Töölö Church	Low energy	YES

The content of the 11 SURE case studies is described in general terms below.

*SURE case study DK1: City of Copenhagen – politics and practices in financing renovation strategies*

The purpose of this case study is to analyse how municipal politics and practices shape the financing of sustainable renovation strategies in a municipality.

*SURE case study DK2: Danish Palace and Properties Agency – working environment for construction and operation*

The purpose of this case study is to analyse how a client organisation can develop and implement a strategy on sustainability and how this will shape the client strategies, existing renovation practices, available knowledge and calculation tools. The example in this case is related to occupational health and safety for construction and operation of an office building.

*SURE case study DK3: Social housing company AKB – revisiting the construction client as change agent*

The purpose of this case study is to analyse how a social housing company had implemented their experiences and knowledge gained from participating in the major European R&D project SUREURO (Sustainable Refurbishment Europe) some five years ago.

*SURE case study NO1: Refurbishing of a listed school in Drammen Municipality, Norway*

The purpose of this case study is to analyse how the energy demand for a listed school building from 1891 can be reduced combined with a change of use. The public building owner (Drammen Properties) wanted the school building to be a part of the Future Built exhibition (2008-2018). Three concepts are evaluated: 1) Technical regulation refurbishment standard, 2) passive house standard, and 3) zero-energy standard.

*SURE case study NO2: Refurbishing of social multi dwelling buildings in Drammen, Norway*

The purpose of this case study is to analyse how the energy demand for a multi dwelling building from 1937 can be reduced. The public building owner (Drammen Properties) wanted the school building to be a part of the Future Built exhibition (2008-2018). Three concepts are evaluated: 1) Technical regulation refurbishment standard, 2) passive house standard, and 3) zero-energy standard.

*SURE case study NO3: From a boarding school to a modern elderly care apartment building (Ringstabekkveien 105 – Bærum, Norway)*

The purpose of this case study is to execute a strategic analysis of a protected building regarding energy demand reduction combined with building physics and energy system. The former boarding school building is expected to function as an apartment building combined with elderly care.

*SURE case study NO4: Refurbishment of multi-dwelling buildings in Kristiansand*

The purpose of this case study is to investigate the energy saving refurbishment of multi-dwelling building in Kristiansand, Norway. The main focus areas are energy demand reduction, sustainable solutions and building physics.

*SURE case study IS1: Reykjavik Municipality – social housing*

The purpose of this case study is to analyse how municipal politics and practices shape the financing of sustainable renovation strategies in a municipality.

*SURE case study FI1: Energy-efficient refurbishment of VAV Sahatie 2 Vantaa*

The purpose of this case study is to study industrial, replicable system solutions for sustainable refurbishment of apartment buildings of the 1970s.

*SURE case study FI2: Renewal of student's hostel DAS III Rovaniemi*

The purpose of this case study is to study industrial, replicable system solutions for sustainable refurbishment of apartment buildings for student housing of the 1970s.

*SURE case study FI3: Helsinki Parish Union – Töölö Church, Helsinki*

The purpose of this case study is to study sustainable refurbishment and renewal guidelines with a focus on carbon footprint of an ethically responsible actor.

### Design of guideline

Figure 5 shows an outline of the design process used in the SURE study to develop the SURE guideline. The similarities and differences between the countries, together with the client discussions and internal workshops, have crystallized some important topics for a Nordic guideline for sustainable refurbishment of buildings. One of the most important output is the great need for a tool to help clients (building owners) change their thinking towards sustainability.

The 11 different case studies in Denmark, Finland, Norway and Iceland have been investigated in order to find sustainable solutions for refurbishment. Further, thorough discussions with the clients regarding ambitions, strategy, energy reduction, future use and a number of other parameters have been conducted. For several of the case studies, a condition survey has been carried out to get an overview of the performance of the building(s). Thereafter, case study reports have summarized the discussions on recommended measures, overall client strategies, procurement strategies, client as a change agent and the use of guidelines in the specific refurbishment project. The guideline on early phase planning here described has been created based on findings and conclusions in the case studies, internal and client-specific discussions/workshops combined with the researcher's theoretical and practical former experiences and knowledge in refurbishment of buildings. The guideline content and structure is created through internal discussions and brainstorming in workshops in the SURE research project.

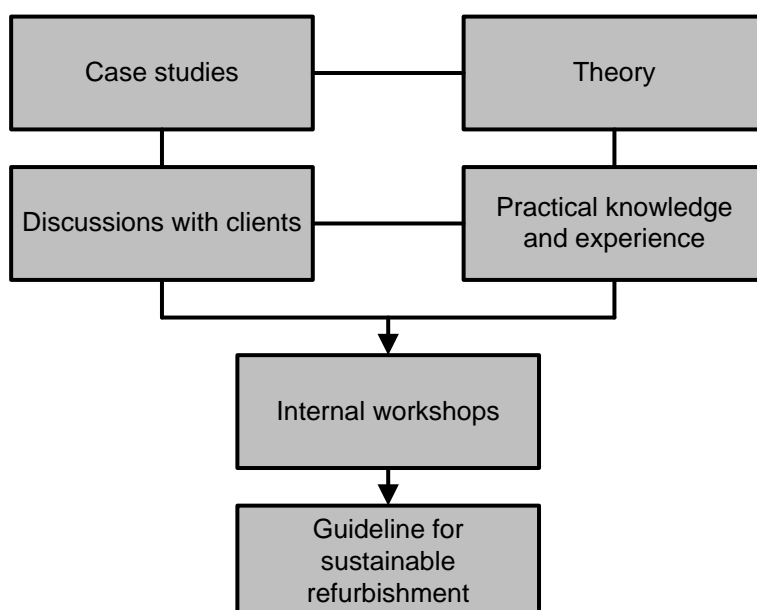


Figure 5. Outline of the design process.



# State-of-the-art in four Nordic countries

In the following summary only the general trends will be summarised and the interested reader is directed to the national reports for the more country specific details.

## Population and building stock

### Population

In all four countries the population continue to increase, but not at the same speed as in the middle of the 20<sup>th</sup> century. The fertility rate in year 2008 is still high in the Nordic countries in comparison with European Union. More specifically, Nordic women gave birth to 1.9 children per woman compared to 1.5 (Nordic Statistical Yearbook 2010). The life expectancy in the Nordic countries is similar to the European Union or 77-80 years for men and 81-83 years for women, compared with 78 and 83 years. The age distribution in the Nordic countries is already getting dominated by middle aged people and in the near future the group of people older than 64 years will grow fast.

The average family size is decreasing and the relative number of households with single persons is growing. There is still a trend for people moving from rural areas to urban areas, and the larger municipalities are preferred above the smaller ones.

As the population is increasing there will be continued need for new buildings in all the countries, but the needs of elderly and disabled persons will be very important in the planning of new constructions. Increasing number of immigrants may also have some effect on living pattern and building design in the years to come.

### Building stock

The built environment is a considerable part of the national wealth and often accounts for 60-70 % in the countries. The public building stock amounts to 7.5-9 m<sup>2</sup>/person. In all the countries the building stock has increased fast the last decades. The average age of buildings is around 30-50 years for the different countries, and the age of public buildings are probably similar. The need for new buildings is now slowing down and the emphasis on maintenance and refurbishment is increasing.

## Impact of building stock on environment

### Energy production and energy use

Energy production differs very much between the four countries as illustrated in Figure 6. The combined ratio of solid fuels, petroleum and natural gas is around 70 % for Denmark, but only 40 % for the other three countries. Electricity is primarily produced by burning of fuels in Denmark, burning of fuels and nuclear energy in Finland, hydro power and geothermal energy in Iceland and hydropower in Norway. The different energy sources result in different emissions and energy prices. Energy prices also depend on whether a country is connected to an international energy distribution net or not. Hydro power and nuclear power as such give very low CO<sub>2</sub> emissions and general-



ly a low energy price, but the price may be dominated by the energy market price on a larger market with another energy profile. Iceland with plenty of geothermal and hydro energy has low CO<sub>2</sub> emissions and very low energy prices as the country is in this aspect isolated from other markets.

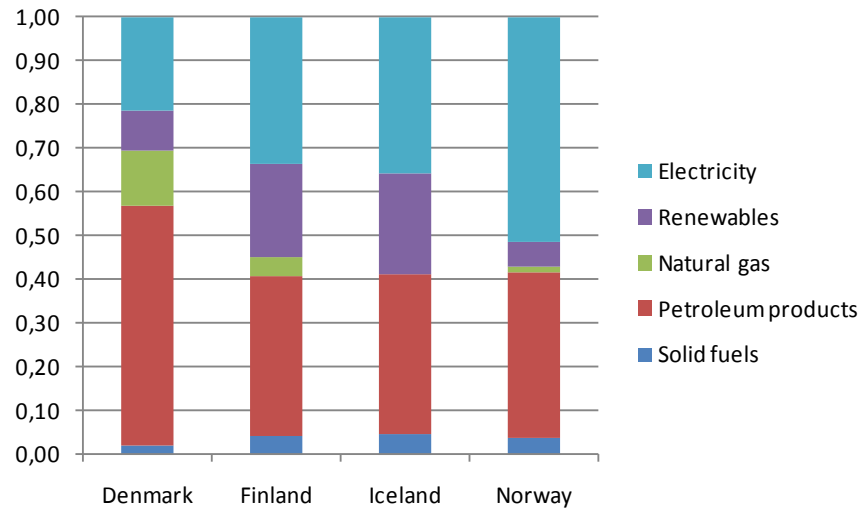


Figure 6. Energy production by source. Source: Eurostat.

The construction sector and operation of buildings together is responsible for 30-40 % of the total amount of energy use in all four countries. It is considered important to reduce energy use, and this has already had impact on the requirements in the building regulations and will be increasingly so at least the next decade or so. The existing building stock is large and refurbishment of buildings to decrease energy use will be an important activity to reduce emission of greenhouse gases.

### Health and indoor environment

Quality of indoor environment is considered insufficient in many of the countries, but the extent varies for different kinds of buildings. The main challenges are related to moisture, radon and acoustics/noise. Emissions from PCB are now also considered problematic in some of the countries, but the risk has not yet been evaluated in full.

### Material use

The building sector is a substantial user of raw materials in all the countries, but type and use of building materials as quantity per m<sup>2</sup> varies greatly between countries. Use of domestic materials is a major part of the total consumption, but the need for import of materials is by far the greatest in Iceland.

### Waste handling

Information on annual amount of waste and waste handling in the construction sector varies between the countries, but measures are being taken to ensure more sustainable handling of waste. In some of the countries plans for sorting and recycling waste on building sites are mandatory.

## Construction sector and the market

### How well does the building stock fulfil market needs

In all the countries the building stock is in great needs of refurbishment to enhance energy efficiency. The incentive for this, though, varies between the

countries depending on age distribution of buildings and the energy source used in buildings.

The population is growing older in all the countries, and accessibility in building stock is growing in importance. Surveys have been done in all the countries, except Iceland, that show that the existing public building stock is in great need for refurbishment to ensure the general technical quality and accessibility of buildings.

### Information available on the market

Information, courses and supporting IT tools regarding maintenance, refurbishment and sustainability is available to some extent in all the countries. Some countries have also applied or are in the process of developing national schemes for evaluation of sustainability in buildings like PromisE in Finland since 2002. At present, frameworks like BREEAM (UK), LEED (US) and DGNB (DE) are gaining popularity, especially when certifying and branding new office buildings. They are applied as they have been developed in their country of origin, or they are adapted to meet the local conditions.

### Safety on working sites

Statistics on frequency and type of accidents in the countries is not entirely reliable, but statistics on fatal accidents is said to be so. Frequency of fatal occupational accidents in the construction sector is shown in Table 2.

Table 2. Fatal accidents in the construction sector 2003-2008 per 100,000 workers per year.

	All Nordic countries	Denmark	Finland	Iceland	Norway	Sweden
Construction	5.31	6.31	5.90	14.93	4.17	4.53
All branches	1.74	2.00	1.75	2.49	1.81	1.51

Source: Tómasson et al. 2011.

Of the branches listed in the official statistics on accidents, only “agriculture, forestry, hunting and fishing” with 9.29 have a higher rate of accidents than the construction sector for all Nordic countries. The corresponding number for “transport and communication” is 4.59. The rate of fatal accidents in construction is exceptionally high in Iceland compared with the other Nordic countries. This may be due to the building of one very big power plant in the time period considered.

## Maintenance and refurbishment of facilities

### Refurbishment and maintenance needs

Availability of information regarding actual maintenance costs in the public sector varies greatly between the countries, as it is not always mandatory to register the costs separately. In all the countries, except Iceland, an estimate has been made for maintenance and upgrading of public buildings or the building stock as whole.

In Denmark and Norway surveys of public buildings have shown that a considerable part of these is in need of refurbishment. The yearly backlog in maintenance in Denmark, Norway and Finland is estimated to have a value that equals some years of the regularly planned maintenance costs.

### Most common renovation actions and results

Maintenance and upgrading varies somewhat between the countries and with building types. Generally building envelopes are considered in need of maintenance and upgrading; this is partly due to needs for increased insula-

tion but also due to degradation. Upgrading of indoor environment, prevention of moisture problems and improved accessibility is of interest along with upgrading of technical systems in larger buildings.

## Sustainable procurement of maintenance and refurbishment

### Sustainable procurement

All countries aim for increased sustainability and in Finland there is a definite goal regarding how sustainable procurement shall be implemented. The term “sustainability” is seldom defined as such, but the national building regulations all include detailed requirements on specific elements like allowed energy consumption in buildings, emissions of certain hazardous compounds like radon etc.

At the time being there are few official national guidelines on sustainable procurement. In Norway a national green procurement guideline is being developed. Locally, the City of Copenhagen along with some other municipalities have created their own guidelines.

The Green Building Councils in the four participating countries have chosen different approaches in regard to commercial certification schemes. Iceland shows interest in applying the British BREEAM guidelines, while Norway has now adopted BREEAM. Denmark has opted for the German DGNB. In Finland, a common set of core sustainability metrics is being compiled following the approach of the Sustainable Building Alliance. These rating systems have so far gained most popularity in office development. This also goes for the American LEED that is required as an alternative to BREEAM by the Icelandic Government Construction Contracting Agency as a basis for design of new public buildings. Experiences from applying the refurbishment versions of these schemes e.g. in housing or office buildings isn't yet widely known in the Nordic countries.

### Ownership and management of facilities

Various organisational schemes are applied when it comes to the relation between the building owner, user and facility manager. In many cases, the user of the public building makes the maintenance plans, often based on a regular condition assessment. In some instances a centralized facility operator takes care of maintenance planning. In Denmark, the Danish Facility Management Network has developed a typology with four different schemes for the organisation of facility management in the municipalities (Due 2007).

### Financing of refurbishment and incentives

Funding for maintenance in public buildings is, with some exceptions, decided on and then budgeted for by the public owner. In some of the countries special funding programs are established for e.g. energy efficiency projects. For rented buildings the owner takes care of exterior work and the lease holder the interior work.

### Methods and methodology, decision making tools for maintenance

Usually there are standards that describe methodology such as condition surveys, and in some cases general information on service life may be found (e.g. SINTEF-Byggforsk, Norway). Open databases with cost figures etc. or IT tools exist in some instances, but are far from common on the market.

# Procurement and innovation strategies

Below, the lessons learned from the case studies will be summarised on a national scale. This summary will be followed by a cross-national business strategy analysis along the five dimensions: arenas, vehicles, differentiators, staging and economic logic. Details on the individual case study can be found in each of the case study reports in Appendix 5-15.

## Lessons learned from the case studies

### Lessons learned from Denmark

The three Danish case studies should be considered in relation to each other. The first case addresses how policy and renovation strategies shape the sustainable practices in a municipal property owner. The second case analyses how client strategies, available knowledge and templates are shaping the refurbishment of office buildings. The third case study questions how the lessons learned from participation in a sustainable development project is implemented and sustained over time in a social housing company.

#### *Procurement strategies*

The three Danish case studies are all pursuing conventional procurement methods along well-established tendering procedures, contractual forms, selection of teams for client's consultancy, design and construction etc.

Although the funding mechanisms at play are somewhat different for the three clients, they all follow the typical procedures for public funding of construction projects. One notable exception is Copenhagen City Properties, who alongside the ordinary funding mechanisms also has been able to establish a specially designated reserve fund of DKK10 million for targeted investments in sustainable construction.

#### *Innovation strategies*

The three Danish clients are active on different arenas. First, they operate on either a local level or the national level. Second, they deal with different types of buildings: 1) housing, 2) office buildings, and 3) a broad range of institutions, sports facilities, cultural buildings etc. Third, the level of ambitions and the rate of success of these have shown to be different.

The vehicles applied by the three clients span two broad groups. First, the clients are using demonstration and development projects in order to test and demonstrate various solutions. Second, the clients have developed and applied various types of tools, guidelines and templates to support their work with sustainability.

Public clients and property managers will need to differentiate themselves towards two types of competitors: private clients and other similar types of public clients. First, the differentiators of public clients and property managers towards private clients are to a large extent pre-defined by their very role as public clients, which provide them – partly – with a market for their services but also set a number of boundaries for their activities, tenants, financing etc. Second, the public clients and property managers are competing against other public clients, which can provide the same services within the

same set of boundaries e.g. social housing. In various ways, the three clients are trying to differentiate themselves by being first-movers.

The staging by the three clients are distinctively different. Copenhagen City Properties is pursuing an ambitious set of goals with a comprehensive scope on sustainability based on a reflexive approach towards converting policies into practices. The housing company AKB adopted a comprehensive policy on sustainability, but lacked a targeted process of converting policies into practices in the organisation. The Palace and Properties Agency is pursuing a more risk-averse approach with a less ambitious set of goals having a more narrow and singular focus on health and safety.

The economic logic of the three clients and property managers shared many similarities, but also carried notable differences. Being public clients and property managers entails very strong budgetary discipline with a focus on keeping a balance-of-cost principle. Despite the similarities between the clients, Copenhagen City Properties singles out with the establishment of a reserve fund to further stimulate investments in sustainable solutions.

The approaches adopted by the three public clients and property managers may stimulate innovation in the construction business systems differently. Despite their relatively small market shares, both Copenhagen City Properties and the Palace and Properties Agency are two significant players who may stimulate change, but in two distinctly different ways. The Palace and Properties Agency aligns its approach with existing practices in an incremental manner, but with a national industry outlook. With its more holistic perspective on sustainable construction, Copenhagen City Properties challenges existing practices in a less incremental sense, but with a more local outlook.

#### *Guidelines*

The three Danish clients and property managers share certain similarities and differences when it comes to the development and use of guidelines for sustainable refurbishment. It is characteristic that the guidelines, tools etc. are all inherently national in scope, whereas e.g. international certification schemes do not play a role. International or rather European developments do indirectly influence client activities through national adaptations for example with regard to energy through the European directive on buildings' energy performance. However, the guidelines applied differ when it comes to their specificity. The template for plan for health and safety is adapted by the Danish Palace and Properties Agency from a nationally enforced template. Although the content may be generally applicable, the environmental policy from the social housing company AKB and the guideline for sustainable construction works from Copenhagen City Properties are client specific.

#### **Lessons learned from Norway**

Below, the lessons learned across the four Norwegian case studies will be discussed in relation to the three overall themes of the SURE project, namely procurement strategies, innovation strategies and sustainable refurbishment guidelines.

#### *Procurement strategies*

The Norwegian clients generally have fine strategies for sustainable building management, but there is a lack of green procurement in real life. The tender documents are mostly focusing on safety, national requirements and standards. There are few, or none, ambitious goals e.g. with regard to energy performance. The client therefore need guidelines for how to implement the right sustainable measures in refurbishment projects and how to measure these. Entra Properties surely aims to be among the best in class re-

garding environmental-friendly refurbishment of buildings. The tender documents shows that Entra Properties is on a good path, but the defined goals in the tender documents could be more ambitious.

For the housing cooperative, SBBL, the procurement documents are quite standard documents strictly focusing on barriers, limitations, law and iron triangle of "time, cost and quality". But the process of involving the contractor, Enova and Husbanken shows that there is a great potential to improve the quality of the project if the right personnel and expertise is brought together. Anyhow, the analysis also shows that the knowledge of sustainable indicators and energy efficiency measures are varying between the building owner, the contractor and the other actors of the refurbishment project. Therefore, there is a great need of a coordinator on sustainable refurbishment who has updated knowledge on the different indicators like energy, indoor climate, economics etc.

#### *Innovation strategies*

A change in the market and stricter requirements forces both the building owner and the contractor to focus on sustainable indicators, like energy efficiency and environmental-friendly materials. All the clients have taken effort to increase the knowledge of sustainability in their refurbishment projects. Still, the level of knowledge varies a lot between the different actors.

Entra Properties has clearly taken their responsibility seriously the latest years regarding environmental aspects in refurbishment projects. Quality programs and tender documents are more characterized by sustainable indicators like energy, waste and use of materials. Still, Entra Properties could be more ambitious as setting targets for sustainable refurbishment in order to stimulate construction innovation.

The public client, Drammen Properties, has definitely changed the past 10 years, revealing the need for ambitious projects in order to be an attractive city to live in. However, the ambitious projects usually focus on new buildings and installations. There is a lack of strategic plans for refurbishing the existing buildings. There is also a need for a strategic tool for sustainable refurbishment so that the municipality can easily and on an early stage find out what to do with the buildings and assess the consequences. Focus on surveys and performance profiles of the buildings combined with a tool for deciding whether to refurbish or tear down the building is also missing. Thus, the ability of the client to stimulate construction innovation through setting new requirements is hampered by the absence of appropriate tools related to sustainable refurbishment.

#### *Guideline*

The use of guidelines and certification systems varies between the different projects. There is a rapid development of new requirements, programs and certification systems regarding sustainable buildings. Therefore, the client needs a tool to make the right strategic choices in an early phase of the projects. There is also a need for a method or a tool to reveal the challenges in the building stock in order to aim at the right measures for refurbishing.

For many of the cases, there is a lack of use of guidelines and certification systems. The needed tool or guideline has to aim for early phase planning. Communication of sustainable parameters, creating a performance profile of the building and a tool to check the sustainable parameters throughout the project are also needed.

The case studies reveal a need for guidelines and tools for the following six aspects:

- 1 Early phase planning guideline for effective communication with the client.
- 2 A guide on sustainable parameters and indicators.
- 3 A clear focus on economic elements of sustainability.
- 4 A tool for creating a performance profile of the building based on sustainable indicators (before the refurbishment).
- 5 A strategic tool to decide whether to refurbish or tear down the building(s).
- 6 A tool to follow up on the sustainable indicators throughout the project from early planning to the operational phase.

### Lessons learned from Iceland

Only one case was studied in Iceland as during the project period the construction industry in Iceland had a very hard time and extremely few projects were on-going. Lessons learned from this case study are discussed below in relation to the three overall themes of the SURE project, namely procurement strategies, innovation strategies and sustainable refurbishment guidelines. The lessons learned have been discussed with a representative of Reykjavik Municipality.

#### *Procurement strategies*

An aim for a more sustainable development in the built environment in Iceland is clearly stated by public bodies; both state and municipalities. The strategies though are not defined so far, and the discussion is mainly qualitative, especially regarding maintenance and refurbishment but somewhat more developed with regard to new buildings.

With regard to procurement of maintenance and refurbishment, the client wishes to keep a tight grip on the process. Parts of decisions are made on a daily basis, especially as it is often very difficult to plan ahead in these operations due to unforeseen situations. Quality assurance is ensured by strict on-site control, decision making and coordination by well-qualified and highly experienced personnel of the owner. The client wished to have very good control of the project:

- Planning and design is done in cooperation between the client and consulting firms especially chosen for the work by the client.
- In the construction phase the client, together with hand-picked consultants, takes care of all quality control and considerable part of both planning and supervision too.
- The construction firms are rather small and specialised actors in the field of refurbishment chosen by the client.

Reykjavik Municipality has a check list that the responsible actors are required to fill out for each work in order to get a better overview of which decisions were taken and the reasons for those decisions. The key factors of importance to the housing company regarding maintenance and refurbishment is to:

- Keep the flats in use and preferably with as few replacements of tenants as possible.
- Keep a good building standard to make the flats desirable for tenants with different needs.
- Keep maintenance costs low.

The company strives for better sustainability and is defining and working on a description of their “green book-keeping”.

#### *Innovation strategies*

The main focus areas for innovation are in connection with better access to and in the buildings, facilities for waste handling (sorting) on site, better en-

ergy management and increased comfort. The innovation strategy is characterised by incremental change, ad-hoc planning and the use of a demonstration project for testing new approaches and solutions.

#### *Guideline*

Maintenance is a heavy post in operation of buildings of the client, and all measures to minimize unforeseen maintenance are of value. The clients have a well based knowledge on necessary material quality but so far these are more based on production type than performance requirements. The knowledge of the public owners is to a great extent based on knowledge and experience by individuals rather than database records. This may cause problems in case of replacements of personnel, and underlines the importance of public accessible databases to ensure a good information flow. A check list is a good beginning but it is difficult to get all parties to apply it when the system is more or less based on a voluntary basis. A formal assessment in a described framework seems to be needed to get all to participate.

#### **Lessons learned from Finland**

Procurement and innovation strategies of different clients are discussed together with sustainable refurbishment guidelines in the text that follows based on three Finnish case studies.

#### *Procurement strategies*

Improved energy-efficiency is the key concern in sustainable refurbishment in Finland. The main barrier for energy-efficient refurbishment is the lack of understanding of the benefits of energy-efficiency upgrading. It is clear that the building owners make refurbishment decisions by the total cost of contract. If e.g. the service life of façades is over and a renewal process is required, the improvement of insulation is a minor cost. Such refurbishment without energy-efficiency upgrade is only a cost that may bring other benefits such as improved architecture and better image, but the energy-efficiency upgrade cost may have reasonable payback time, especially when considering potential evolution of energy prices.

Sustainable refurbishment concerns also other performance aspects than energy consumption. Improved indoor environment quality and usability of spaces over their service life with optimal cost are also considered.

Procurement strategies should take into consideration the long-term plan for maintenance and up-grading. The necessary maintenance and refurbishment work can be divided into periods, which enable energy-efficiency upgrade for the specific building part or system. This is very important in cases where no incentives or financial support is available.

Procurement planning typically requires external services. A technical feasibility study needs to be carried out for decision making. The study should conclude the possibilities of renewal in terms of investment costs and life cycle costs as well as impacts on future maintenance demand. Profitability analysis should consider the impact of energy-efficiency up-grade only to payback time.

#### *Innovation strategies*

The Finnish energy requirements for refurbishment will be published year 2012. The present understanding of the coming requirements is that there will not be a straightforward requirement for energy-efficiency up-grade for typical maintenance repairs such as maintenance painting of window frames or repair of façades. The value of refurbishment in total until 2020 is estimated at €10-20 billion. The market potential should enable market niches for



new integrated solutions for refurbishment and energy-efficiency up-grade. One supporting factor for such niches is the shorter delivery cycle of the contract. Industrial systems have already been developed. However, their utilisation in refurbishment is rather low.

#### *Guideline*

The key guidelines needed for real estate owners is communication of refurbishment goals and benefits to decision-makers. At this level specific technical data is not required, rather the performance based targets and corresponding benefits, also other than impacts on property value, for the refurbishment. The refurbishment project has two key players: a design team that is able to design the refurbishment for efficient implementation, and a site supervisor who makes the refurbishment implemented according to the design.

The case studies reveal a need for guidelines and tools for the following five aspects:

- 1 Early phase planning guideline for effective communication with the client.
- 2 A guide for performance based targets for the refurbishment.
- 3 A guide for a feasibility study for technical and economic – and sometimes social – assessment of the refurbishment or demolition of the building.
- 4 A tool for creating a performance profile for targeting the refurbishment.
- 5 Guidelines for site supervision.

## Sustainable refurbishment strategies

Below, the procurement and innovation strategies will be characterised according to the five elements in the strategy diamond provided by Hambrick & Fredricksson (2005): arenas, vehicles, differentiators, staging and economic logic.

### **Arenas**

The arenas, in which the clients operates, are effectively being framed by 1) the functions, 2) the type of properties in the portfolio of the client, 3) geographical coverage of the client, and 4) their perception of sustainability.

First, the characteristic functionalities of the client organisation are crucial to the arenas in which the client will be able to operate. Besides the Parish Union of Helsinki, none of the clients are or will be the actual user. Instead, the clients will be providing facilities for a range of different type of users defined by the building type. Neither are any of the clients part of the construction sector in a traditional sense (being a consultant, contractor or manufacturer). Although extended autonomy is typically granted to the client organisation, in most cases the clients are not the actual owner of the property, but rather managing the property on behalf of the municipality, a board of tenants etc. All of the clients occupy a specialised position as in-betweens of the supply side and the demand side of construction in line with the analysis by IVA (1997).

Second, the type of properties in the portfolio of the client defines to a large extent their outlook as being related to a specific building type, either housing, offices, schools or religious facilities. Although two of the case studies are related to conversion of facilities to other purposes, most of the case studies are related to the continuation of use of the facilities through upgrading of the performance. It is symptomatic that the two cases of conversion

are among the cases, which are delayed and effectively put on hold at present. Converting a property into new use not only poses challenges to the existing modus operandi of the client being tied up with specific building types, but also makes it even more challenging to make that conversion a sustainable one.

A special challenge is related to upgrading or converting listed buildings as have been shown in four of the case studies scrutinized. In these cases strict regulation and concerns about the cultural heritage puts extra pressure on the client.

Third, the geographical coverage of the client is also a characteristic. Typically the clients are operating on a very local or regional level defined by the ownership – municipalities like Drammen and Copenhagen generally operates within a strict local perimeter defined by the physical and legal boundaries of that particular municipality. Other clients like Entra Eiendom and the Danish Palace and Properties Agency may operate on a national scale, but may divide the national market in to smaller regional markets.

Fourth, their perception of sustainability is defining what actions may be pursued to ensure sustainability. Only a small number of the cases adopted a comprehensive perspective on sustainability, whereas most of the cases were predominantly linked to a more narrow perspective on energy savings. At one end, an all-embracing definition is applied as witnessed in the case of Copenhagen City Properties. At the other end, sustainability is effectively being limited to singular issues, most profoundly energy savings as can be witnessed in several of the Norwegian and Finnish cases.

## Vehicles

In recent years, new procurement methods like energy service companies (ESCO), long-term contracting, public-private partnerships etc. have been heralded as means to ensure long-term commitments among suppliers towards sustainability, whole-life costing etc. Thus, it could have been expected that various new procurement methods would have been appointed as one of the core vehicles of clients to move towards sustainable refurbishment.

Despite these trends none of the case studies have tested any of these new procurement methods. In fact most of the case studies have applied quite conventional and well-established forms of procurement like design-bid-build or design-build contracting. Only a few of the clients are considering alternative procurement methods like ESCOs or have actual experiences with e.g. public-private partnerships. In the last instance, the experiences are related to only a very few examples and only with new building projects, not refurbishment. Whether this observation reflects the selection of case studies, reluctance on the part of clients to apply alternative procurement methods, or rather reflect that traditional procurement methods actually are flexible enough to accommodate for procurement of sustainability remains to be answered.

The vehicles towards change span two broad groups applied by the clients and property managers. First, they are using demonstration and development projects in order to test and demonstrate various sustainable solutions. Second, the clients have developed and applied various types of tools, guidelines and templates to support their work with sustainability.

It is a notable characteristic that none of the clients apply international tools, guidelines or certification schemes directly. This is not to say that international development of tools etc. does not have an impact at all. For example

clients apply the building's energy labelling scheme regularly, which is based on European regulation but adapted to the national context. Instead clients are either in search of guidelines, have made adaptations of national templates or have developed their own concepts, guidelines and tools.

Another notable characteristic is the fact that public clients are typically closely linked to the political-administrative system or trade associations for clients and property managers. Consequently, public clients may be in a unique position to shape public policy-making and support a sustainable development.

### Differentiators

Being a public construction client or property manager does not in itself protect against competition or ensure that the public client will get the job. Public clients and property managers will typically need to differentiate themselves towards two types of competitors, who may also deliver the same service to the public: 1) private clients, and 2) other similar types of public clients.

First, public clients and property managers will need to differentiate themselves towards private clients, since many public construction and property services are procured not only from public entities but also private firms. The differentiators are to a large extent pre-defined by their very role as public clients. On one hand it provides them – partly – with a market for their services but also set a number of boundaries for their activities, tenants, financing etc. On the other hand the role as public client entails being subject to ethical and political drivers, which is not necessarily internally congruent and consistent. Thus the ability to master the many public policies, which may at times be divergent or possibly even contradictory, is a key strategic resource that differentiates public clients from private operators. At the same time it also makes public construction clients very cautious of risks, verging on risk-aversion towards changing practices.

Second, the public clients and property managers are competing against other public clients, which can provide the same services within the same set of boundaries e.g. social housing. In various ways, the clients are trying to differentiate themselves towards their competitors for example by being first-movers on sustainability and embedding their policies in the organisation through the use of internal guidelines, procedures and routines.

The differences in will, abilities and conditions to turn intentions into organisationally embedded skills are demonstrated by two opposites: At one end, Copenhagen City Properties is pursuing an ambitious set of goals with a comprehensive scope on sustainability based on a reflexive approach towards converting policies into practices and supported by a financial reserve fund for designated investments in sustainable solutions as well as an extensive guideline, which defines the concept of sustainability being pursued by the client. This guideline is an integrated part of the working procedures of the organisation. At the other end, the Finnish DAS Foundation is not having a clearly defined approach and was effectively relying on the individual commitment of one centrally placed manager and that person's perception of what counts as sustainability. The leave of that particular manager shows the vulnerability of such an approach.

### Staging

The staging of the change process by the clients are distinctively different. When striving towards sustainable refurbishment, it may be useful to turn to the systemic perspective on construction innovation suggested by Gann &

Salter (2000). A number of analytical points based on the 11 case studies can be made, which have implications for the role of the construction clients as change agents in construction:

- The client relation to project-based firms: The main focus of most of the clients is on the individual refurbishment project, less on organisational change of the construction client organisation.
- The client relation to the technical infrastructure system: The development activities have a tendency to focus on development and demonstration projects rather than concerted and on-going R&D activities.
- The client relation to the regulatory and institutional framework: Being public servants, the public construction clients are highly dependent on their capability to master and navigate in a political environment of multiple complementary or even contradictory public policies, which are frequently being changed by the political system.
- The client organisation itself: The strategies and the elements hereof pursued by public clients exhibit a considerable variation as illustrated in the 11 case studies. Thus, a joint and coordinated change effort towards shared objectives will be difficult to achieve.

Based on the 11 case studies in Denmark, Norway, Finland and Iceland, the SURE project will point at the following strategies when it comes to driving sustainable refurbishment.

The first strategy will be labelled a procurement-driven strategy towards sustainable refurbishment. Within this strategy, the client will primarily adopt a procurement orientation with a focus on setting strict requirements, which will typically be applied in the individual project. Moreover, the construction client will typically not be having much of an R&D budget in place. At best, the procurement may be framed to stimulate innovation, but in general innovation is a more or less unplanned outcome of procurement and refurbishment activities.

The second strategy may be labelled an innovation-driven strategy towards sustainable refurbishment. Within this strategy, the construction client will have a well-developed and conscious action plan in place for its innovative activities, and these will be linked to the procurement activities and business processes of the client. The expectation will be that participation in R&D activities will lead to new solutions that can afterwards be procured by the client, thus leading towards sustainable refurbishment. The client may have a R&D budget and plans in place, either as part of the general business operation of the client organisation or as investments set aside within the individual project budget, but on a successive and recurrent basis for example through a set percentage for R&D activities similar to the investments in art. However, this is a rare situation except for a very few public clients.

A third strategy may be labelled an ad-hoc strategy towards sustainable refurbishment, which is the most widespread among the case studies. Within this strategy, the construction client may typically be involved in development and demonstration projects, where certain solutions are tested and applied. At best, the construction client will be involved in some R&D activities for example through R&D projects with research institutions. Although results may be achieved in the individual demonstration project, these results have a tendency to be the outcome of stand-alone activities rather than being an integral part of the business processes of the client organisation. Thus, embedding them in the client organisation and applying them in other subsequent projects is often hampered. This approach can be found in a variety of forms among the studied client organisations. Although they share some of the same characteristics, they differ with respect to the degree of clarity and design of a targeted process on how the lessons learned from the

demonstration projects will feed into the client organisation and be embedded in policies and daily practices.

### **Economic logic**

None of the clients are providing facilities for profit-maximization purposes but for a balance-of-cost principle. In most but not all cases, the balance-of-cost principle is associated with the individual property and not the portfolio as such. Consequently, refurbishment and sustainable initiatives of the individual property can only be financed through grants from the e.g. the municipality; subsidies and loans e.g. from funding bodies like ARA in Finland, Husbanken in Norway or Landsbyggefonden in Denmark; optimising a pre-given refurbishment budget across multiple projects; extending the rentable floor area (as explored by both VAV and DAS, but eventually given up); or increasing the rent (the latter being a challenge).

Although the public clients in general are not profit-maximising entities, they will still need to generate an income to cover the property cost. In most cases the clients and property managers are operating on a market-like basis. Thus the income is generated through a rent agreement with the actual user. The rent is typically set according to two different principles: 1) a market-based rent level; or 2) a fixed maximum rent level defined by the operational cost of the facility.

# Guideline on sustainable refurbishment

This chapter will examine seven lessons learned across the 11 case studies, present the ten-step model of the SURE Guideline, and introduce the SURE Indicator Tool to be used for creating a performance profile, define the project and setting requirements.

This chapter is partly based on previously published conference papers presented at the World Sustainable Building Conference 2011 (Almås et al. 2011a & 2011b). Besides being part of the SURE project, the development of the SURE guideline has also been part of the PhD study of Anders-Johan Almås at NTNU in Norway (Almås 2013).

## Seven lessons learned from the case studies

Despite the differences between the 11 case studies, seven lessons were learned across the cases, which highlight important focus areas for a guideline on sustainable refurbishment.

The first lesson is that although some of the client and owner organisation of the individual refurbishment projects have developed strategies, elaborate policies and explicit priorities like the Copenhagen City Properties, most of them have not. In some cases client organisations are in the process of developing a strategy like the Finnish Parish Union of Helsinki, in others the client organisation like the Finnish Domus Arctica Foundation effectively rely on the commitment of individuals to fill in very broadly defined missions and visions. Consequently, strategic questions related to arenas, vehicles, differentiators, staging and economic logic to follow Hambrick & Fredricksson (2005) are seldom answered in a systemic and comprehensive way.

The second lesson is that the processes of some of the investigated refurbishment projects may be improved. Doing the right thing at the right time is the key to a successful sustainable refurbishment. As an example, some of the buildings had undergone a detailed condition survey before the planners tried to conclude on a refurbishment concept, while others had not. Thus, building owners will require more guidance in the process of planning a sustainable refurbishment.

The third lesson is that the meaning of sustainable refurbishment differed between the building owners. Some clients have a very comprehensive perspective on sustainability like the Copenhagen City Properties, while others focused narrowly on energy reduction or material use. To promote a more nuanced and holistic understanding of sustainability amongst building owners, it is necessary to explicitly define what is meant by sustainability. Thus, providing a set of indicators could be a valuable support in this process.

The fourth lesson is that client and building owners with elaborated strategies as well as those with less developed strategies are faced with the challenge of transforming strategies and policies into practical action. Strategic objectives of a client and building owner needs to be translated into project-specific objectives and targets related to the actual refurbishment project in question. However, there seems to be a tendency towards a project-on-

project based approach to sustainability. Only a very limited number of the clients and building owners, most notable Copenhagen City Properties have developed practical guidelines and procedures for addressing sustainable issues, which can be applied during construction and refurbishment projects.

The fifth lesson from several of the cases is that the character of existing financial models poses a significant challenge to realising long-term objectives like sustainability. The financial frame for manoeuvring is essentially determined by fixed target rent levels or possibly the simple (short) payback time of investments. However, some examples of alternative approaches exist like:

- Negotiating another rent level with the end user like the Finnish housing association VAV.
- Increasing the financial frame by adding additional floors to rent out like the Finnish Domus Arctica Foundation did in a foregoing refurbishment.
- Setting up a designated budget for sustainable investments within the client organisation like Copenhagen City Properties.
- Pursuing a long-term ambition based on small continuous steps forward like the Danish Palace and Property Agency and Copenhagen City Properties.

Despite these examples, the relationship between sustainable ambitions, financial realm and alternative business models are poorly modelled and understood in a lifecycle perspective in general. Unfortunately, there was often a mismatch between ambitions and finances in the investigated cases, and the building owners were sometimes not aware of the economic consequences of an ambitious refurbishment strategy.

A sixth lesson is that with a few notable exceptions target setting does not seem to take place as a systematic and comprehensive endeavour, but tends to be a rather fragmented process guided by a focus on single “hot” issues. Hardly any of the clients and building owners operates a systematic benchmarking or assessment system based on a recognised set of indicators, which are specific, measurable, attainable, relevant and time-bound, in short SMART.

A seventh lesson is that the majority of clients are predominantly linked to or even defined by specific building types set within a limited geographical area, typically a nation state. Only few clients operate internationally. Consequently, the prevailing objectives, methodologies and tools applied by clients and building owners are to a very large extent related to national regulation, political targets etc. Although international standards, certification schemes etc. do play a role in a national context, this happens mostly through translations and adaptations on a local or national scale. Thus, a Nordic guideline will need to be based on a flexible framework that allows for these local and national adaptations.

## The SURE Guideline: A ten-step model

The Nordic Guideline on Sustainable Refurbishment (SURE) of buildings is built upon the flowchart shown in Figure 8. Figure 8 shows the different phases during a refurbishment project starting from left. The vertical axis shows the performance of the building during time (horizontal axis). It must be stressed that the considerations behind Figure 7 refers to a situation dealing with a single renovation project. Clients who have a portfolio of buildings or deals with successive (incremental) refurbishment initiatives over a

longer time span will often could gain inspiration to their renovation, but will approach along another process path.

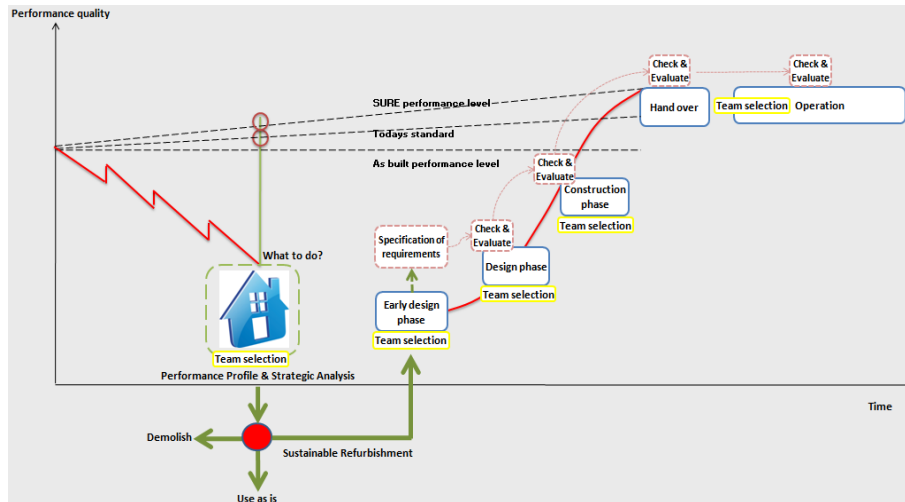


Figure 7. The SURE Guideline flowchart.

From the building is new, the quality and standard will decrease compared to present standards, among others depending on maintenance intervals and replacement of building parts. When the performance or usability of the building has decreased to a certain point, there is a need for a major renovation (visualized with the sign “What to do?”). Now the building owner has four main choices: 1) tear down the building, 2) use it as it is, 3) refurbish the building according to present performance standards and requirements or 4) raise the performance standard of the building to a sustainable standard – a SURE standard. Basically the standard can be regarded as a client chosen, project specific design solution with special awareness to the “SURE indicator Tool”. If the client has decided to refurbish the building, requirements have to be set on different indicators in the early design phase. Thereafter, a more detailed design phase is followed by the construction phase. When approaching the handover phase, the building has reached its highest performance standard. Then, the operational phase starts. To achieve a sustainable quality of the building, the requirements set in the early design phase has to be implemented in all the other phases. The implementation has to be systematised through a so-called “Quality Program on Sustainable Refurbishment” (QPSR), which have to follow the entire project. Milestones, checklists and action plans for the different phases should be implemented in this quality assurance program.

The SURE Guideline is divided in ten steps to help the client focus on sustainability of the refurbishment from a strategic perspective:

- 1 Awareness of the process and timeline of the project.
- 2 Defining sustainability and strategy.
- 3 Ambition level and finances.
- 4 Creating a performance profile of the building.
- 5 Strategic analysis – what to do?
- 6 Requirement (target) setting.
- 7 Selecting teams.
- 8 Implement a sustainable quality program in all phases of the project.
- 9 Check and act.
- 10 Monitoring and user behaviour.

Each of the ten steps is explained below. The guideline and indicator tool with its set of indicators for defining ambitions, creating a performance profile and setting requirements can be downloaded from:

<http://sustainablerefurbishment.wordpress.com>.



The front page of the SURE Guideline is shown in Figure 8.



Figure 8. Front page of SURE Guideline.

### Step 1. Awareness of the process and timeline of the project

The first step is to ensure that the client or building owner is aware of and understand the different processes and time aspects of the refurbishment project. This is illustrated in the flowchart of the SURE Guideline (see Figure 9).

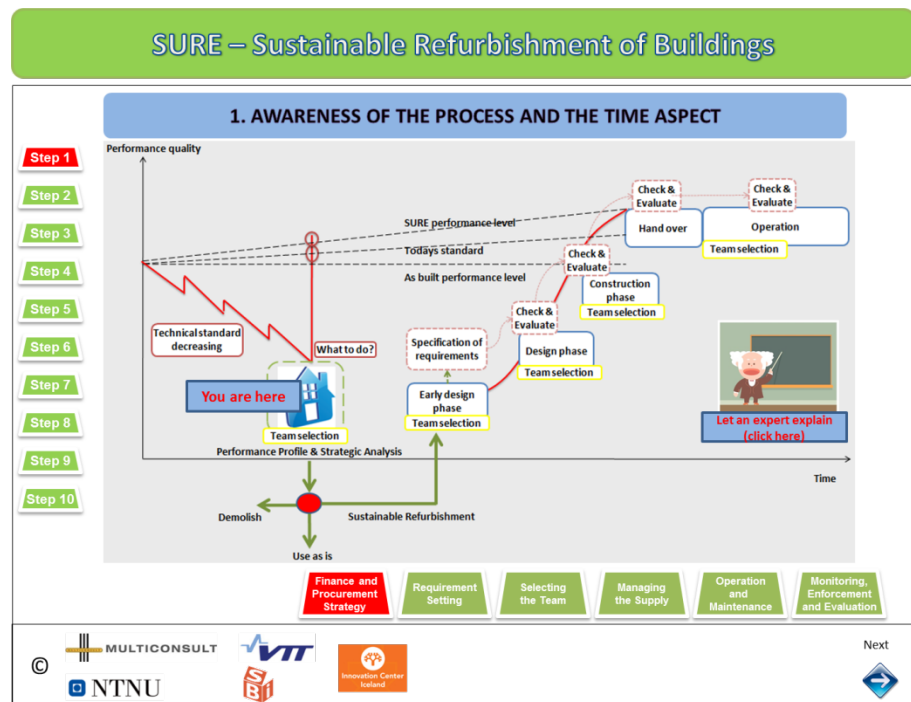


Figure 9. Step 1: Awareness of the process and the time aspect.

### Step 2. Defining sustainability and strategy

In the second step the client has to gain insight into the term sustainability: what does the term mean, and which indicators are being important? The meaning of sustainability could differ for each project. What is sustainable for the specific refurbishment project in the specific location with the given as-

assumptions, limitations and possibilities? After answering these questions, a strategy and ambition level for the refurbishment project can be defined.

In a guideline for sustainable refurbishment of buildings, a helpful tool to make the client conclude on this question should be implemented based on a list of sustainable indicators. The SURE indicators are sorted in five main groups: social, environmental, economic, technical and process indicators. The indicators should be mostly quantitative so that they can be measured and benchmarked. The guideline should help the client to plan how to implement these indicators in the project, but also give guidance on how to check the indicators both during the planning, building and operational phases. The lack of measuring, monitoring and benchmarking of important sustainable indicators is one of the main barriers against a successful achieving of a more sustainable development (see Figure 10).

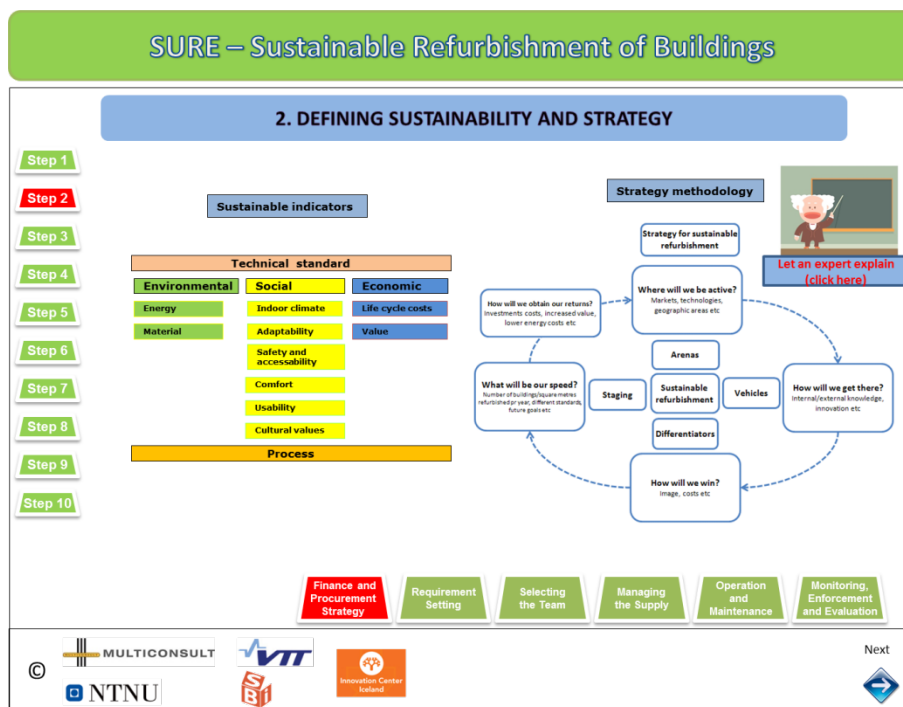


Figure 10. Step 2: Defining sustainability and strategy.

### Step 3. Ambition level and finances

The third step is related to setting the ambition level and the required finances. There are often a mismatch between ambition level and finances. The financial model should be decided in a very early phase of the project. Who will finance the project? Are there any support funds that can help funding? Will the rental income increase and how much? How long is the payback time on different measures? Which will be the major costs? Which functions are absolutely necessary to improve, and what will it cost? To define the ambition level on the different sustainable indicators, please download the spread sheet of the SURE Indicator Tool. In the next step of the guideline, a performance profile of the building will be created using this tool (see Figure 11).

## SURE – Sustainable Refurbishment of Buildings

3. AMBITION LEVEL AND FINANCES

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

Step 9

Step 10

There are often mismatch between ambition level and finances. The finance model should be decided in a very early phase of the project. Who will finance the project? Are there any support funds that can help founding? Will the rental income increase? How much? How long is the payback time on the different measures? Which will be the major costs? Which functions are absolutely necessary to improve, and what will it cost? To define your ambition level on the different sustainable indicators, please download the SURE-tool by clicking on the button 'Define ambitions'. In the next step of the Guideline, you will create a performance profile of the building, using the same tool. The performance profile should thereafter be compared to the ambition level to reveal the most challenging measures for refurbishment.

**Ambitions**

**Finances**

**Define ambitions**

Finance and Procurement Strategy

Requirement Setting

Selecting the Team

Managing the Supply

Operation and Maintenance

Monitoring, Enforcement and Evaluation

Next

Figure 11. Step 3: Ambition level and finances.

### Step 4. Creating a performance profile of the building

There is no use in planning a refurbishment without knowing the performance profile of the building. Therefore, a condition survey should be conducted at a very early phase of the project. A condition survey must be carried out by highly qualified personnel, and should give alternative concepts for the refurbishment as outputs, highlighting the economic, social and environmental consequences of the different concepts. The SURE Indicator Tool presented in the third step can be a helpful tool to create a performance profile of the building in question (see Figure 12).

4. CREATING A PERFORMANCE PROFILE OF THE BUILDING

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

Step 9

Step 10

There is no use of planning a refurbishment without knowing the performance profile of the building. Therefore, a survey should be conducted in a very early phase of the project. An example of a performance profile is shown below. Please use the SURE-tool presented in step 3 (click the button 'Create performance profile') to create a performance profile of your building.

Category	Score
LCC	2.0
Value	2.8
Technical standard	2.5
Energy	2.5
Material	2.5
Indoor climate	1.8
Adaptability	2.5
Safety and accessibility	3.0
Comfort	2.5
Usability	2.5
Cultural values	2.5
Process	3.0

**Create performance profile**

Finance and Procurement Strategy

Requirement Setting

Selecting the Team

Managing the Supply

Operation and Maintenance

Monitoring, Enforcement and Evaluation

Next

Figure 12. Step 4: Creating a performance profile of the building(s).

### Step 5. Strategic analysis – what to do?

The performance profile should be compared with the project ambitions and finances using the SURE Indicator Tool. This will reveal which measures to focus on and give an indication on whether to tear down or refurbish the building. If it is concluded to refurbish the building, the ambitions should be

revised based on the analysis. Thereafter, a priority list on measures should be conducted using the same tool as in the previous steps 3 and 4 to compare ambitions and performance profile (see Figure 13).

### SURE – Sustainable Refurbishment of Buildings

#### 5. STRATEGIC ANALYSIS – WHAT TO DO?

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

Step 9

Step 10

The performance profile should be compiled with the project ambitions (using the SURE-tool) and finances. This will reveal which measures to focus on, and give an indication on whether to tear down or refurbish the building. If it's concluded to refurbish the building, the ambitions should be revised based on the analysis. Thereafter, a priority list on measures should be conducted. Please use the same tool as in step 3 & 4 to compare ambitions and performance profile.

Let an expert explain [\(click here\)](#)

**Compare profile and ambitions**

Finance and Procurement Strategy | Requirement Setting | Selecting the Team | Managing the Supply | Operation and Maintenance | Monitoring, Enforcement and Evaluation

Next

Figure 13. Step 5: Strategic analysis – what to do?

### Step 6. Requirement (target) setting

Based on the strategic analysis performance profile, ambition level and finances, the client has now decided to refurbish the building (if the decision is to tear down the building, the guideline ends here). The ambition level has been revised and a priority list on measures is finalised. Now, the client has to set targets on the sustainable indicators evaluated in the performance profile (see Figure 14).

### SURE – Sustainable Refurbishment of Buildings

#### 6. REQUIREMENT SETTING – SET TARGETS – DEFINE A QUALITY PROGRAM

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

Step 9

Step 10

Based on the strategic analysis including finances, performance profile and ambition level, it's now decided to refurbish the building. (If the decision is to tear down the building, the guideline ends here). The ambition level has been revised and a priority list on measures is finalized. Now, the planners have to set targets on the sustainable indicators evaluated in the performance profile. The targets should be quantitative, as far as possible. They should also reflect ambitiousness, available finances and technical, realistic measures. Please use the same SURE-tool as in step 3, 4 & 5 to set requirements and create a Quality Program for Sustainable Refurbishment (QPSR).

Let an expert explain [\(click here\)](#)

Quality Program for Sustainable Refurbishment

**Set requirements**

Finance and Procurement Strategy | Requirement Setting | Selecting the Team | Managing the Supply | Operation and Maintenance | Monitoring, Enforcement and Evaluation

Next

Figure 14. Step 6: Requirement (target) setting.

The targets should as far as possible be quantifiable and measurable. They should also reflect ambitiousness, available finances and technical, realistic



measures. It is advised to use the same SURE Indicator Tool as in steps 3, 4 and 5 to set requirements and create a so-called Quality Program for Sustainable Refurbishment (QPSR).

### Step 7. Selecting teams

One of the most challenging tasks in a refurbishment project is “to find the right guy for the job”. It is all about selecting the right expert teams to handle the different phases of the project. Sometimes the same team can be used in several phases, maybe also throughout the entire project, but anyhow there must be a consideration of the best team composition in at least the following eight phases: 1) Condition survey; 2) Create a performance profile; 3) Strategic analysis (together with the building owner); 4) Early design; 5) Design; 6) Construction; 7) Operation and maintenance; and 8) Monitoring, enforcement and evaluation. Each of the selection processes should include a description of the task, criteria for the selection, a tender request, tender evaluation and contracting (see Figure 15).

SURE – Sustainable Refurbishment of Buildings

7. SELECTING TEAMS

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

Step 9

Step 10

One of the most challenging tasks in a refurbishment project is “to find the right guy for the job”. It’s all about selecting the right expert teams to handle the different phases of the project. Sometimes the same team can be used in several phases, maybe also throughout the whole project, but anyhow there must be a team selection in at least the following 8 phases; 1. Condition survey, 2. Create a performance profile, 3. Strategic analysis (together with the building owner), 4. Early design, 5. Design, 6. Construction, 7. Operation and maintenance, 8. Monitoring, enforcement and evaluation. Each of the selection processes should include a description of the task, criteria for the selection, a tender request, tender evaluation and contracting. An example of requirement setting for selecting a team is shown on the figure below.

Requirement category	Description	Example
Qualification requirements	Requirements to the provider who wants to participate in the contest. If the provider does not meet the qualification requirements, he is rejected.	Tax and duty matters are ok. The provider has experience from similar missions. The quality system of the provider is satisfactory.
Award criteria:	Criteria to choose the most favorable offer, i.e. which provider should be chosen.	Cost 50 % Experiences 25 % Understanding of the task 25 %
Specification requirements:	Requirements for the deliveries.	Design a passive house standard Install a heat pump with detailed specifications Waste management specifications Insulation thickness in the wall

Let an expert explain (click here)

Finance and Procurement Strategy

Requirement Setting

Selecting the Team

Managing the Supply

Operation and Maintenance

Monitoring, Enforcement and Evaluation

Next

Figure 15. Step 7: Selecting teams.

### Step 8. Implement a quality program in all phases of the project

Even if the Quality Program for Sustainable Refurbishment (QPSR) is well documented and decided, the program will not implement itself into the different processes of the refurbishment project. Therefore, an evaluation of the quality program is required in all the phases of the project. The project management should impose the designers and contractors to review the QPSR (checklist) to ensure that the sustainable requirements are addressed. In the handover phase, the building owner and the contractor should check the QPSR together. Last but not least, the operating personnel should have strict guidelines on regularly checks and evaluations during the complete operational phase (see Figure 16).

## SURE – Sustainable Refurbishment of Buildings

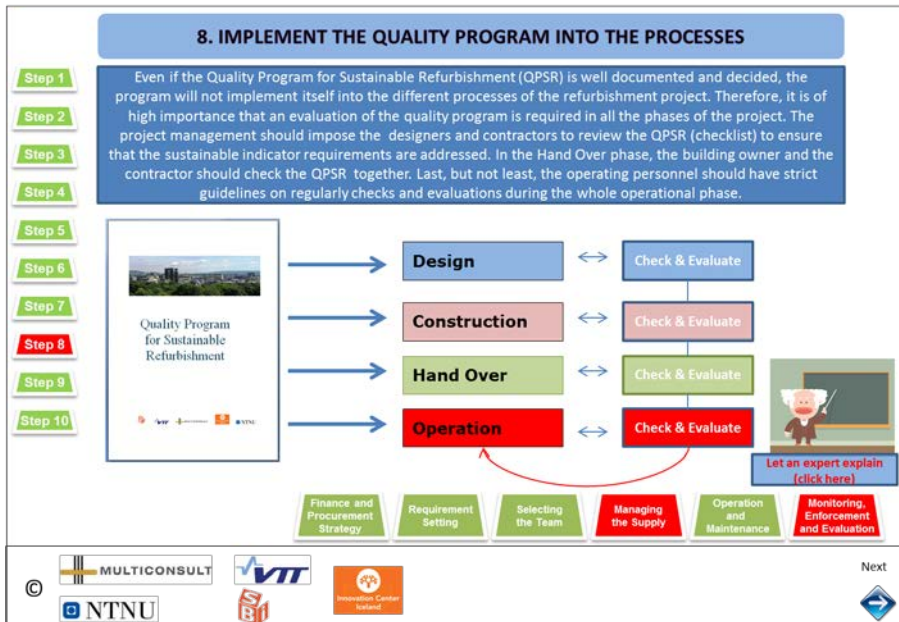


Figure 16. Step 8: Implement a quality program for sustainable refurbishment.

### Step 9. Check and act

When the requirements in the Quality Program of Sustainable Refurbishment (QPSR) are evaluated in the different phases of the project, they could prove to be incorrect. In that case, the designer, the contractor, the building owner or the operating personnel need an action plan to know how to act to improve the performance of the indicator. This is the only way to ensure high quality on the sustainable indicators of the building. The guideline shows examples of how this could be implemented in the QPSR using the Deming wheel of Plan-Do-Check-Act (see Figure 17).

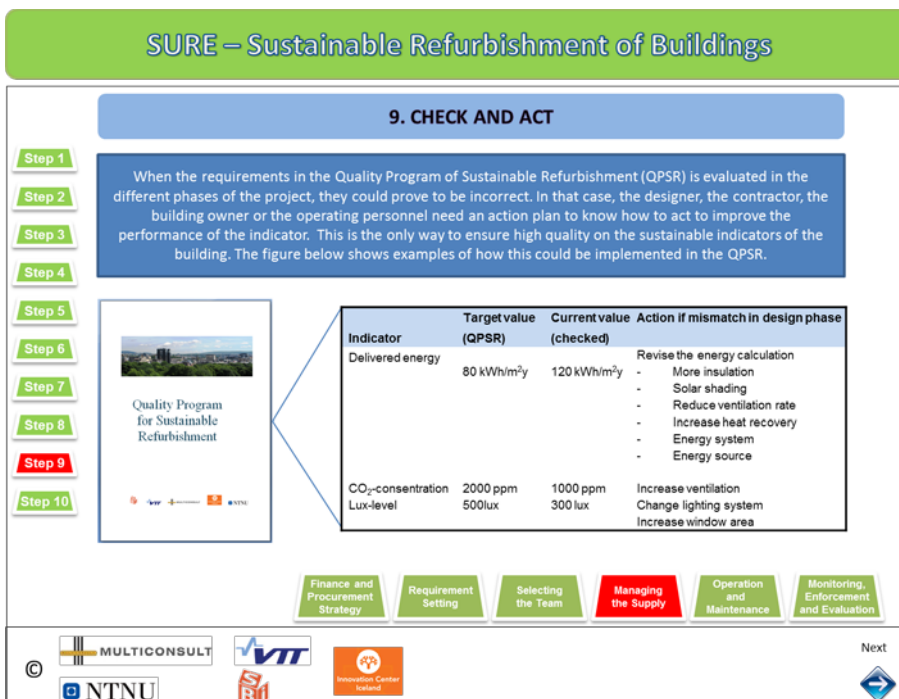


Figure 17. Step 9: Check and act.

### Step 10. Monitoring and user behaviour

In the operational phase, the sustainable indicators in the QPSR should be monitored continuously. But even if the performance of the building and its technical equipment fulfils the requirements, the behaviour of the users

could have a huge impact on the performance. Often, a sustainable refurbished building turns out to be less sustainable because of unintended use or misperceptions of the actual use. Therefore, detailed user guidelines together with monitoring and involving should be implemented into the operating procedures of the building (see Figure 18).

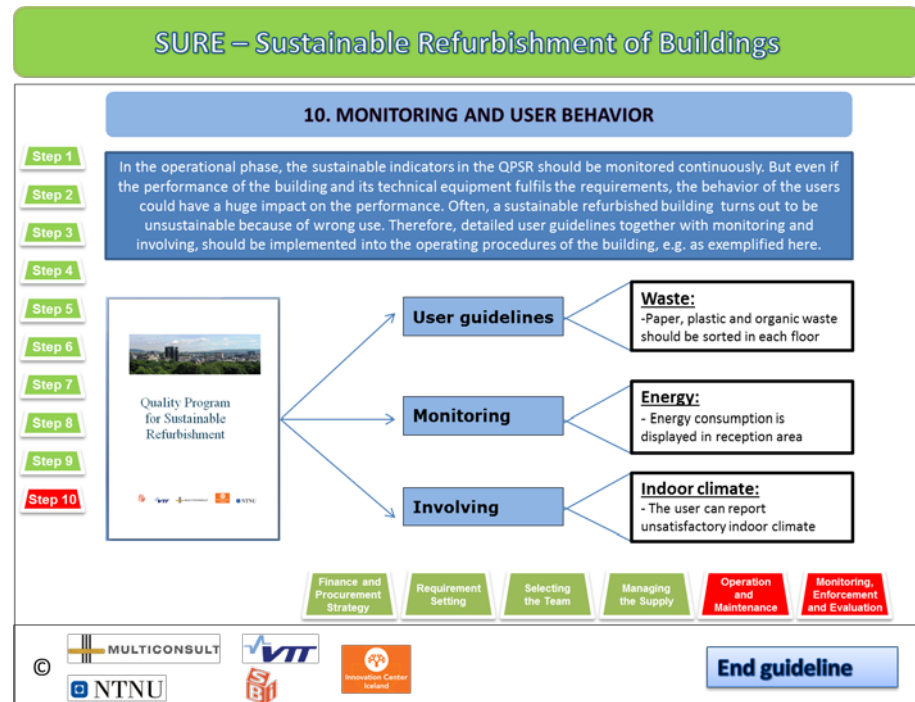


Figure 18. Step 10: Monitoring and user behaviour.

## The SURE Indicator Tool

To set ambitions, create a performance profile of the building, and to build a quality program for sustainable refurbishment, there is a need for a tool of sustainable indicators. The SURE research team has discussed various indicators, starting with a list of approximately 200 indicators. For practical reasons had to be narrowed down to approximately 70 indicators. The indicators are sorted in five categories: social, environmental, economic, technical standard and process. Each of the categories is divided in subcategories, e.g. indoor climate (social) and energy (environmental). Further, the subcategories are divided in different sustainable indicators, e.g. CO<sub>2</sub> concentration (indoor climate) and delivered energy (energy). As many as possible of the indicators are quantifiable, so that they can be measured in the different phases of the project making it possible to check and act continuously. Each of the indicators have four reference values, making it possible to rate the quality level of each indicator. An overview of the individual indicators distributed on the main categories is shown in Figure 19.

Category	Subcategory	Indicator	Category	Subcategory	Indicator			
Technical standard		Ground, foundations and grid	Social	Indoor climate	Room temperature			
		Windows, exterior doors			Design air flow			
		Exterior cladding and surface			Air velocity			
		Roof, surfaces (floor, wall, ceiling)			Noise level			
		Fixtures			Formaldehyde concentration			
		Water and sanitation			Air quality			
		Heating			Acoustics			
		Cooling			Lighting intensity			
		Fire			Thermal comfort			
		Air treatment / ventilation			Radon			
		Electricity, general construction / distribution			CO <sub>2</sub> -concentration			
		Electrical lighting, electric heating, operational technology			Emission from materials			
		Telecom and auto: general construction, electrical and			Cleanness of air-handling components			
		Elevators						
		Outdoor technical facilities						
		Drainage, terrain management						
		Environmental			Energy	Delivered energy	Adaptability	Flexibility
Primary energy	Elasticity							
Electrical	Climate change							
Heating								
Material	Life time		Safety and accessibility	Number of accidents/deaths	Structural safety			
	Product documentation	Fire safety						
Economic	LCC	Paybacktime				Comfort	View to outside	Architectural design
		Annual costs						Support spaces
	Value	Plot opportunities						Usability
		Meeting owner's/user's strategy	Capacity					
Branding/certification		Logistics						
Process		Cost	Cultural values	Protection level	Cultural heritage			
		Time				Community acceptance		
		Users						
		Maintenance						
		Life Cycle Commission						
		Monitoring						
		Measurements						

Figure 19. The SURE indicators.

Below, a selection of spread sheets from the SURE Indicator Tool is shown starting with Figure 20, which shows the front page of the spread sheet.

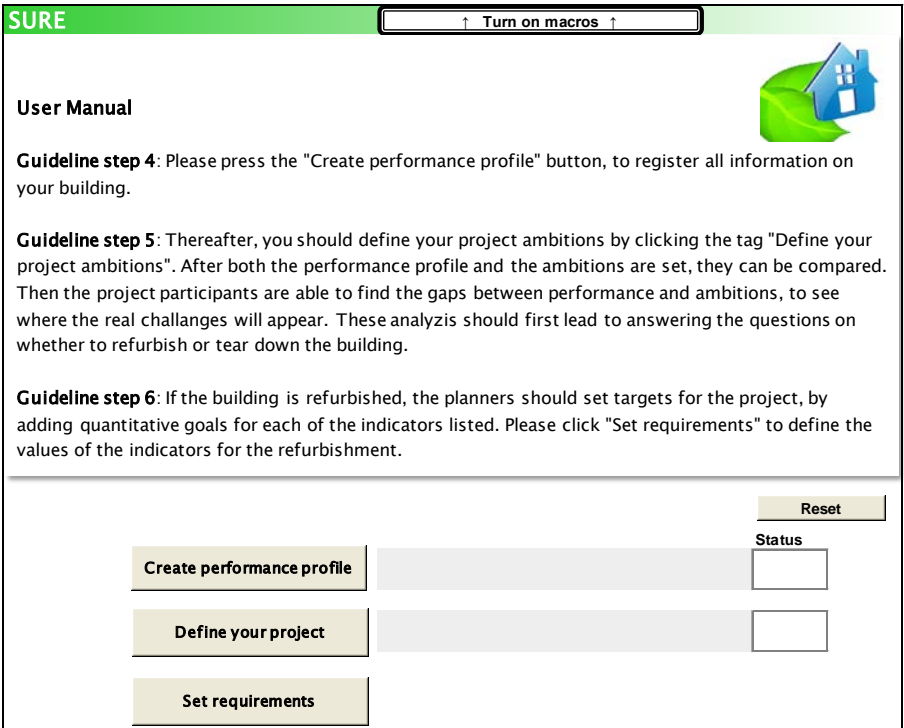


Figure 20. Front page of SURE Indicator Tool.

Figure 21 shows the main input spread sheet with the performance profile defined in the five main categories and the 12 subcategories:

- Economy: Lifecycle costing and value.
- Technical standard.
- Environmental: Energy and material.
- Social: Indoor climate, adaptability, safety and accessibility, comfort, usability and cultural values.
- Process.




Performance profile		Basic information	
		Address	
		Owner	
		Contact person data	
		Buildt year	
		Filled out by	
		Date	
Categories			
LCC	Indicator input		Status
Value	Indicator input		Status
Technical standard	Indicator input		Status
Energy	Indicator input		Status
Material	Indicator input		Status
Indoor climate	Indicator input		Status
Adaptability	Indicator input		Status
Safety and accessibility	Indicator input		Status
Comfort	Indicator input		Status
Usability	Indicator input		Status
Cultural values	Indicator input		Status
Process	Indicator input		Status
<input style="border: 1px solid black;" type="button" value=" &lt;&lt; Back to menu "/>		<input style="border: 1px solid black;" type="button" value=" Show my profile "/>	

Figure 21. Main input spread sheet.

Figure 22 shows the main output spread sheet with scores for each of the 12 subcategories.

Performance profile	
Address	0
Owner	0
Contact person data	0
Buildt year	0
Filled out by	0
Date	00-01-1900



Category	Score
LCC	0,0
Value	0,0
Technical standard	0,0
Energy	0,0
Material	0,0
Indoor climate	0,0
Adaptability	0,0
Safety and accessibility	0,0
Comfort	0,0
Usability	0,0
Cultural values	0,0
Process	0,0

**Sustainable score** 0,0 of 48 possible points

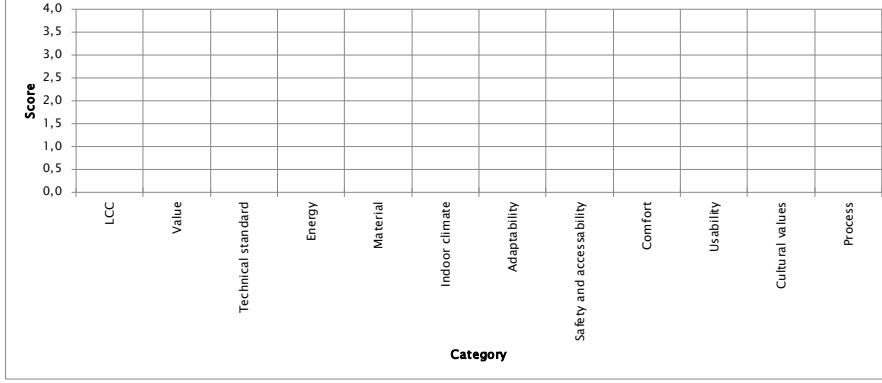


Figure 22. The main output spread sheet.

Figure 23 shows the spread sheet for setting requirements distributed on the some 70 indicators. For each indicator, the performance profile is assessed using a scale of four: low, medium, high and ambitious. Similar, the project ambitions or requirements are set using a scale of four: low, medium, high and ambitious.

Set your requirements								Compare	Start menu
Indicator	Performance profile				Project ambitions				Your requirements
	Low	Medium	High	Ambitious	Low	Medium	High	Ambitious	
Paybacktime									
Annual costs									
Plot opportunities									
Meeting owner s/user's strategy									
Branding/certification									
Ground, foundations and grid systems									
Windows, exterior doors									
Exterior cladding and surface									
Roof, gutters, drains									
Interior trim, surfaces (floor, wall, ceiling)									
fixtures									
Water and sanitation									
heating									
cooling									
Fire fighting									
Air treatment / ventilation									
Electricity: general construction / distribution									
Electrical: lighting, electric heating, operational technology									
Telecom and auto: general construction, electrical and electronics systems									
elevators									
Waste management equipment									
Outdoor technical facilities									
Drainage, terrain management									
Delivered energy									
Primary energy									
Electrical									
Heating									
Life time									
Product documentation									
Waste management									
Room temperature									
Design air flow									
Air velocity									
Noise level									
Formaldehyd concentration									
Air quality									
Aqustics									
Lightening intensity									
Thermal comfort									
Radon									
CO2-concentration									
Emission									
Cleanness of air-handling components									
Flexibility									
Generality									
Elasticity									
Climate change									
Structual safety									
Fire safety									
Accessibility (HC/UU)									
Safety in use (slippery floors etc.)									
Feeling of safety									
View to outside									
Architectaural design									
Support spaces									
Visual stimulation									
Functions (core activity)									
Support functions									
Capacity									
Logistics									
Protection level									
Cultural heritage									
Community acceptance									
#NA									
Cost									
Time									
Users									
Maintenance									
Life Cycle Commision									
Monitoring									
Measurements									
Construction waste									
Number of accidents/deaths									

Figure 23. Spread sheet for setting requirements.

Figure 24 shows the spread sheet for comparing performance and ambitions.



Figure 24. Comparing performance and ambitions.

Figure 25 shows the suggested default weights for each indicator. All sub-groups are summed up to 100 %.

	Low	Medium	High	Ambitious	Vekt	SUM
Paybacktime					50%	100%
Annual costs					50%	
Plot opportunities					33%	100%
Meeting owner's/user's strategy					34%	
Branding/certification					33%	
Ground, foundations and grid systems					10%	100%
Windows, exterior doors					6%	
Exterior cladding and surface					6%	
Roof, gutters, drains					6%	
Interior trim, surfaces (floor, wall, ceiling fixtures					6%	
Water and sanitation					4%	
heating					6%	
cooling					6%	
Fire fighting					6%	
Air treatment / ventilation					6%	
Electricity: general construction / distrib					6%	
Electrical: lighting, electric heating, open					6%	
Telecom and auto: general construction, elevators					6%	
waste					4%	
Outdoor technical facilities					6%	
Drainage, terrain management					6%	
Delivered energy					25%	100%
Primary energy					25%	
Electrical					25%	
Heating					25%	
Life time					34%	100%
EPD					33%	
Waste management					33%	
Room temperature					8%	100%
Design air flow					8%	
Air velocity					8%	
Noise level					8%	
Formaldehyd concentration					8%	
Air quality					8%	
Aqustics					8%	
Lightening intensity					8%	
Thermal comfort					8%	
Radon					8%	
CO2-concentration					8%	
Emission					8%	
Cleanness of air-handling components					8%	
Flexibility					30%	100%
Generality					20%	
Elasticity					20%	
Climate change					30%	
Number of accidents/deaths					10%	100%
Structural safety					30%	
Fire safety					30%	
Accessibility (HC/UU)					10%	
Safety in use (slippery floors etc.)					10%	
Feeling of safety					10%	
View to outside					25%	100%
Architectaural design					25%	
Support spaces					25%	
Visual stimulation					25%	
Functions (core activity)					40%	100%
Support functions					20%	
Capacity					20%	
Logistics					20%	
Protection level					50%	100%
Cultural heritage					25%	
Community acceptance					25%	
#NA					0%	

Figure 25. Default weighting system for each indicator.



# Conclusion

Below, the lessons that were learned across the national case studies are discussed in relation to the three overall themes of the SURE project, namely procurement strategies, innovation strategies and sustainable refurbishment guidelines.

## Lessons learned

The characteristics of public clients' procurement and innovation strategies are summarised in Figure 26 below.

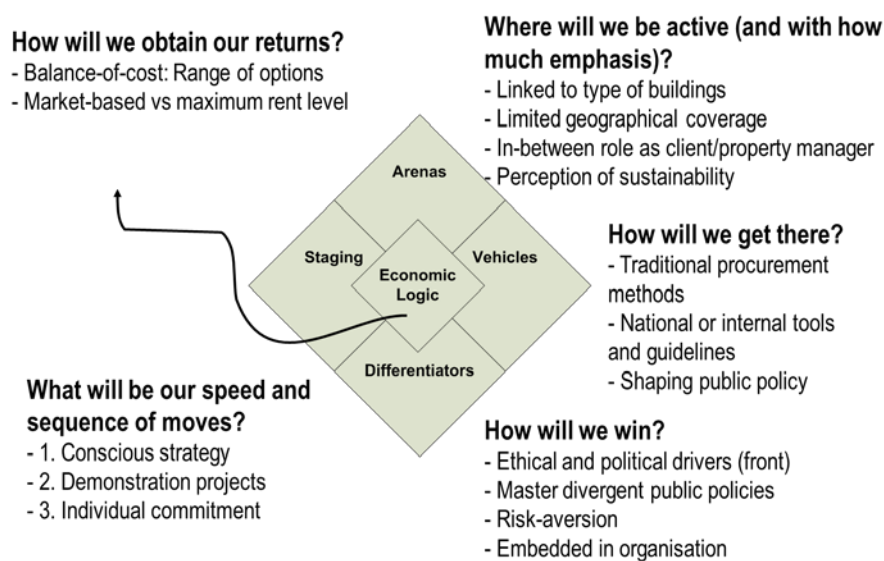


Figure 26. Overview of business strategy analysis of the 11 case studies.

The arenas of clients are predominantly linked to specific building types set within a limited geographical coverage. Most of the clients play an in-between role as client and/or property manager, since the clients themselves do usually not use the facilities for own purposes but rent them out to others. Their focus is defined by their perception of sustainability, where most of the cases apply a more narrow perspective predominantly linked to energy savings.

The vehicles applied by clients include conventional and well-established forms of procurement like design-bid-build or design-build contracting. The vehicles towards change span three broad groups: 1) demonstration and development projects, and 2) various national or organisation-specific types of tools, guidelines and templates, and 3) shaping public policy-making.

Public clients and property managers will typically need to differentiate themselves towards two types of competitors, who may also deliver the same service to the public: private clients and other similar types of public clients. The differentiators are to a large extent pre-defined by their very role as public clients, their ability to master many – often divergent or even contradictory – public policies, being obliged to be first-movers, and the ability to turn intentions into organisationally embedded skills.

The staging of the change process by the individual client were distinctively different spanning from relying on the commitment of one individual over the use of demonstration projects and diffusion of lessons learned in the client organisation to a comprehensive and reflexive approach.

In most cases the public clients and property managers are operating on a market-like basis, where the income often is generated through rental agreement with the actual user. The public clients are providing facilities for a balance-of-cost principle. Consequently, refurbishment of the individual property can only be financed through e.g. grants, subsidies, rent increase etc.

Based on the 11 case studies in Denmark, Norway, Finland and Iceland, the SURE project has identified three different strategies when it comes to driving sustainable refurbishment:

- The first strategy is labelled a procurement-driven strategy towards sustainable refurbishment.
- The second strategy is labelled an innovation-driven strategy towards sustainable refurbishment.
- The third strategy is labelled an ad-hoc strategy towards sustainable refurbishment.

## SURE Guideline and Indicator Tool

Summarising the lessons learned, the case studies emphasise the need 1) to develop strategies and policies on sustainability in client and owner organisations and to transform them into practical action, 2) to encourage a more comprehensive approach towards sustainability, 3) to implement condition surveys of buildings as a basis for making decisions 4) to identify a recognised set of indicators for a systematic benchmarking or assessment system, 5) to balance sustainable ambitions with available finances, 6) to establish a quality program for sustainable refurbishment throughout the entire project, and 7) to provide a flexible framework that can be adapted locally and nationally.

The main reason for creating a SURE Guideline and Indicator Tool is to give building owners (clients) a helpful tool to take the right choices when aiming for a sustainable refurbishment. Very often, the clients have high ambitions, but not as high finances. In addition to finances, both the quality standard of the building and the possibilities and restrictions has to be mapped before setting the ambition level. By going through the guideline, a performance profile of the building(s) will be set. This profile will help improve the awareness of sustainability with the help of indicators. The guideline can also be used as a checklist.

One of the major challenges in developing a common Nordic guideline has been the differences in defining sustainability and the national requirements, building codes, climates, building practice etc. However, the most challenging part is the need for client changes. Therefore, the SURE Guideline is focusing on the client as a change agent in a 10-step process. Further, the guideline focuses on sustainable indicators to help the client to be aware of important parameters to achieve sustainable refurbishment of buildings.

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# Appendix 1: State-of-the-art Denmark

By Peter Vogelius & Kim Haugbølle, Danish Building Research Institute/Aalborg University

## Population

### Population size

Since the early 1970s, Denmark has had a population of more than 5 million inhabitants. The size of the population has seen a slow, but steady increase since 1970, and on 1 January 2010 the number was 5.5 million. During the early 1980s, the population fell due to reductions in the number of births (Danmarks Statistik, 2010a).

*"Population developments depend on four components: live births, deaths, immigration, and emigration. The population increase during recent years is the result of two things: positive natural increase (births-deaths) and positive net migration (immigration-emigration). Positive net migration means that more people enter Denmark than leave it" (Danmarks Statistik, 2010a: 18).*

The shift in the components responsible for population development is presented in Table 3 for the 10 year period 2000 to 2009.

Table 3. Population movements.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Population	5,345,168	5,363,718	5,363,718	5,396,198	5,408,716	5,425,420	5,444,203	5,469,994	5,504,685	5,530,077
Birth-death, netto	1,553	705	305	808	1,488	1,843	1,767	1,873	1,592	1,410
Net migration	1,908	3,067	471	-647	407	-207	953	3,955	5,304	3,375
Population growth	3,461	3,772	776	161	1,895	1,636	2,720	5,828	6,896	4,785

Source: (Danmarks Statistik, 2010a: Statistikbanken).

Statistics Denmark makes the following observation on the past 30 years population development:

*"In the first half of the 1980s extraordinarily few children were born in Denmark. The expression "The small youth generations" refers to children born during this period. Until 1984 the low birth rate led to negative population growth. In 1985 the picture changed due to increased immigration. Since then the number of people has increased. In 1995 the population grew particularly much due to immigration from former Yugoslavia. In recent years the immigration has increased again due to work permits given to foreigners. Immigration to Denmark is far from a new phenomenon.*

*Today immigrants and their descendants constitute about 9.5 per cent of the population, corresponding to 526,000 persons. Immigrants and their descendants from non-western countries constitute 6.4 per cent of the Danish population. In recent years emigration has also grown" (Statistics Denmark 2010d: 5).*

Figure 27 below illustrates graphically the development. It can be noted that the immigration has increased steadily since approximately 1980.

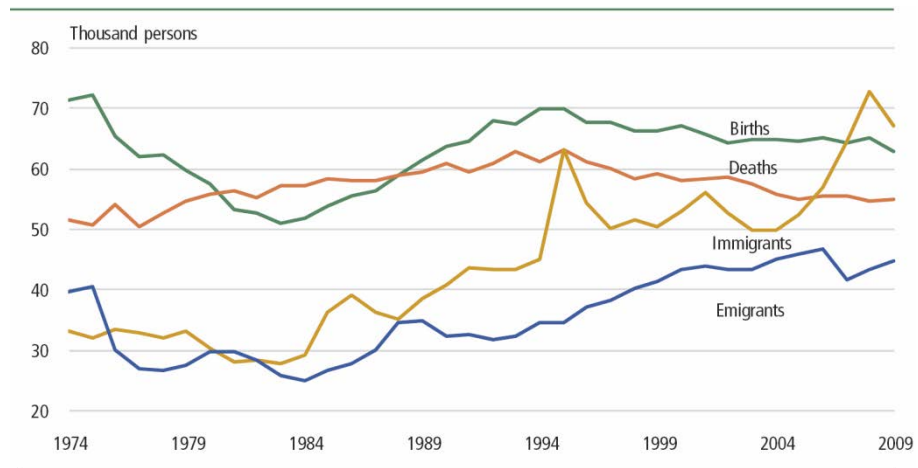


Figure 27. Population development 1974 – 2009. Source: (Danmarks Statistik, 2010a).

Below the population pyramid shows a rather old population with relative small variations in population increase over time (see Figure 28).

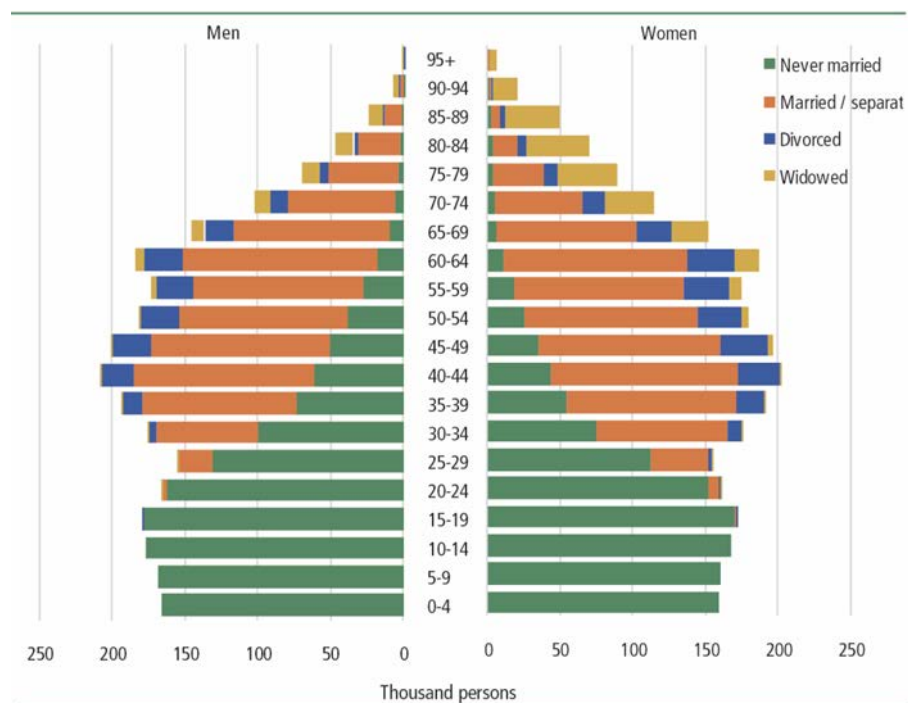


Figure 28. The Danish population by age at 1 January 2010. Source: (Danmark Statistik 2010a).

### Expected population in the future

According to Statistics Denmark (2010a) the average age in Denmark was 40.2 years as of 1 January 2010 compared to 36.8 years in 1980. This increase in the average age is caused by an increase of 60 % in the number of people over the age of 80. The increase is also occasioned by the fact that the large generations from the mid-1940s have now reached their sixties, as well as the fact that the large generations from the mid-1960s are now being classified to an older age group and by smaller younger generations.

### The proportion of elderly

According to Statistics Denmark (2010b), the proportion of the Danish population, who are 65 years old or more, is expected to increase from 16 % in 2010 to 25 % in 2042 (see Figure 29). The increase in population is low. According to the most recent models, the population will first reach 6 million in 2050 – compared to the 5.5 million today (Statistics Denmark, 2010a).

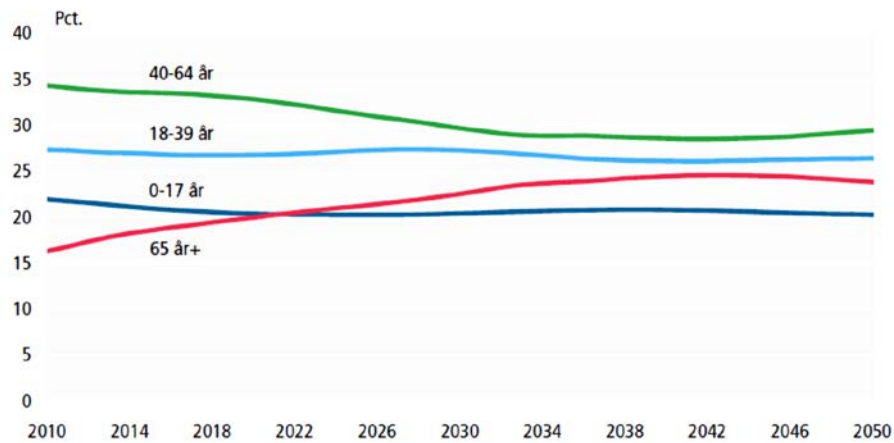


Figure 29. Age groups and their proportion of the total population, 2010-2050. Source: (Danmarks Statistik 2010b: 1).

### More elderly people in the periphery – fewer in the towns

The age distribution has a regional unbalance, which tends to become more marked in the future. In 2020 the proportion of elderly people in Denmark's two largest towns (Copenhagen and Aarhus) is expected to reach 11 % and 15 %, respectively, and in the other end of the spectrum to reach 40 % and 35 % in the minor Danish islands Læsø and Ærø. This tendency counts for the country as such (Statistics Denmark, 2010a).

### Building stock: Value, age distribution, amount and ownership

In 2008, a joint committee published a review of the state-of-the-art of the public building stock. The joint committee consisted of the interest organisations for the five regions (Danske Regioner) and the local municipalities in Denmark (Kommunernes Landsforening), the governmental building owner the Palace and Properties Agency (Slots- og Ejendomsstyrelsen) and three ministries for finance (Finansministeriet), social housing (Velfærdsministeriet) and business can and construction authorities (Erhvervs- og Byggestyrelsen).

The public Danish building stock is heavily dominated by institutions owned by the municipalities in terms number of buildings, gross floor area and value (see Table 4).

Table 4. Public building stock by 2007.

	Number of buildings	Gross floor area	Maintenance cost			Value	Value
			Exterior	Interior	Total		
		Million sqm	Billion DKK	Billion DKK	Billion DKK	Billion DKK	Billion EUR
Municipalities	45,000	30.0	1.0	1.6	2.6	189	25.4
Regions	3,700	5.2	-	-	-	38	5.1
Government	1,500	8.3	-	-	-	-	-
Total	50,200	43.5	-	-	-	-	-

Source: Adapted from (Danske Regioner et.al., 2008).

Note: Value is balanced primo 2007 and includes value of both building and property. Due to a reform of administrative organisation between municipalities and regions by 2008, a current balance would give higher figures for municipalities' and lower for regions.

If we take a look at the complete building stock we will find a steady growth both in gross floor area and number of buildings. According to Statistics Denmark (2011) Denmark has 2,530,000 buildings (January 2011) against 2,320,000 in 1986 (an increase by 9 %). The increase in gross floor area in m<sup>2</sup> has been more marked in the same period. By 2011 the gross floor area is 717.6 million m<sup>2</sup>, which is an increase by 27 % compared to 1986. The building stock is dominated by housing and business/commercial facilities (see Table 5).

Table 5. The distribution of buildings by purpose.

Building use	Distribution (in %)
Housing	61
Leisure	10
Business/commercial	27
Institutions and culture	2
Total	100

Source: Based on (Statistics Denmark, 2011).

## Impact of building stock on environment

### Energy production by source

By 2011 Denmark had a building stock of 498.8 million m<sup>2</sup> that was heated. This is equivalent to an increase of 34 % compared to 1986. The largest increase in the past 25 years (1986 – 2011) has been heating the gross floor area by district heating. In Figure 30 the distribution of Danish dwellings by form of heating is illustrated.

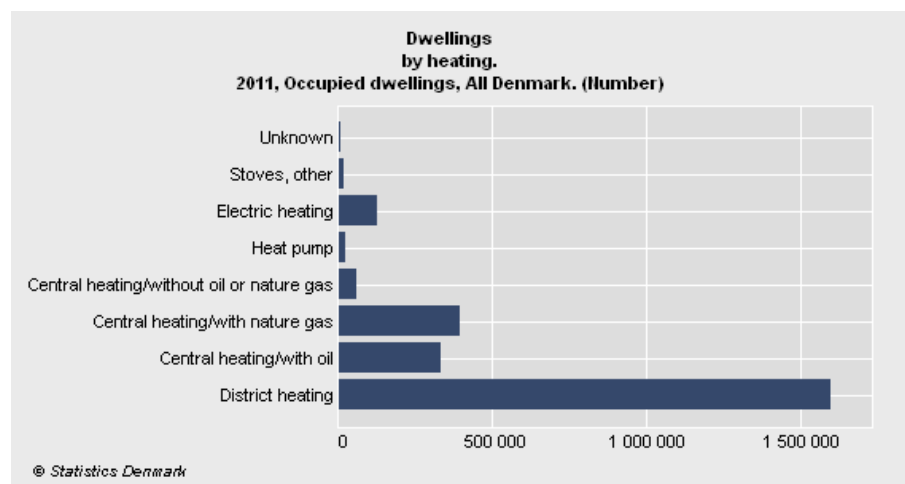


Figure 30. Dwellings by heating in 2011. Source: (Danmarks Statistik, 2011b).

The proportion of dwellings heated by district heating is very high and the result of concerted political actions. In Table 6 the absolute figures are entered.

Table 6. Occupied dwellings by type of heating in 2011.

Type of heating	Number of dwellings
District heating	1,598,861
Central heating with oil	332,893
Central heating with natural gas	399,322
Central heating without oil or natural gas	61,508
Heat pump	25,141
Electric heating	127,163
Stoves, other	22,261
Unknown	7,839

Source: (Statistics Denmark, 2011b).

### Use of resources and construction waste

It is estimated that in Denmark the building and construction sector consumes more than 90 % of the total Danish production of raw materials distributed with 2/3 to construction and 1/3 to building (this section is based on Bach et al. (2001)). Further it is estimated that approximately 1.1 tons/m<sup>2</sup> of material is used in new building. Sand, gravel, tiles, bricks etc. accounts for about 70 %.

As an average the estimated yearly consumption of raw materials in the building and construction sector during 1990s was between 6 and 9 million tons. Miljøstyrelsen (1993) calculates that the material input for the year 1989 roughly speaking was 10 million tons and the output as mainly building waste was 2 million tons.

### Health and indoor environment

In the last couple of decades there has been an increasing focus on indoor climate, especially problems with moisture in buildings and the development of mould and hazardous substances like PCB and radon. Efforts has been made to reduce humidity in building materials because of inexpedient handling at the building site, bad design, defects in construction process and inappropriate behaviour by the user of the building. However there is still much research and practical work to be done. Two other problems are important, namely the exposure from radon and recently also the emissions from PCB in buildings (most profound in buildings from the 1960'es). With regard to moisture and radon prevention, much have been done in recent versions of the building regulation, but with regard to PCB on-going research is expected to give important clues on how serious the problem is and which means will be most appropriate in the renovation process.

## Construction sector and the market

### How well does the building stock fulfil market needs

For more than a decade there has been a strong tendency towards re-urbanization. The prices on property have shown an accelerated difference between rural districts and urban areas, both before and after the financial crisis in 2008.

With the national goals for reduction in carbon emissions in Denmark (with the new government October 2011 the goal are intensified to 40% reduction in 2020 compared to 1990) there will be a challenging task in transforming the existing buildings to new energy standards.



## Information available on the market

Several types of courses regarding different aspects of low energy buildings (both design and regulations) are offered by private and semiprivate organisations. To some extent this also counts for sustainable renovation although the primary focus often is more narrowly on energy savings.

## Maintenance and refurbishment of facilities

Recently the Danish Construction Association has published a memorandum (Dansk Byggeri, 2010) in which the association determine the backlog for buildings administrated by the Danish municipalities. The memorandum states that the backlog is approximately DKK14 billion by year 2008 and that the actual maintenance cost in the sector from year 2000 to 2008 for the municipalities has been approximately DKK2.8 billion lower than the total budget at DKK26 billion.

These results have been heavily disputed by local governments (Kommunernes Landsforening, 2010) who argued that there are severe methodological mistakes in the calculations and came up with a result telling nearly the opposite. To point out, it is bound with severe problems to get reliable and standardised figures for backlog and maintenance cost for public buildings at a national level.

In the previously mentioned report (Danske Regioner et al., 2008) a questionnaire survey from a random sample of Danish municipalities are presented. The survey includes 295 buildings from 7 municipalities and 12 buildings from one region. The municipalities in the test were selected to ensure variation regarding size and geography. Furthermore different measures were taken to ensure harmonisation in the evaluation – among other initiatives the technicians had to participate in a joint meeting with the purpose of establishing a consistent methodology in their evaluations.

The survey classified buildings using four variables:

- Functionality (Funktionalitet).
- Technical state (Teknisk tilstand).
- Properties favouring good physical working environment (Fysisk arbejdsmiljø).
- The degree to which the building comply with building regulation (Målopfyldelse ifht. Bygningsreglement m.v.).

The technical departments in the municipalities (e.g. the technicians allocated for the building) gave the buildings a score between 0-100. In the interval from 70 to 100 it was estimated that the building could sustain its technical standard with the input from the ordinary scheduled maintenance program. Below score 70 extra input was regarded necessary to regain a standard where steady state could be maintained with the input from the scheduled maintenance program. Between score 40 and 10, the standard was regarded so low that acute measures should be taken to avoid progressive damage of the building. Figure 31 below illustrates the result of the survey for the municipal buildings alone. In Denmark, public engagement in social housing takes place via a structured dialogue process (in Danish “styringsdialog”) between the individual municipality and the social housing companies. The survey does not cover the social housing sector.

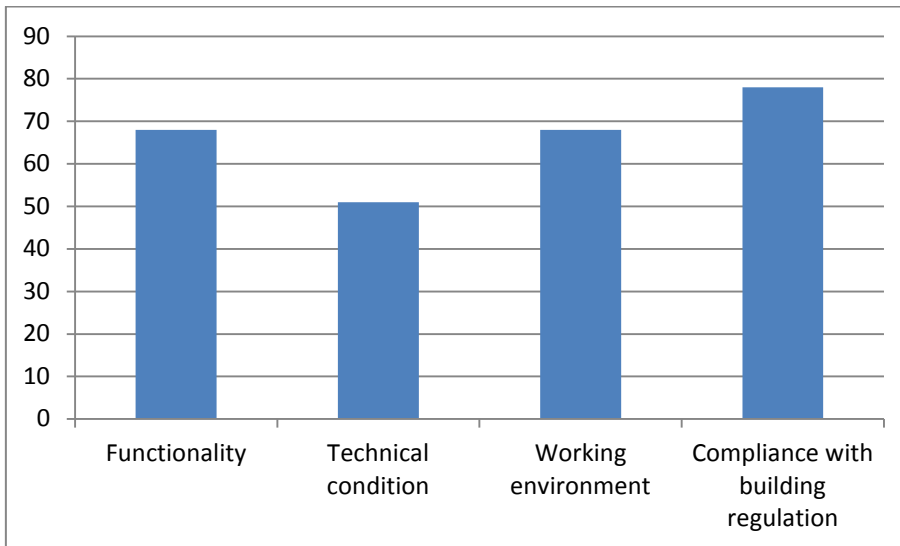


Figure 31. Survey from a random sample of Danish municipalities assessed by four variables. Source: Adapted after Danske Regioner et al. (2008: 23).

The report concludes that Figure 31 above gives a representative picture of the state of public buildings owned by Danish municipalities. The low score on the variable “Technical state” is primarily due to bad technical installations (heating, plumbing, electricity) according to the survey. It is also concluded that the low technical standard cannot be fixed alone via the regular budget for maintenance, but extra finances are needed.

It is not illustrated in Figure 31 how the problems are distributed on different types of buildings. However the report informs that the most serious problems are connected to schools. This is also confirmed by later studies (Kommunernes Landsforening, 2009) and (Dansk Byggeri, 2008).

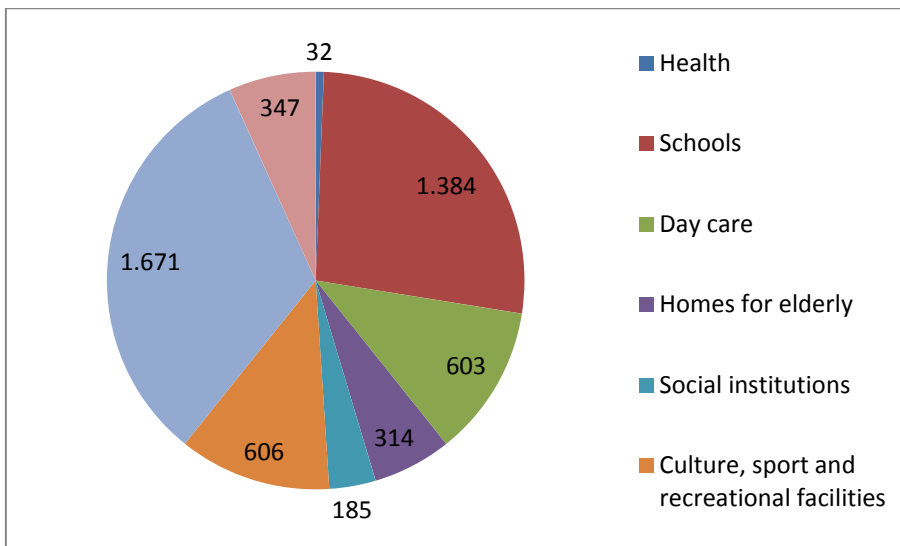


Figure 32. Estimated backlog in municipalities distributed on building type. Source: Adapted after (Kommunernes Landsforening 2009: 31).

Figure 32 gives an average measure by sector over Danish municipalities for the difference between finances allocated (according to budgets for 2009) and the estimated need if backlog should be compensated. The two major fields are infrastructure (primarily roads) and schools with a difference at respectively DKK1,671 million and DKK1,384 million.

## Sustainable procurement of maintenance and refurbishment

In the existing building regulation there are no defined standards for sustainability included, but a number of detailed rules for certain elements like energy consumption, exposure of hazardous emissions like radon, formaldehyde etc. The principle of sustainability is incorporated in several town plans, but primarily as declarations of intent, rather than specific standards for buildings, design or construction.

The recently established Green Building Council Denmark has a broad representation from all actors, private and public with reference to construction, building and urban planning practice. GBC-DK has selected the German DGNB system for certification of sustainable buildings. Currently an adaptation of the German system to Danish regulation, standards and practices are in process.

Another major initiative at regional and municipality level is worth mentioning. The City of Copenhagen is part of a broader development initiative involving Copenhagen itself and the surrounding municipalities. The initiative called Gate 21 has as its primary goal to be a central pivot for new climate end energy solutions. The initiative hosts projects for low energy solutions for renovation with a very broad participation from different actors (<http://www.gate21.dk>, in Danish only).

### Financing of refurbishment

The government is establishing funding via running budgets or specific construction laws for projects adopted in parliament (mostly large projects especially in relation to infrastructure).

Regions, which today primarily are dealing with hospitals and health care, are receiving their finances from the state, but make its own budgets. In the last couple of years a frame of some DKK38 billion has been allocated to the regions to invest in a renewal of the Danish hospitals through both new hospitals and major renovations of existing hospitals.

The individual municipalities are raising finances through taxes. But as a group the municipalities has to settle the total sum of expenses with the government each year for all municipalities together.

Various renting schemes also exist. In the municipalities, different models are applied and it is varying from one municipality to another. To make the situation even more complex it is also dependent on what kind of model the municipality is using for administration of its properties (Due, 2006). A continuum with two opposite poles can be identified. At one end, the full administration of maintenance etc. is placed as near the users as possible. The full consequence here is that each institution (school etc.) has a considerable job in taking care of building, inside as well as outside.

At the other end of the continuum, all administration, planning of maintenance etc. is organised in a central unit in the municipality, which across administrative areas operates the properties. In the latter model, institutions are normally renting their premises according to schemes, which state that internal maintenance is imposed at the renting organisation. There has, for municipalities in all, in some years been a movement against the last mentioned pole in the continuum (Danske Regioner et. al., 2008).

The government has for the past 10 years been running a renting scheme model for its institutions (universities, governmental institutions etc.) as a result of the so-called SEA reform (By- og Boligministeriet et al., 1999).

The regions have only smaller technical departments as a part of their client administration. Instead, the responsibility for renovation and maintenance is to a large extent decentralised to the individual hospitals.

### Methods and methodology, decision making tools for maintenance

The joint initiative Renovering 2010 between the Landowners' Investment Association (Grundejernes Investeringsfond – GI) and the private foundation Realdania is offering IT tools for systematic maintenance and energy-renovation for multi-storey buildings. Several tools of similar type have been introduced the last couple of years, which can assist the planning of renovation and maintenance (including energy). Some of these can be accessed at for example:

- <http://www.renovering2010.dk>.
- <http://www.energikoncept.dk>.
- <http://ejendomsviden.dk>.

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## Appendix 2: State-of-the-art in Norway

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### Population

#### Population

The population in Norway counts about 4.9 million people (Jan 1<sup>st</sup> 2011). In 1665 the population was 440,000, in 1822 it reached 1 million, in 1890 2 million, in 1942 3 million and in 1975 4 million people. The number of births per women is now 1.98 and in 2009 61,800 children were born in Norway. The average lifetime of a human being has increased the last 200 years, especially the last 20 years for men. For women the average lifetime is 83 years, for men about 79. The average age of the population is 39 years. There is about just as many women as men in Norway (Figure 33). 10.6 % of the population are immigrants or people born in Norway with immigrant parents (Statistics Norway, 2010).

Population, by age, sex and civil status. Jan 1st 2010

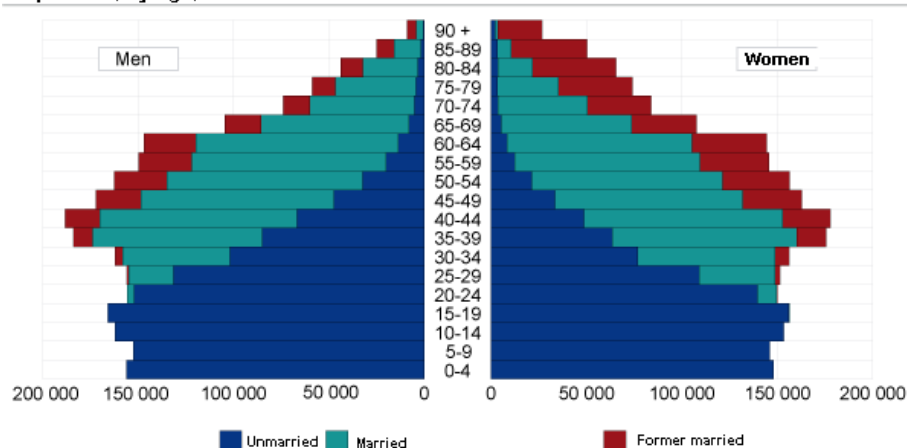


Figure 33. Population in Norway by age, sex and civil status. Source: (Statistics Norway, 2010).

#### Expected population in the future

The population will probably increase in the future due to a still high amount of immigrants, increasing average lifetime and the high birth rate (Figure 34). The scenarios shows that the population most likely will increase to about 6.9 million in 2060 (44 %), with a span from 5.4 to 8.5 million (Statistics Norway, 2010).

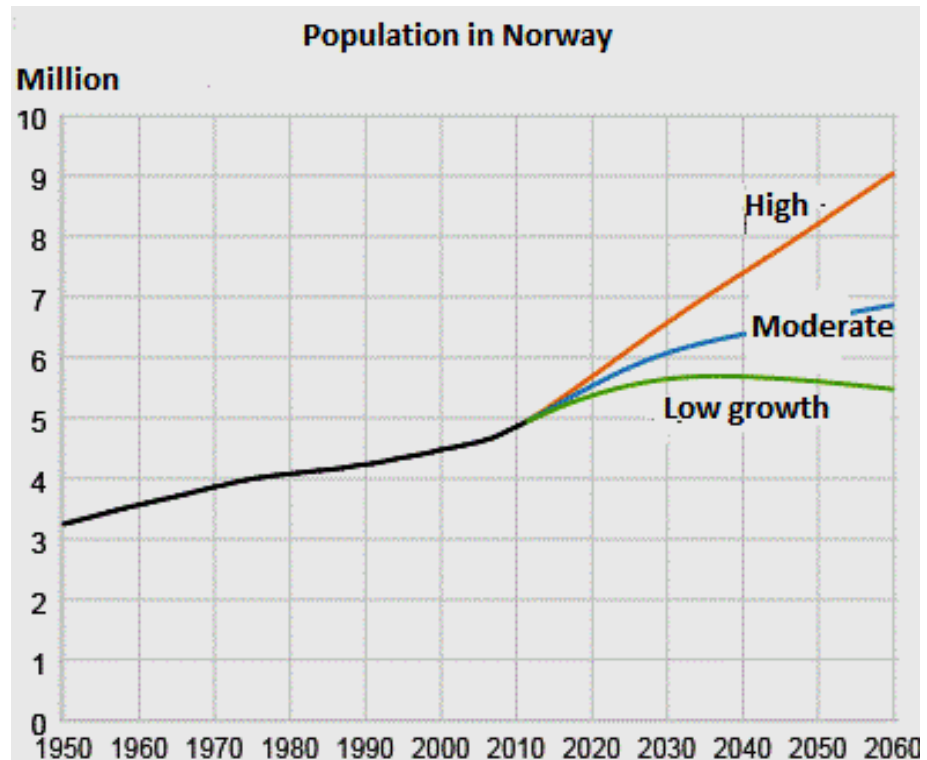


Figure 34. Population growth as expected for the next 50 years. Source: (Statistics Norway, 2010).

There will probably be a higher number of elderly people in the coming years. The number of people more than 67 years old will most likely increase from 617,000 in 2010 to about 1.5 million in 2060 (Statistics Norway, 2010). There has been a trend of decreasing population in the rural areas the last years, while the population in the larger cities increases rapidly. There is a high amount of immigrants, which also will give directions on how the living patterns and building design should be in the years to come.

### Building stock: Value, age distribution, amount and ownership

There are about 3.8 million buildings in Norway. Among these 1.4 million (37 %) are residential buildings (1 January 2010). There are approximately 2.3 million housings (houses and apartments) and in 2001 there were 2.3 persons per housing (Statistics Norway, 2010).

Figure 35 shows the number of buildings in Norway categorized by building type (the Norwegian building matrix). Figure 35 illustrates that the number of fishery and agricultural buildings is high. Both fishing and agriculture have been large industries in Norway, and they still are to a certain degree as evidenced in the overview of the number of buildings. Residential buildings count for about 2/3 of the total gross floor area.

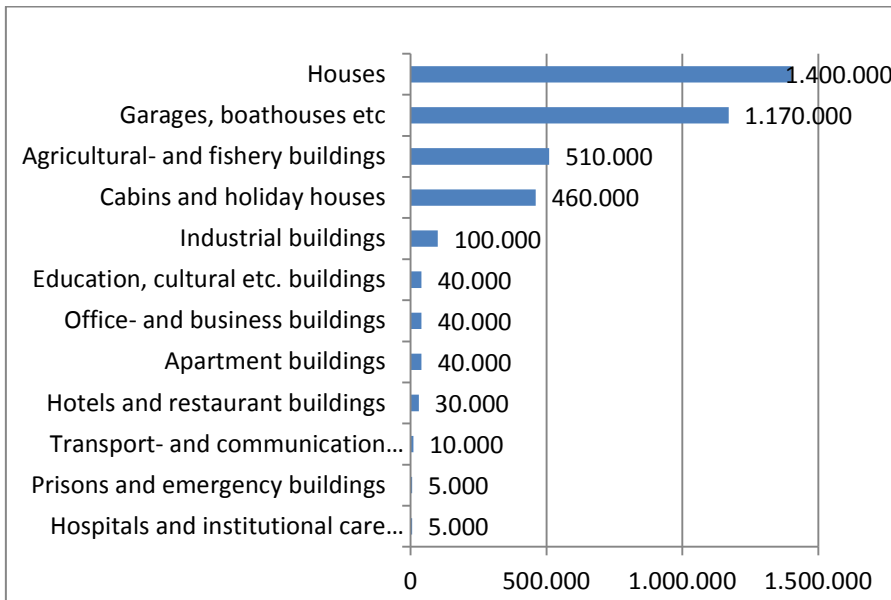


Figure 35. Number of buildings in Norway distributed by building category (the Norwegian building matrix) by January 2010.

Figure 36 shows the amount of buildings in Norway counted by square metres (Evjenth et al., 2011). Figure 36 shows that there are many small houses and garages in Norway. Most families in rural areas have their own house (often with a garage) while in the city centres apartment buildings are more common. There are also many cottages in Norway, approximately 450,000. It is quite common for families to have a cottage, either in the mountains or at sea, or both.

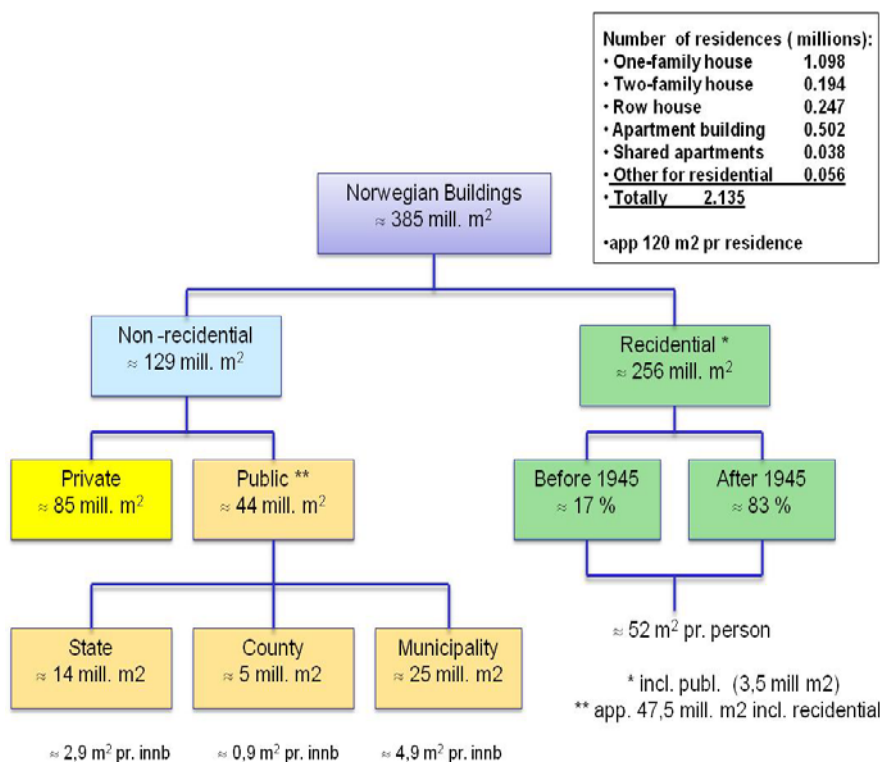


Figure 36. Building stock in Norway. Source: (Evjenth et al., 2011: 11).

In 2010, approximately NOK257 billion (€32 billion) were used on investments or maintenance in the construction sector in Norway. For buildings, NOK111 billion (€14 billion) were invested in new buildings, and NOK83 billion (€10 billion) in maintenance and refurbishment (BNL, 2011).

Figure 37 shows the construction of new housing, public buildings and private commercial buildings in square meters.



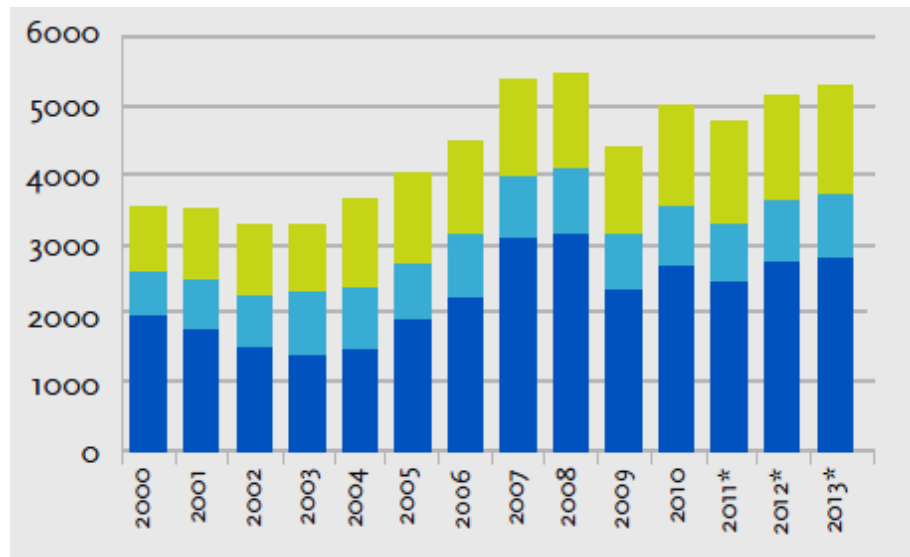


Figure 37. New square metres (\*1,000) of housing (green), public buildings (light blue) and private commercial buildings (dark blue). 2011-2013 is estimated. Source: (NBL, 2011).

Figure 38 shows the number of new housing, public buildings and private commercial buildings.

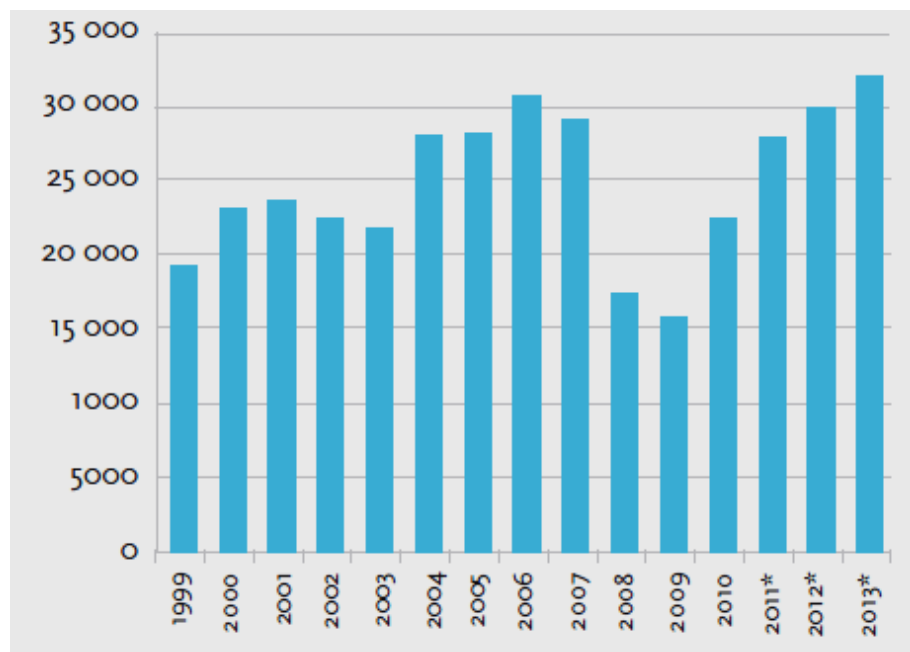


Figure 38. Number of new houses. 2011-2013 is estimated. Source: (NBL, 2011).

In 2010 there were approximately 310,000 people working in the building industry in Norway. Approximately 25 % of the registered workers on site are foreign citizens. Some 140 countries are represented.

According to Sartori et al. (2008) renovation is likely to overtake construction as the major activity in the Norwegian residential sector (Figure 39).

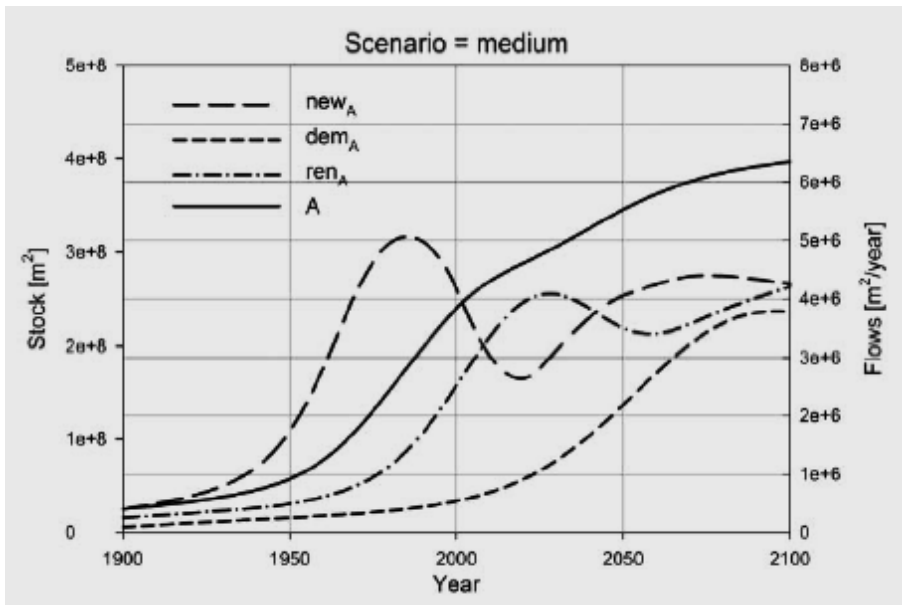


Figure 39. Renovation (ren) is likely to overtake construction (new) as the major activity towards 2050. Source: (Sartori et al., 2008: 418).

## Impact of building stock on environment

### Energy production and energy use

In 2009 the total emission of greenhouse gases in Norway was about 50 million tonnes CO<sub>2</sub> equivalents, i.e. about 11 tonnes per capita (Figure 40).

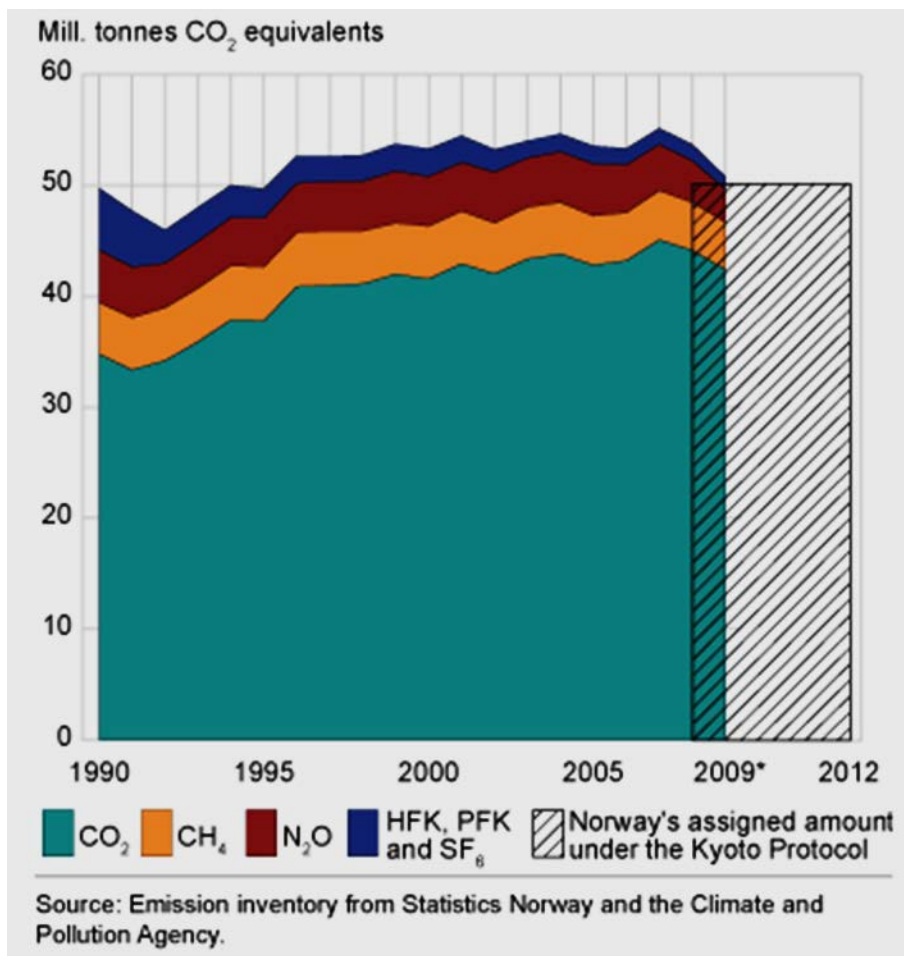
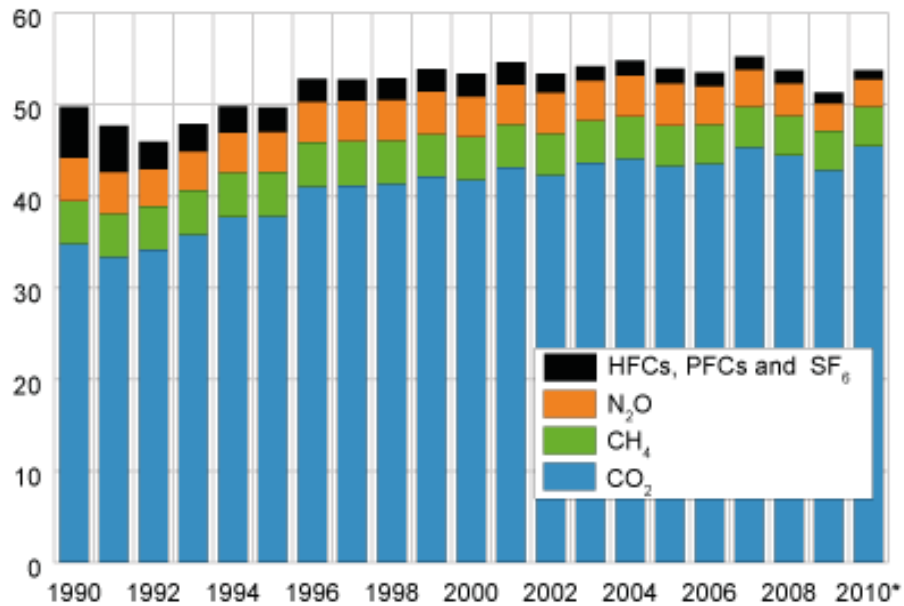


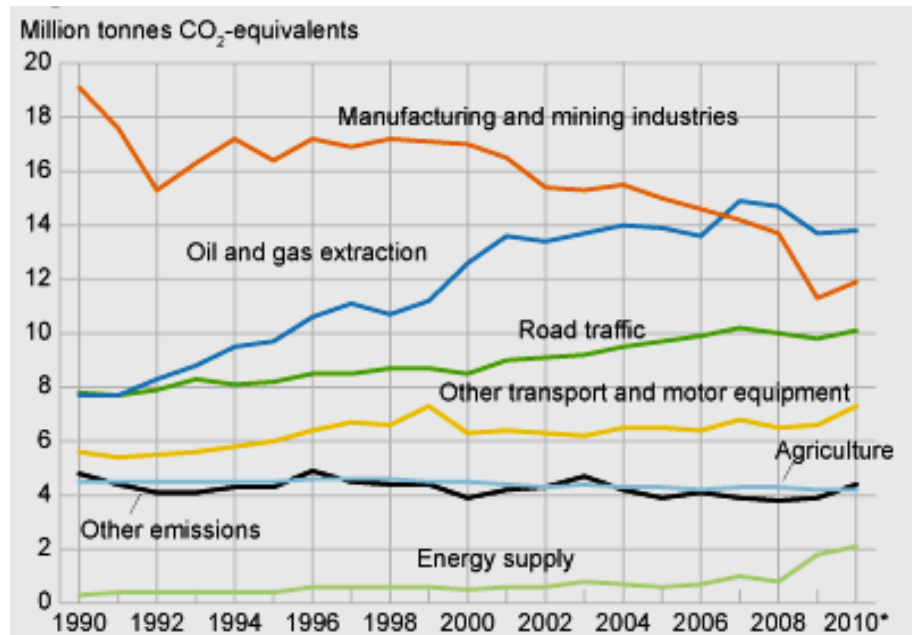
Figure 40. Emissions of greenhouse gases 1990-2009 and Norway's assigned amount 2008-2012. Million tonnes CO<sub>2</sub> equivalents. Source: (Statistics Norway, 2011).

Carbon dioxide accounted for 83 % of the total greenhouse gas emissions (Figure 41).



Source: Emission inventory from Statistics Norway and the Climate and Pollution Agency. Figure 41. Inventory of emissions of greenhouse gases 1990-2010. Source: (Statistics Norway, 2011).

The oil and gas industries, manufacturing and road traffic are the greatest sources of CO<sub>2</sub> emissions (Figure 42). Since 1990 there has been an increase of about 2 % in total.



Source: Emission inventory from Statistics Norway and the Climate and Pollution Agency. Figure 42. Greenhouse gas emissions in Norway. Source: (Statistics Norway, 2011).

According to a report published by (Bernhard & Jørgensen, 2007), the construction and operation of buildings counts for about 14 % of the total greenhouse gas emissions in Norway, i.e. 7 million tons CO<sub>2</sub> equivalents. Operation of buildings represents about 4 % in this context, i.e. 2 million tons CO<sub>2</sub> equivalents.

In 2006 the total energy demand for the Norwegian building stock was 74 TWh (82 TWh in 2001), and counts for approximately 40 % of the total energy demand in Norway (Enova, 2001, 2007 & 2008). The total energy demand for residential buildings in 2006 was 44 TWh. Out of this, 27 TWh was

used for space heating (19 TWh by electricity). For other buildings (office buildings etc.) the total energy demand was 30 TWh. Out of this, 15 TWh was used for space heating (10 TWh by electricity). No other sector has had a larger growth in energy use in the past 30 years (Enova, 2001).

This shows that residential buildings count for about 60 % of the total energy demand of the Norwegian building stock. For residential buildings space heating counts for approximately 60 %, and 70 % of the space heating is supplied by electricity. Other buildings use 40 % of the total energy where 50 % is for space heating and 67 % of the space heating is supplied by electricity. In other words the main challenge for residential buildings is to reduce the need for space heating, while for other buildings reducing energy demand for both space heating, technical equipment and ventilation should be of highest priority.

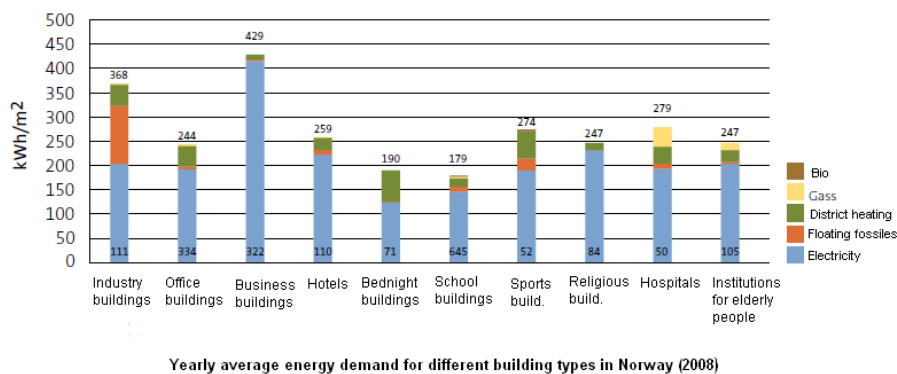


Figure 43. Statistics for delivered energy for different building types, based on data for 5-10 % of the Norwegian building stock. Source: (Enova, 2008: 16).

As Figure 43 shows, the energy use in Norway is highly based on electricity and district heating. There is a high use of floating fossils (i.e. oil) in industry buildings, while gas mainly is used in hospitals and institutions.

The electricity production in Norway is normally about 121 TWh per year (2006). This includes wind, hydro and heat power. Hydro power counts for approximately 99 % of the production (Ministry of Petroleum and Energy, 2006). Thus, in a local perspective the electricity energy could be considered a renewable and green energy source.

By reducing the electricity demand in Norway the export of renewable electricity abroad will increase. The renewable electricity replaces electricity generated by fossil fuel burning abroad (coal, oil etc.). Combined with a growing demand and shortage of electricity in Norway it will therefore be very important to reduce the need for electricity in the Norwegian building stock.

### Health and indoor environment

Studies indicate that the Norwegian people stay inside a building as much as over 90 % of the day. But the indoor climate in buildings varies a lot. Late years focusing on indoor climate in school buildings has revealed bad performance, illness and allergic reactions. Also, a number of kindergartens have problems with the indoor climate. Usually, an old ventilation system, moisture problems and/or poor cleaning are the reasons to the problems. Usually, buildings with low technical standard experience these problems. In housing, the situation is generally somewhat better. But lack of knowledge of indoor climate often leads to poor ventilation and moisture damages even in apartments and houses. In office buildings, though, the indoor climate is much better in general. Here, problems related to dry air sometimes are reported, usually in winter season.

## Material use

The dominating materials used are wood, concrete and steel. Also, gypsum boards, plastic and different types of sealing products are used. The majority of houses are built as an insulated wood structure with an indoor vapour barrier and an outdoor wind barrier. Outside of the wind barrier, an air gap and a cladding are mounted (two layer structure). Some houses are built of masonry or concrete. Bigger buildings, as office buildings, hotels etc. usually have a bearing frame of steel or concrete and concrete slabs. The wall elements are usually built as for housing, but some buildings have only concrete wall elements (one layer structure). Roofs are usually built in two ways. Small houses usually have wooden framed and insulated pitched roofs with a two layer wind and rain barrier (e.g. tiles). Larger buildings usually have flat, insulated roofs built upon concrete slabs.

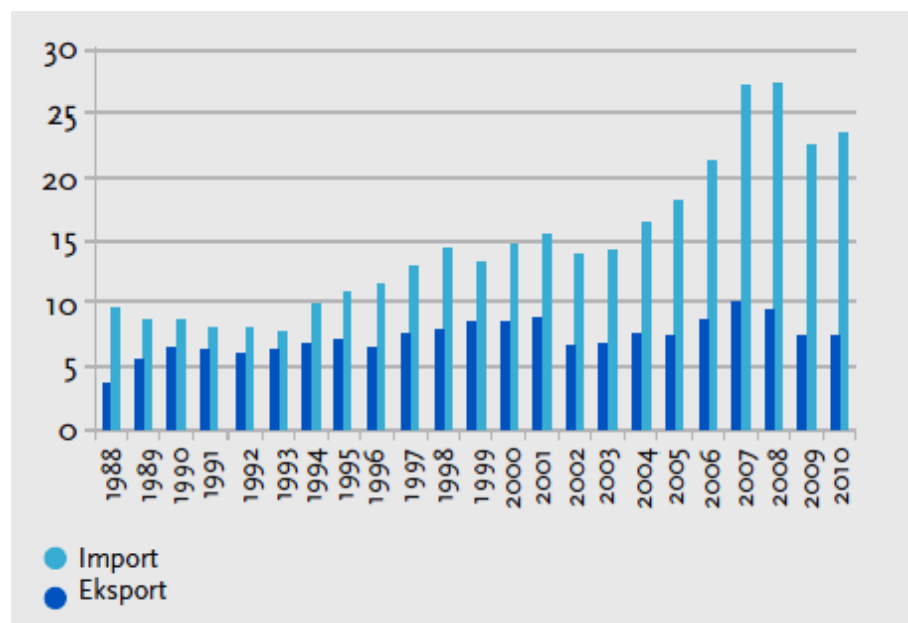


Figure 44. Import and export of building materials in Norway, billion NOK. Source: (NBL, 2011).

Most materials are domestic, but there is an increasing amount of imported “new” materials (Figure 44). The dominating materials for both export and import are iron, steel, wood, plastic and painting. For stone and gypsum, the export is higher than import. Almost half of the export finds its way to the Nordic countries, followed by Germany, China, Great Britain and The Netherlands. The import is mostly from Sweden (25 %), Germany, Denmark, Finland and Poland.

## Waste handling

Every year about 1.5 million tons of waste is produced by the building sector. This includes new buildings, refurbishment and demolition. The producer of the waste (owner and contractor) is responsible for the handling of the waste. The department of environment has made a new requirement (2008) of waste handling. New buildings over 300 m<sup>2</sup> and refurbished buildings over 100 m<sup>2</sup> must have a waste plan. For existing buildings you also need to produce a description of environmental issues for the refurbishment. In addition there is a quantitative demand that at least 60 % of all the waste shall be recycled on site.

## Construction sector and the market

### How well does the building stock fulfil market needs

The large cities in Norway experience a rapid population growth. In the capital Oslo there is a great need of new apartments and houses. Also, the

number of elderly people increases. New thinking for housing elderly and to fulfil the increasing demands of comfort will be of crucial importance. Further, the technical standard and flexibility of the building stock is not as good as it should be. Sustainable refurbishment will be one of the major challenges for the years to come.

### Information available on the market

There are a lot of training courses on the market aiming to increase the knowledge on sustainable planning of both new buildings and refurbishment projects. The main focus is on BREEAM, energy labelling, project planning, energy efficiency, Passive House standard and energy sources.

### Safety on working sites

Safety on working sites has been on the agenda in the construction industry the last decades. Within the construction industry, an average of 13 people has lost their lives in workplace accidents every year since 1988. One in four occupational injuries in the industry is due to falls.

### Other subjects of interest

#### *Knowledge on best practice*

SINTEF Building Detail Sheets (SINTEF – Norwegian Building Research Institute, 2010) is a huge library of best building practice based on 60 years of knowledge. This library is used by most of the actors in the Norwegian building industry and gives a great opportunity to build buildings with as few building defects as possible.

#### *Challenges for the existing buildings*

The report “Basis and requirements for existing buildings in Norway” commissioned by The Ministry of Local Government and Regional Development (Multiconsult & Kluge, 2011) reveals a number of challenges for the existing buildings in Norway. The challenges are divided into 10 different areas: Laws and regulations, energy efficiency, indoor climate, universal design, listed buildings and building physics, technical systems and equipment, operation and use, climate adaptation and new buildings. One of the major challenges is imprecise laws and regulations. This leads to many exemptions e.g. from energy demand, which will make the national energy reduction goals almost impossible to reach.

#### *The law on public procurement*

According to § 6 of the law on public procurement, the state, municipal and county governments (including public legal bodies) should, during planning of each acquisition, take into account life cycle costs, universal design and environmental impact of the acquisition.

#### *Protected and listed buildings*

Some of the most challenging refurbishment projects are the ones where the buildings or parts of the buildings are protected or listed. There are many protected buildings in Norway, mainly buildings in the large cities, but also cultural buildings in rural areas, like old churches.

Buildings could be protected under the Heritage Act or the Building Conservation Act of 1920. There are two main types of listed buildings: Those that are automatically protected due to age, and those that are protected by individual decisions. Buildings built before the year 1537 are automatically protected, and in 2001 this was extended to include also standing structures from the period 1537 to 1649. Also Sami buildings older than 100 years are automatically protected. For the latter the underlying data is currently quite

incomplete. When it comes to buildings protected by individual decision, the Ministry of Environment can preserve buildings and installations of cultural or architectural value from the modern era (since 1537). The resolution also includes fixtures (cabinets, stoves etc.). The buildings protected by the principle of age are attached to a safety zone of 5 meters from the house's visible edge, which is protected (Norwegian Ministry of Environment, 2010).

## Maintenance and refurbishment of facilities

### Refurbishment and maintenance needs

A report from 2008 (Multiconsult & PriceWaterhouseCoopers, 2008) evaluates the public building stock owned by the municipalities and counties in Norway. The building stock being analysed represents values of about NOK500 billion (about €60 billion). Through surveys the technical condition of the building stock has been mapped. The survey shows that the technical condition of the building stock can be divided in three. One third of the buildings are in rather good condition, one third needs some technical upgrading and the last third is in so bad condition that it has a large need for technical upgrading.

The need for technical upgrading is great, but depends on the level of ambition. For a high level of ambition (alternative A: good or acceptable condition) the cost for the next 10 years will be NOK142 billion (€17 billion) (4,400 NOK/m<sup>2</sup> or 530 EUR/m<sup>2</sup>). For some lower level of ambition (alternative B: condition without serious defects) the cost is estimated to NOK94 billion (€11 billion) (2,900 NOK/ m<sup>2</sup> or 350 EUR/m<sup>2</sup>). Regardless alternative A or B, NOK60 billion (€7.2 billion) is needed as an initial cost.

In addition there are 1,620 churches, which with their service buildings cover approximately 1 million m<sup>2</sup>. The churches have an estimated cost of clearing the backlog of NOK13 billion (€1.7 billion).

To meet these challenges the municipalities need to develop strategies for their buildings where maintenance has high priority. According to the report State of the Nation (RIF – Association of Consulting Engineers, 2010), buildings owned by the municipalities represent a value of NOK900 billion (€110 billion) and 32 million m<sup>2</sup>. The buildings have an average condition-level of 1.3 (where 0 is best, and 3 is worst). Upgrading the building stock owned by the municipalities to a good level is estimated to cost NOK150 billion (€19 billion).

The buildings for health care (hospitals etc.) in Norway represent a value of NOK170 billion (€21 billion). The buildings have an average condition-level of 1.2. Upgrading to an acceptable level is estimated to NOK25 billion (€3 billion).

The Government has stated that approximately 80 % of the total building stock of today will still be in use in 2050 (Ministry of local government and regional development, 2009), but they shall undergo refurbishment to meet new requirements regarding energy, environmental and space efficiency. The challenge will be to identify the most suitable properties and focus the maintenance, investment and development efforts on the selected properties. For the less suitable buildings and those with general poor condition it is recommended to seek to replace them with new buildings or alternative locations.

## Most common renovation actions and results

The most common renovation actions depend on the building type. For residential buildings insulation, painting, replacement of cladding and especially indoor upgrading are the most common actions. For larger buildings (office buildings etc.) replacement and upgrading of technical equipment (ventilation systems etc.) is more common.

## Sustainable procurement of maintenance and refurbishment

### Sustainable procurement

In Norway there are different tools for how to build in a sustainable way, but these are mainly guidelines. At present, "green procurement text" is being developed for public purchase in the building sector. In addition, the technical requirements state the following: "All the phases of a building project should minimize the impact of resources and environment". There are also specific demands for energy use and regulations for the use and treatment of hazards. Also, the BREEAM classification system is now implemented. The Norwegian Green Building Council has decided to develop a Norwegian version of the BREEAM system, and parts of the construction and property market are now preparing for a BREEAM "revolution".

### Ownership and management of facilities

The building owner takes the final decisions regarding refurbishment of a building, usually based on advices from architects and consultants. The decisions are often based on a technical survey of the buildings (Norwegian Standard, 1995), which usually includes technical condition, payback time and sometimes life cycle costs.

### Financing of refurbishment and incentives

The owner is financing the refurbishment of a building, but there are some public funding programs, i.e. for low energy projects. If renting a building the owner takes care of the outside work and the lease holder of inside work.

### Methods and methodology, decision making tools for maintenance

The Norwegian Standard NS 3424 (Norwegian Standard, 1995) describes a methodology for a survey of a building. The standard shows how to estimate the needs for upgrading and maintenance. Thereafter, a cost estimate is made by using key numbers for similar work.

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## Appendix 3: State-of-the-art Iceland

By Björn Marteinsson, Innovation Center Iceland & University of Iceland

### Population

The population of Iceland counts by 1 January 2012 a total of 318,452 inhabitants (Hagstofan, 2012). The number of inhabitants has been steadily increasing during the last decades with some exceptions at times of great plagues and also emigration in later half of the 18<sup>th</sup> century (Figure 45).

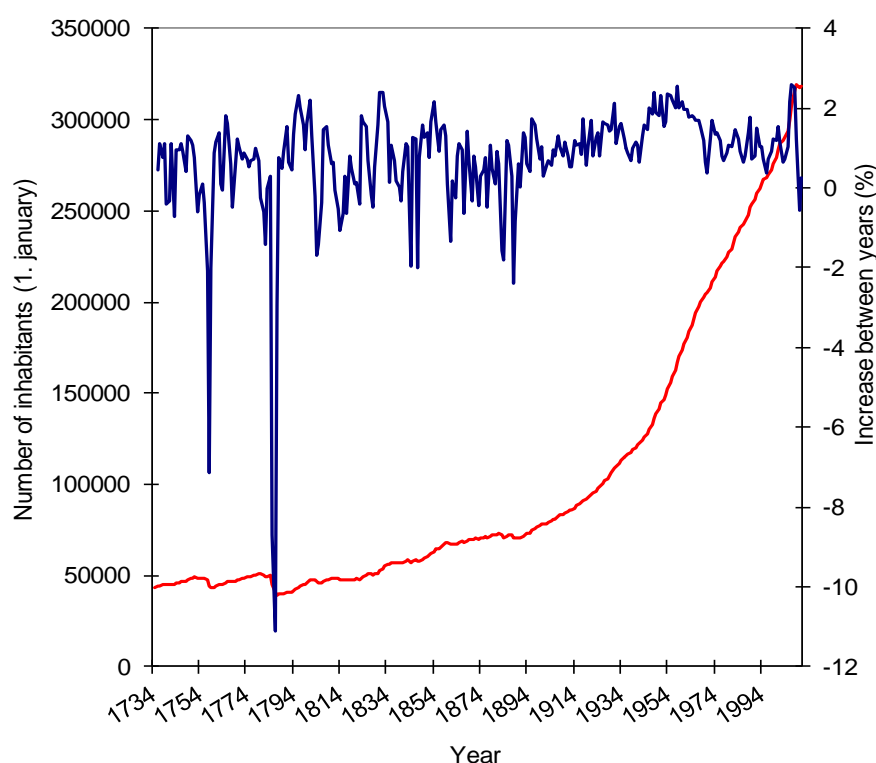


Figure 45. Population in Iceland 1735-2005 and yearly increase. Adapted after: (Hagstofan, 2012a).

Around the middle of the 20<sup>th</sup> century the average increase in population was about 2 % (called the baby boom), but is now down to 1 % (see Figure 45 and Figure 46), if the period 2005-2008 with unusually high immigration due to very good opportunities on the labour market is excluded. In 2008, the number of births per woman was 2.14 and the total number of births (living children) 4,835 or 15.1 children per 1,000 inhabitants. Life expectancy at birth is then 79.6 years for men and 83.0 years for women. The number of immigrants account to 7.6 % of the population (Hagstofan, 2011).

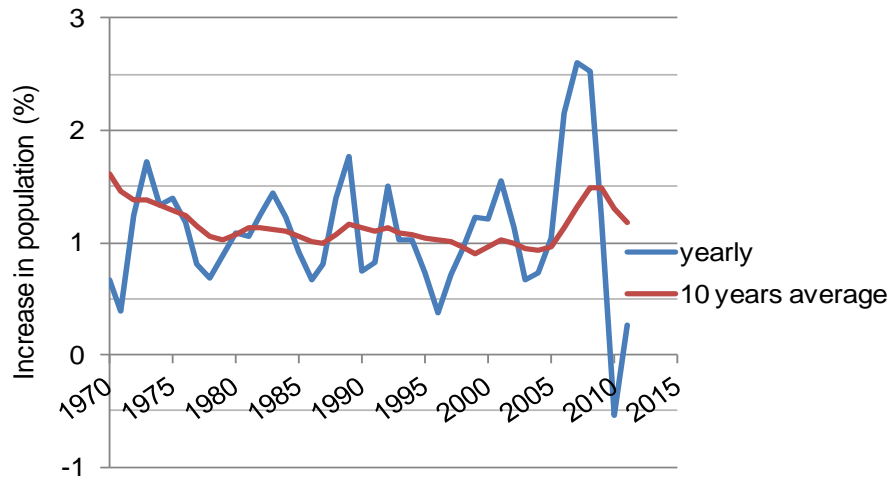


Figure 46. Yearly increase in population 1970-2008. Adapted after: (Hagstofan, 2012a).

The annual increase in population in the near future is estimated to be similar to the last decades or slightly lower than 1 % per year (Orkuspárnefnd, 2008). Age distribution of the Icelandic population is now changing rather fast from a domination of children and young people to middle aged groups becoming more dominant (see Figure 47).

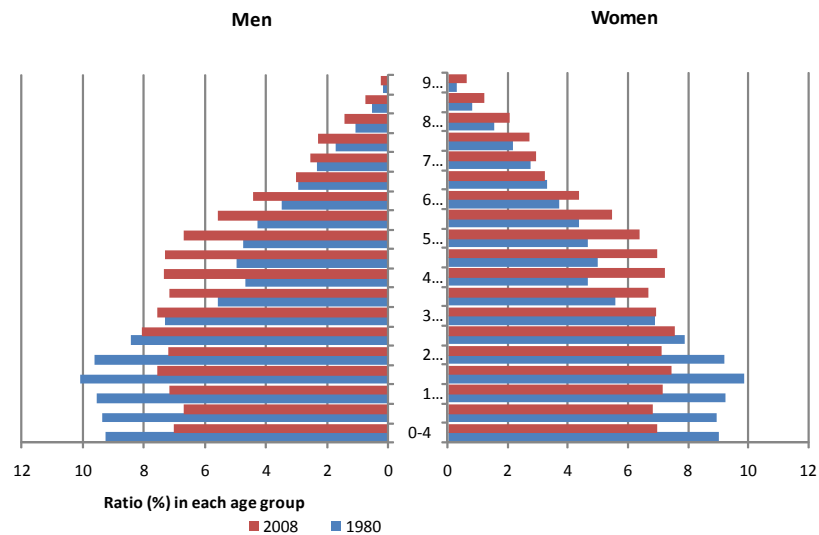


Figure 47. Age distribution of the Icelandic population (% in each age group) in years 1980 and 2008. Adapted after: (Hagstofan, 2012a).

Clearly a relative increase in elderly people is to be seen, and the increase of this age group will be dominating in the future (Table 7).

Table 7. Population in different age groups year 2008 and expected increase (in %) at different times.

Age group (years)	Population 2008 (persons)	Increase in population group (%)		
		2020	2030	2050
0-14	65,801	3.4	5.1	6.5
15-64	211,168	3.8	7.3	15.6
64-	36,407	45.3	99.6	159.8

Note: Adapted after: (Hagstofan, 2012a).

The changing age distribution will affect the needs of living for the elderly or disabled persons; especially better access for elderly and disabled persons to buildings and inside them, but how this will be solved has not been discussed in public at least.

Population in municipalities outside the capital area has been decreasing in number for some years. There have been some public debate of whether this is a trend that cannot be turned around but a scenario for the future has not been published.

The average family now consists of 2.37 persons and has been decreasing during the years. At the same time, the number of single family households is increasing.

### Building stock: Value, age distribution, amount and ownership

The population has been increasing fast since around 1950 and the building stock also (Figure 48). There are three main reasons for the latter statement: (i) natural increase in population, (ii) the existing buildings where many of them are built of poor materials and very small, and so needed to be rebuilt, and (iii) people moving from rural to urban areas, mainly the capital area and the corresponding need for housing. During this time period the need for space has increased dramatically along with the need for public service. Thus, the building stock has increased fast.

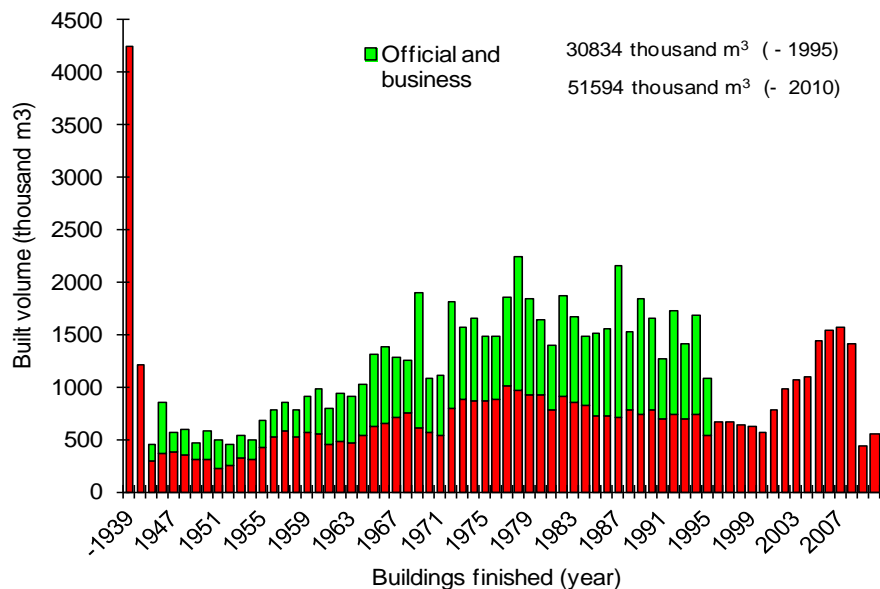


Figure 48. Built volume of buildings each year. Adapted after: (Hagstofan, 2012b).

The gross fixed capital of the nation in 2009 totals ISK5,870 billion (Figure 49) and has been fast increasing over the past years (Hagstofan, 2012). It is difficult to decide accurately the share of construction, but it is probably somewhat higher than 60 %. Public works amount to 19 % of the fixed assets, dwellings 39 % and privately owned companies 42 %.

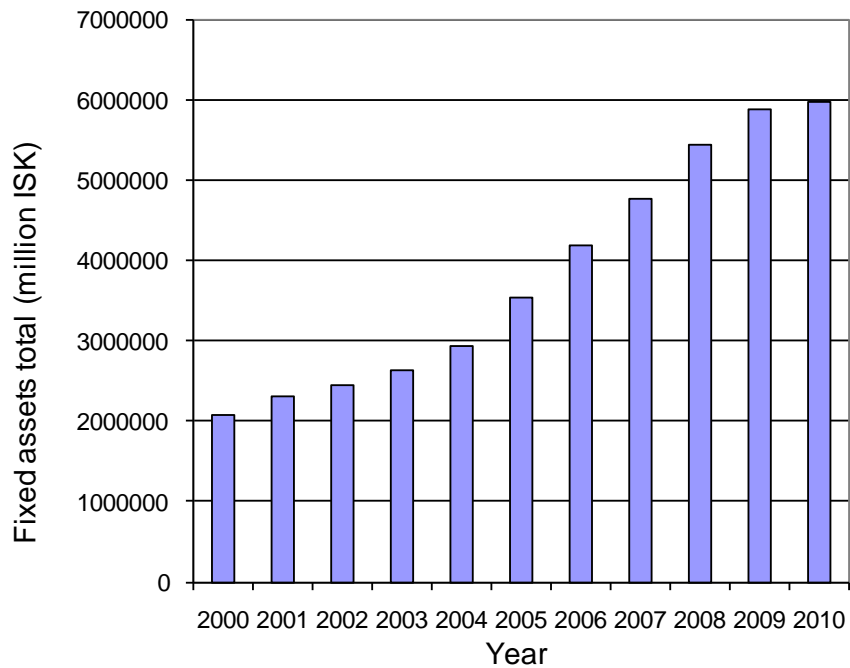


Figure 49. Gross fixed capital, monetary value of each year in million ISK. Adapted after: (Hagstofan, 2012c).

The gross fixed capital formation each year was far above average in the period 2004-2008 (a building boom), but generally the building industry accounts for 65-70 % (see fig Figure 50).

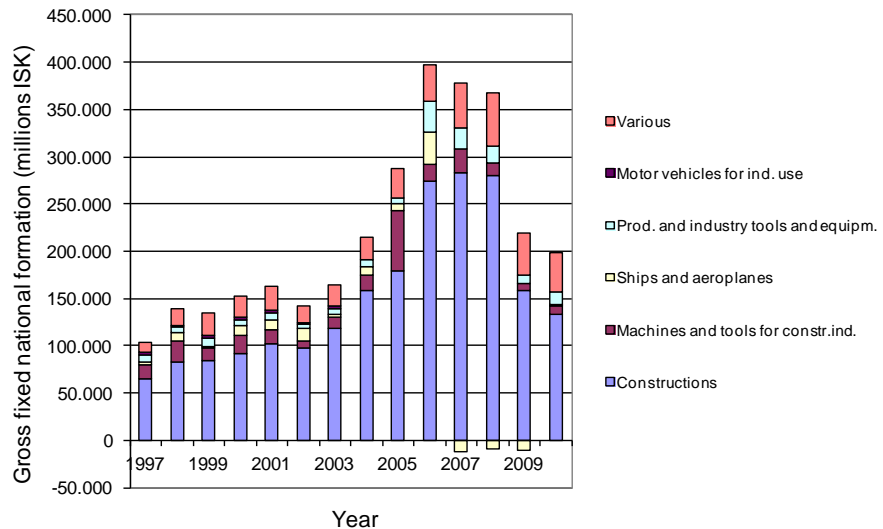


Figure 50. Gross fixed capital formation 1997-2010; monetary value of each year in million ISK. Adapted after: (Hagstofan, 2012c).

Dwellings in total have often been about half of the built volume each year, at least until 1994 (Figure 48). From 1994, the total volume built of public and business buildings has not been published, but the age distribution of public and business buildings can be expected to be similar to that of dwellings (Figure 51). Owner occupied dwellings are 76.9 % and rented dwellings 23.1 %.

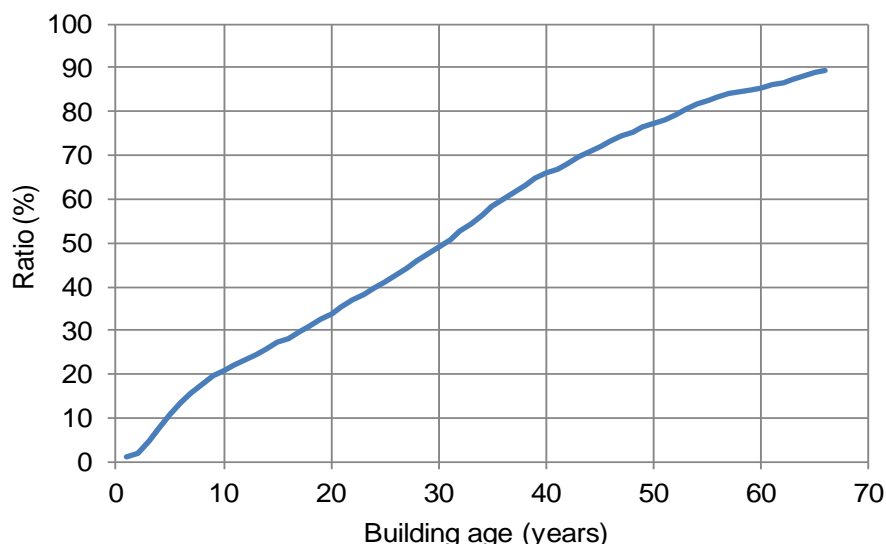


Figure 51. Cumulative age distribution of dwellings in Iceland. Adapted after: (Hagstofan, 2012d).

At the end of year 2010, the government owned a total amount of 1,300 buildings with a gross floor area of 1,002,147 m<sup>2</sup> at an estimated value (currency 2011-10) of €675.8 million (Fasteignir ríkissjóðs, 2012). The government owned building stock is thus about 3.15 m<sup>2</sup> per inhabitant. The total amount of buildings owned by the municipalities has not been published, even though all buildings in Iceland are registered in a national database at “Fasteignaská Íslands”. The amount of buildings owned by Reykjavik municipality categorized by building type is shown in Table 8. The diversity of the municipal buildings is wide, but school buildings and sports facilities are dominating (57.9 % of total). The municipal buildings amount to about 4.5 m<sup>2</sup> per inhabitant in the city, social housing not included. This figure may be an indicator for the amount of public buildings in other municipalities but due to the very various sizes of municipalities – some are very small – this is far from certain.

Table 8. Public buildings owned by Reykjavik Municipality in 2010.

Type of building	Gross floor area (m <sup>2</sup> )	Ratio of total (%)
District service stations	4,505	0.96
Community centres	14,668	3.14
Store rooms	3,054	0.65
Green houses	3,287	0.70
Nursing homes	10,690	2.29
Sport facilities	65,655	14.04
Theatre	12,607	2.70
Nursery schools and day care	45,714	9.78
Schools	205,207	43.89
Offices	18,008	3.85
Museums	19,168	4.10
Studies	5,420	1.16
Institutional homes	5,026	1.07
Others	54,581	11.67
<b>Total</b>	<b>467,590</b>	<b>100.00</b>

Source: Adapted after (Reykjavik Municipality, 2011).

The size of dwellings has been increasing steadily in the past decades (Figure 52). In 2008 the average gross floor area in Reykjavik was 66.7 m<sup>2</sup>/person. The size of households is diminishing; the average family size (two or more persons living together) is now (year 2010) 2.37 persons in

Reykjavik and a little higher outside the capital area, but at the same time the number of households with single persons is increasing.

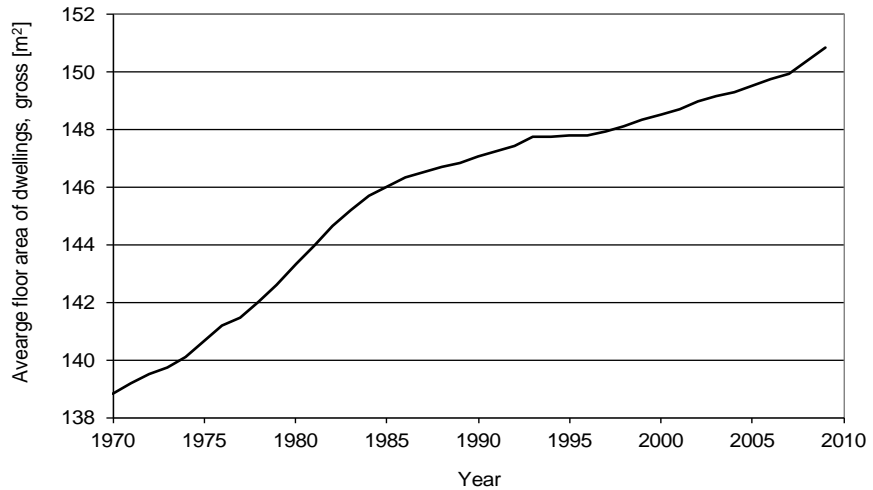


Figure 52. Average gross floor area of dwellings in Reykjavik. Adapted after: (Fasteignaskrá Íslands, 2010).

The apartments are generally large (Figure 53), and the number of small apartments is low. People are now growing more aware of the cost of living, and this may result in increased demand for smaller apartments.

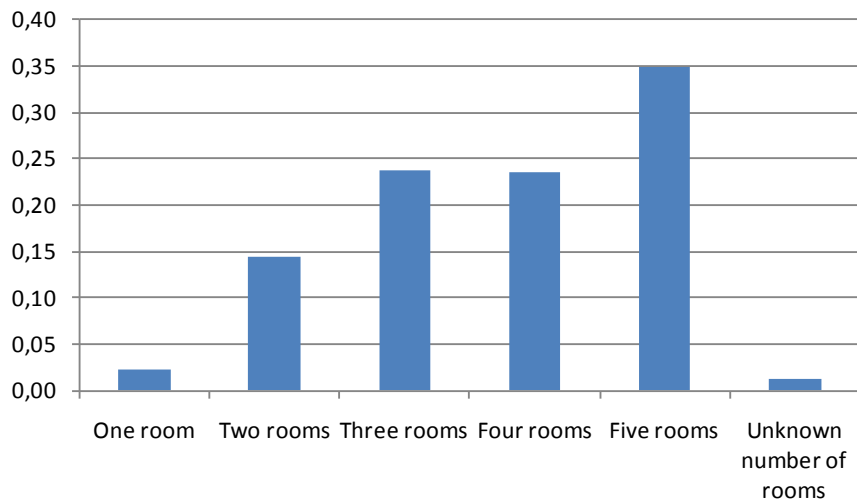


Figure 53. Relative number of apartments with different number of living rooms, kitchen and bathrooms come in addition, year 2009. Adapted after: (Hagstofan, 2012d).

At the end of year 2009, the number of finished or almost finished dwellings totalled 130,019 (Fasteignaskrá Íslands, 2010). The estimated average need for new dwellings per year is 1,800 (of these 1,500 are in the capital area) amounting to 5.66 dwellings per thousand inhabitants and a yearly increase of dwellings by approximately 1.4 %. The necessary yearly amount of new dwellings is expected to decrease in the future and amount to about 1,500 in year 2030, when the total amount of living units is estimated to be about 165,000 (Figure 54).

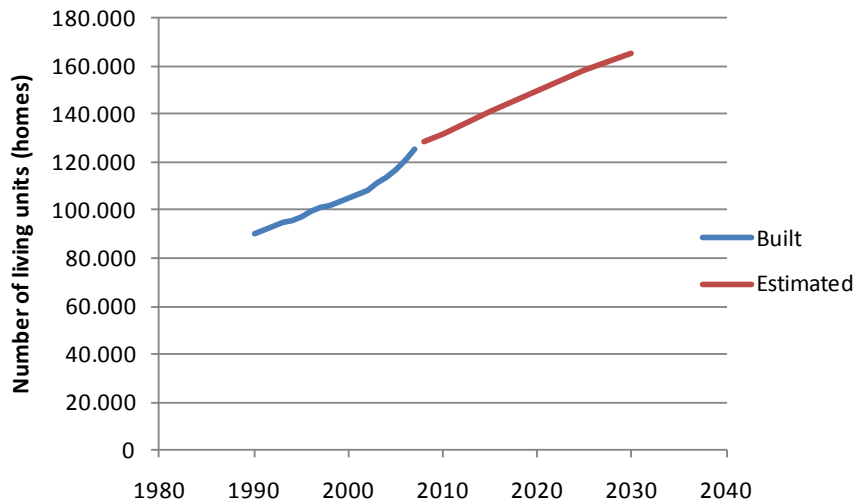


Figure 54. Existing dwellings and estimated need for new dwellings. Adapted after: (Orkuspárnefnd, 2008: 12.1).

Of the total number of dwellings only about 3,300 are owned by public companies or associations in 2009.

There are no studies found concerning assessment of future changes in living/dwelling needs for fully active people, except that the average living space in homes per capita is expected to increase slowly in near future (Orkuspárnefnd, 2008). In the near future it would be efficient to increase the relative number of smaller dwellings that can fulfil the needs of small families, disabled people and elderly. The result may be that existing larger dwellings will be more readily available for young families with children. It is not clear how changes in age distribution of the population may affect needs for public buildings. Growth in population will naturally put demand on increased amount of public buildings. This may be as much as 8-9 m<sup>2</sup> per inhabitant.

## Impact of building stock on environment

### Energy production and energy use

In Iceland geothermal energy and electricity produced in hydropower stations are plentiful. Heating and lighting of buildings is entirely done with sustainable energy: 90 % geothermal and 10 % hydropower. Large quantities of building materials and products are imported: the only domestic materials are rock materials, cement and stone wool. The main impact of buildings and the building sector on the environment is due to production of cement, electricity is used in the production of stone wool and generally transport of goods. It is not seen as important to increase insulation standard of existing buildings, except when this is necessary due to health and wellbeing. Higher standard for new buildings is though aimed for (a new building regulation is due).

The main reasons for CO<sub>2</sub> emissions to air in Iceland are road transport and fishing vessels (Figure 55). The third highest is industry and construction, where emissions in particular come from three large aluminium factories and one silica factory along with the only cement factory in the country, which produces about 50 % of the cement being used.



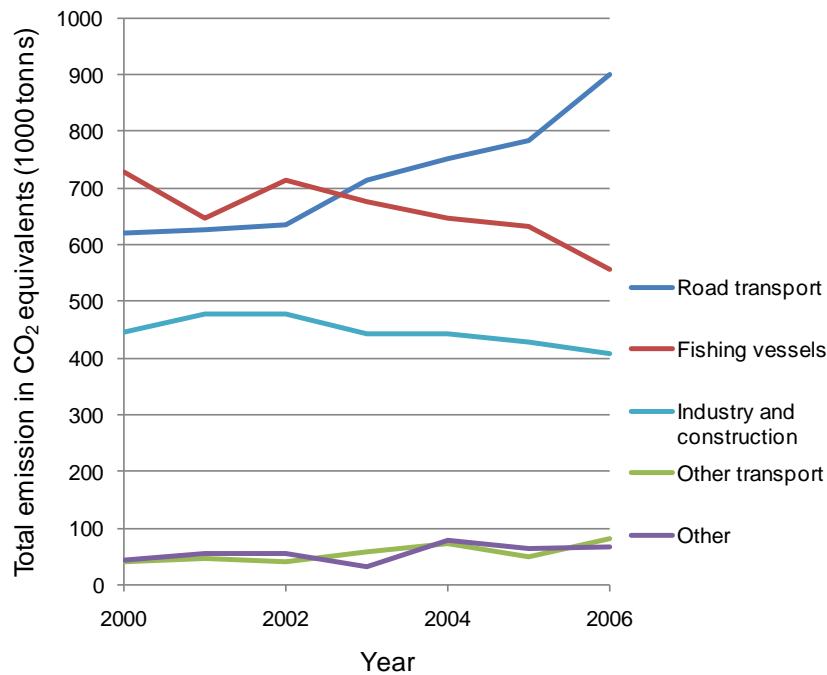


Figure 55. Emissions of CO<sub>2</sub> equivalents from different sources in Iceland in years 2000-2006. Adapted after: (Hagstofan, 2008: 33).

Energy from geothermal district heating is most often sold plainly as hot water (most often 80 °C) and the unit is cubic meter (m<sup>3</sup>). It is therefore far from easy to give the energy demand for heating in energy terms; the actual energy used depends on efficiency in the heating system (panel size and insulation of pipes) and temperature drop in the heating system. The district heating system is usually open ended (the water is not returned to the power station) as either hot groundwater is plentiful or else enough cold water exists that can be heated at the power station for the district heating system. Typical hot water demand from district heating is 1-1.5 m<sup>3</sup> hot water pr. m<sup>3</sup> of heated space, including hot tap water, depending on technical standard, type of use and size of building (the ratio: building envelope vs. heated volume).

### Health and indoor environment

Until recently indoor air problems were not discussed, and air quality was generally deemed to be good. Problems with dwellings in moist cellars have been known, but in buildings built since the 1950s the indoor materials used are to some part non-organic (concrete and cement plaster) even though acrylic paints are used to a great deal. The indoor spaces are frequently heated with cheap geothermal energy and ventilated with natural ventilation; this resulting in an often high ventilation rate and rather dry indoor air during winters in Icelandic buildings.

A study of six school buildings in Reykjavik (Þorsteinsson, 1996) showed that the users (teachers and students) most frequently complained of tiredness, headache, concentration problems and running noses.

Problems with indoor air quality are though now well known in Iceland, but the frequency or seriousness has only been mapped to a small extent. The main problems seem to be connected with mould, and these problems are getting more weight in public discussion.

### Material use

The largest share of buildings in Iceland is by far made of concrete, poured in situ. Roofs are usually made of wood, clad with corrugated, galvanized

steel. The building tradition is very material consuming; heavy buildings built on a gravel filling. For a multifamily house it has been calculated that the total amount of materials used is 3.4 ton/m<sup>2</sup> gross floor area (Marteinsson, 2002).

Materials produced domestically are gravel and stone materials needed for concrete, road pavements and as filling materials for roads and buildings, stone wool and about half of the market share of cement. Other materials and components are imported from all over the world, but nearly 80 % of the total mass is imported from the countries around the Baltic Sea (the largest share is wood, steel and cement).

### Waste handling

The published waste amount and handling is shown in Table 9. The amount shown for the building sector does not include excavated materials (soils and rocks) and amounts in 2008 to 70.2 kg waste per person and year, unusually low compared to year 2005 during the building boom but also much lower a fraction of total waste of 2,300.8 kg than the often mentioned 40 % reference figure.

Table 9. Waste amount and handling (kg waste per person and year). Adapted after: (Hagstofan, 2012e).

	1995	2000	2005	2008
Waste total	1,460.0	1,562.7	1,746.8	2,300.8
Municipal waste total	425.7	459.6	527.7	504.2
Mixed non-household waste	918.6	965.2	1,035.4	1,586.0
- Hereof separated construction waste	-	-	116.9	70.2
Other waste total	115.8	137.9	183.7	217.0
Recycled waste total	54	87	170	457

## Construction sector and the market

### How well does the building stock fulfil market needs

The total amount of buildings in Reykjavik in 2010 was 17,439,345 m<sup>2</sup>. Of these, municipal buildings alone accounted for 467,590 m<sup>2</sup> (social housing is not included as these are kept in a public limited company) or about 4.52 m<sup>2</sup> per inhabitant in Reykjavik. With increased number of inhabitants the amount of public buildings in the capital area may be expected to increase with this ratio. In the rural areas of Iceland the municipalities are many and often small, and the population reducing in number each year (so far at least). Work is on-going to unify municipalities to get larger and stronger units, but it is not clear what this will result in regarding demands for public buildings in the future.

The building stock is rather new. Figure 51 shows the cumulative distribution for dwellings, but other types of buildings have similar age distribution. Average age is about 30 years and 22 % of the stock is older than 50 years. Since maintenance is so far rather limited and buildings are seldom demolished, the increase of the building stock is mainly due to natural increase in number of inhabitants (about 1 % per year). The situation in the future may be assessed based on the existing building stock, earlier mentioned yearly average increase of the nation (1 %) and a yearly obsolescence ratio of buildings as 0.25 (a quick study of existing data points to this figure, but it will increase as time goes by). For year 2050 it may be estimated that about 90 % buildings already built now will still exist and then form about 67 % of

the total building stock<sup>1</sup>. It is evident that already existing buildings will affect the future quality of the built environment and impact on environment very much, but buildings still to be built will also have great impact and it is important to choose building type and size carefully so as to maximize their value for the future (Marteinsson, 2011).

### Information available on the market

Yearly the associations of master craftsmen and craftsmen initiate and support refreshing courses in various subjects. In later years courses in maintenance and refurbishment of buildings have been of special interest to their members.

A working group with members from Reykjavik Municipality, the Government Construction Contracting Agency FSR ("*Framkvæmdasýsla ríkisins*"), government facility management ("*Fasteignir ríkisins*") and Innovation Center Iceland are working on a public LCC model and database with key figures, which will be available to the general market.

Sustainability in the building sector is gaining more interest and the Icelandic Green Building Council and the Government Construction Contracting Agency are important initiators of sustainability discussions on the construction market.

Innovation Center Iceland publishes guidelines for some maintenance and refurbishment actions and reports that discuss different building components, but the publication list does not give an exhaustive description of all building parts.

## Maintenance and refurbishment of facilities

### Refurbishment and maintenance needs

Buildings in Iceland are usually made of concrete, as cement and ballast material for concrete are rare examples of domestic building materials. The ballast materials in Iceland are almost entirely made of very porous basalt, and Icelandic concrete is therefore highly water absorbent. Outer walls of buildings are usually made of concrete, and until around 1995 these walls were usually insulated on the inside, putting the concrete in a difficult environment as the climate is wet and windy with high number of freeze-thaw cycles. Concrete in outdoor environment usually needs some kind of surface treatment e.g. painting. The concrete produced in the period 1960-1980 was highly alkali-silica reactive and sooner or later needed to be insulated on the outside and cladded to ensure acceptable service life. These actions are now mostly finished.

Roofs in Iceland are typically made of wood and cladded with corrugated, galvanised steel and ventilated. The roofing material was earlier painted in situ to prolong the service life, but now factory coatings are getting more frequent. The experience of these roofs is rather good so long as the form is not too complicated, the ventilation channels not too long and the inclination of outer surface is appropriate to minimize risk for leakage. The service life of corrugated steel roof cladding in Reykjavik is typically about 40-45 years (on average), but moisture damages are frequent and rot in wood sometimes makes a total renovation of the roof needed.

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<sup>1</sup> If gross floor area per person diminishes (as it probably will) then this number will be higher.

Windows made of wood are most numerous on the market and the service life typically about 40 years (on average). Sewage pipes are shown to have a service life of 30-50 years. Still the average age of buildings in Iceland is less than 30 years and so in general maintenance actions are mostly painting of surfaces and some minor replacement of materials, but the rather large volume of buildings built in 1960-90 is starting to be noticeable in maintenance.

Owners of facilities often use the method of surveys to evaluate the technical condition of their buildings, but an overview of the condition of public buildings has never been published in Iceland. In general it may be questioned how well the condition of public (as well as private) buildings is known, and there is no knowledge of general maintenance plans for the building stock of public buildings.

It is clear that a great deal of already existing buildings will be in use for decades to be, and to maximize their value for the future a regular maintenance will be necessary to ensure that the buildings are fit for the intended use.

It is generally accepted that average annual total maintenance cost of dwellings is at least 1-2 % of the building cost, the building cost now (year 2010) is often 250-300,000 ISK/m<sup>2</sup> (1,500-1,800 €/m<sup>2</sup>). As it is not required that the cost for maintenance shall be kept separated from other cost items for the buildings, it is extremely difficult to evaluate the actual cost of maintenance for public buildings. Reykjavik municipality and the Government Construction Contracting Agency FSR together with Innovation Center of Iceland are now working in cooperation to change this and get an agreement for using the same bookkeeping rules for public buildings to make comparison easier.

In the period 2002-08 there was a huge building boom in Iceland for new buildings. During this period there was a great shortage of labour force on the market and (temporary) immigrants from e.g. Poland were common. This also resulted in that prices for works in the building sector were high and that it was very difficult to get work done in the maintenance market. There are no figures regarding the amount of maintenance work as a ratio of construction work in general. Furthermore it is known (Jónsson & Marteinson, 1999) that owners of detached and semidetached houses do much of the maintenance work themselves, and then neither the cost for material nor workmanship is accounted for in official statistics.

It is not required of municipalities that they make separate registration of maintenance costs, nor to conduct regular inspection of technical conditions of their buildings. Condition of public buildings in general has not been assessed, and it is therefore not known if condition is good or if backlog in maintenance exists. In a case study from 2005-06 it is shown that there is a backlog of maintenance needs for dwellings. For instance it is estimated that 25 % of concrete walls are in need of more maintenance than has been customary the last decade or so (both maintenance of concrete surfaces and painting of these surfaces). The quality of dwellings is considered by the owners/dwellers as satisfactory regardless of age of the buildings (Marteinson, 2008).

The government has recently decided to put in extra financing for maintenance of public buildings. This is done now as a help for the labour market. Owners on the private market get repaid the VAT (value added tax) of work in connection with maintenance.

## Most common renovation actions and results

The biggest part of buildings that are in need for major renovation are built in the time period 1960-80 as the major renovation needs start at building age of about 30-35 year and during this period a lot of buildings were built in Iceland (Figure 49). The most frequent actions needed are rebuilding wooden roofs and maintenance of concrete surfaces, changes in electricity systems and replacement of interior, wooden windows, heating systems, tap water and sewage systems.

A few large maintenance works in social housing in Reykjavik have shown that the maintenance and refurbishment cost can be as high as 50 % of building cost for a similar building. The tenants are on the other hand very pleased with the results and happy when they are able to move back to their "old" environment.

## Sustainable procurement of maintenance and refurbishment

### Sustainable procurement

The government and the municipalities have agreed to aim for sustainable procurement, but the recommendations so far are limited to chemical substances and inventories of buildings. The Nordic eco-label "Svanen" directives are explicitly mentioned as a recommendation. The building regulation does not define sustainability as such, but includes e.g. detailed requirements on allowed energy consumption. Sustainability is included in the town plan for Reykjavik municipality, but then more as declaration of intent rather than specific standards or guidelines.

For new public buildings the Government Construction Contracting Agency FSR ("*Framkvæmdasýsla ríkisins*") requires that design is based on either LEED or BREEAM rating systems (in three instances formal assessment has been required), but Reykjavik municipality does not intend to demand a formal environmental certification of their buildings. Icelandic Green Building Council ("*Vistbyggðarráð*") has been established in Iceland and they are interested in promoting the BREEAM certification system or similar Nordic system if such will be established.

In Iceland 90 % of all energy for space heating is geothermal energy and all electricity is produced in hydropower stations. Buildings that do not have access to geothermal energy use electricity for heating. Far less than 1 % of buildings use other kinds of energy for heating. It can therefore be stated that all energy used in buildings for heating or electricity for lighting and appliances is environmentally friendly and sustainable, and the energy price is low compared to other European countries. Due to the special energy situation in Iceland requirements on energy use in buildings are not as strict as the environment alone could give reason to and the feasibility of refurbishment for increased energy efficiency is rather small.

Planning of sustainable procurement in refurbishment therefore aims mainly at sustainable materials and better accessibility of buildings, rather than increased energy efficiency.

### Ownership and management of facilities

Ownership of buildings for public use in Iceland is according to one of the three following models:

- Fully owned by government or municipality, which is by far the most usual form.

- Public-private partnership (PPP), examples of this ownership form are known for both government and municipality. To be a true form of PPP a certain service agreement must be included in the contract. The contract time is always long term, usually 25 or 30 years.
- The public leases a building on a (short or long term) leasing contract.

The responsibility for maintenance and refurbishment cost therefore varies according to ownership model:

- In the case of a building fully owned by a public body (government or municipality), the owner takes full responsibility for the building and has alone the full right to make decisions regarding maintenance and refurbishment.
- In a PPP consortium the private partner usually takes care of all exterior maintenance as well as the building structure, but the public partner takes care of indoor maintenance. This form of ownership is used for the new concert hall “*Harpa*” in Reykjavík and is now discussed for a new building for the national university hospital in Reykjavík.
- In case of a traditional leasing contract the maintenance decisions are as in a PPP contract described above.

For public buildings it is the aim that the institute or firm using the facility has to pay a rent, but this model is for now far from being the general case.

Decisions on maintenance actions are usually based on a condition survey of the building, either done by a technical division of the owner or private consultants, but in some cases the user asks for funding for some maintenance he sees as needed. Reykjavik municipality regularly makes a maintenance plan some years ahead (usually 5 years) for their buildings so as to better foresee needs for funding, but this is not the general case for other actors in public buildings. Maintenance plans are usually based on a technical condition survey and including a cost estimate, but usually do not address questions such as adaptability, future value or LCC. In many municipalities though, as with most house owners in general, maintenance is more often done when needed and not according to a predefined maintenance plan.

### Financing of refurbishment and incentives

Funding for maintenance, when the public is responsible for the cost, is most often a part of the public budget. Increasingly the government owned property is handed over to a facility management office that decides on maintenance in cooperation with the user.

Social housing companies may ask for funding from the government owned Housing Financing Fund (“*Íbúðalánasjóður*”) so long as they can pay back the loans by regular income.

Private owners, as in PPP, look for the necessary capital on the private market but they may also ask the Housing Financing Fund for loans for refurbishment of dwellings.

### Methods and methodology, decision making tools for maintenance

There are no standards or guidelines in Icelandic regarding maintenance planning of buildings, but some guidelines for maintenance of some building parts and materials are published by the Innovation Center of Iceland (“*Nýsköpunarmiðstöð Íslands*”). The methodology is therefore somewhat different depending on the house owner and consultants. The description of measures needed is done, often without discussion of different scenarios or of what is actually gained, and a cost estimate is always required.

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# Appendix 4: State-of-the-art Finland

By Pekka Huovila & Jyri Nieminen, *VTT Technical Research Centre of Finland*

## Population

The population of Finland is 5.4 million people (Statistics Finland, 2010). The age distribution shows that the proportion of people 40-60 years old is high and the proportion of people over 60 years old is low (see Figure 56).

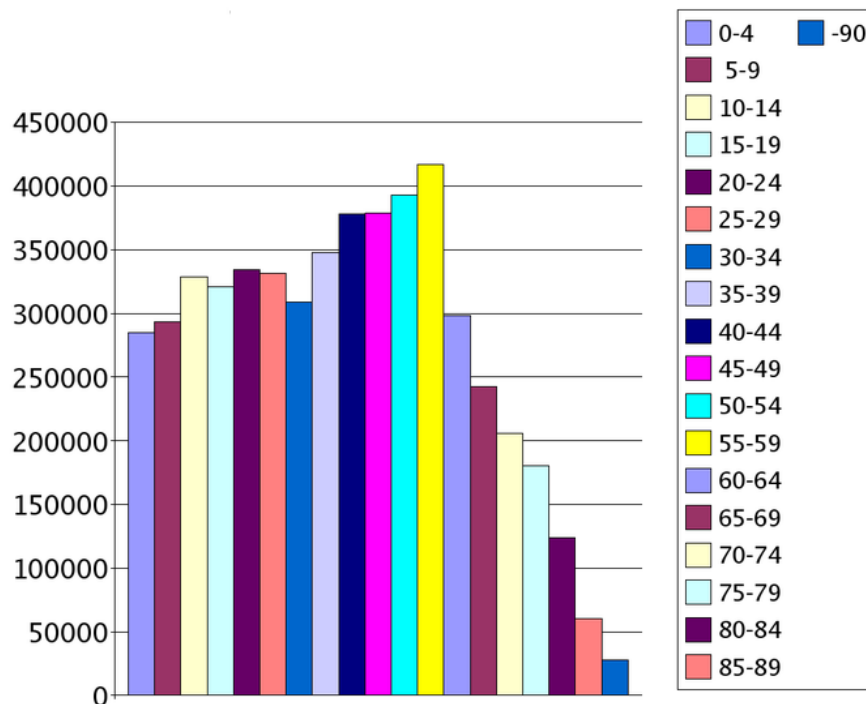


Figure 56. Age distribution of the Finnish population. Source: (Statistics Finland, 2006).

The proportion of old people (more than 65 years) will grow gradually from 18 % to 29 % between 2010 and 2060 as estimated by Statistics Finland (see Table 10). This demands special attention in refurbishment on e.g. accessibility (Ministry of the Environment, 2007). The fact that the population continues to grow implies also that construction of new buildings continues actively (Lehtinen et al, 2005).

Table 10. Population forecast 2010-2060.

	Unit	2010	2020	2030	2040	2050	2060
Population	1,000	5,378	5,636	5,850	5,985	6,090	6,213
0-14 years	%	16	17	16	15	16	15
15-64 years	%	66	60	58	58	57	56
>65 years	%	18	23	26	27	28	29

Source: (Statistics Finland, 2009).

## Building stock: Value, age distribution, amount and ownership

At the end of 2009 there were 1,434,000 buildings in Finland (excluding free-time residences and agricultural buildings). Most of the building stock, particularly residential buildings were built after the 1970s. The gross floor area of the building stock totalled about 429 million square meters. The average gross floor area of all buildings was about 299 square meters; in other than residential buildings the average gross floor area was about 747 square meters. Residential buildings accounted for 63 % of the total gross floor area. The proportion of completed new buildings is annually around 1 % of the whole building stock (Statistic Finland, 2010).

The number of residential buildings accounted for 85 % of the total building stock (see Table 11).

Table 11. The Finnish building stock by intended use on 31 December 2009.

	Buildings	Distribution (%)
BUILDINGS TOTAL	1,433,890	100.0
A. Residential buildings	1,224,209	85,4
Detached houses	1,092,363	76,2
Attached houses	75,618	5,3
Block of flats	56,228	3,9
C-N Other buildings	209,771	14,6
C. Commercial buildings	41,697	2,9
D. Office buildings	10,748	0,7
E. Traffic buildings	54,535	3,8
F. Institutional buildings	7,993	0,6
G. Buildings for assembly	13,432	0,9
H. Educational buildings	8,868	0,6
J. Industrial buildings	40,173	2,8
K. Warehouses	26,712	1,9
L, N. Other buildings	5,613	0,4

Source: (Statistics Finland, 2010).

Buildings constitute more than 50 % and the built environment in general almost 75 % of Finnish national wealth. The total value of the Finnish building stock was estimated in 2005 to be €285 billion of which more than 60 % was from housing (€170 billion). Since the renewal of the building stock is very slow, refurbishment activities are an essential way to improve the quality of the building stock (Nemry & Uihlein, 2008). The total value of the building stock is €320 billion (ROTI, 2009). About 34 % of the dwellings are rented.

According to Statistics Finland there were 2,517,000 household dwelling units in Finland at the end of 2009. The Finnish building stock is young. The age distribution of residential buildings is shown in Figure 57.

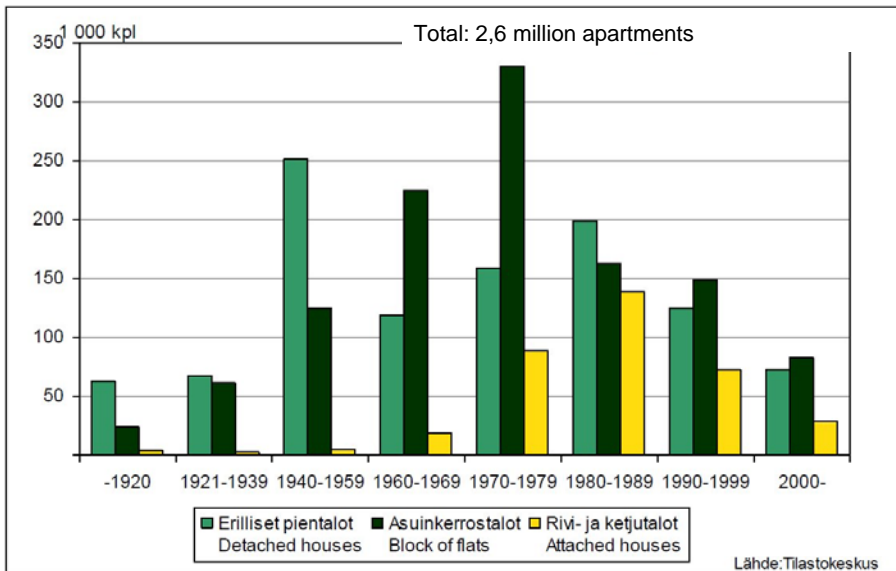


Figure 57. Number of dwellings (total 2,6 million dwellings) in Finnish housing stock according to the construction year. Source: (Rossilahti, 2009a).

The number grew by 18,000 from the previous year. Most of the growth was due to increases in the numbers of one and two-person household dwelling units. The number of one-person household dwelling units increased by 11,000 and of two-person household dwelling units by 8,000. By contrast, the number of larger household dwelling units with at least three members decreased (Figure 58).

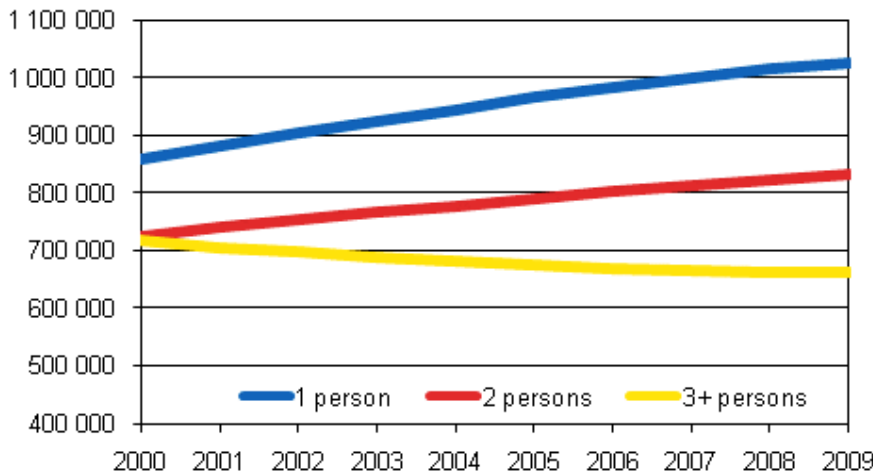


Figure 58. Size of the household dwelling unit. Source: (Statistics Finland, 2010).

Figure 59 presents the distribution of different building types according to gross floor area and number of apartments.

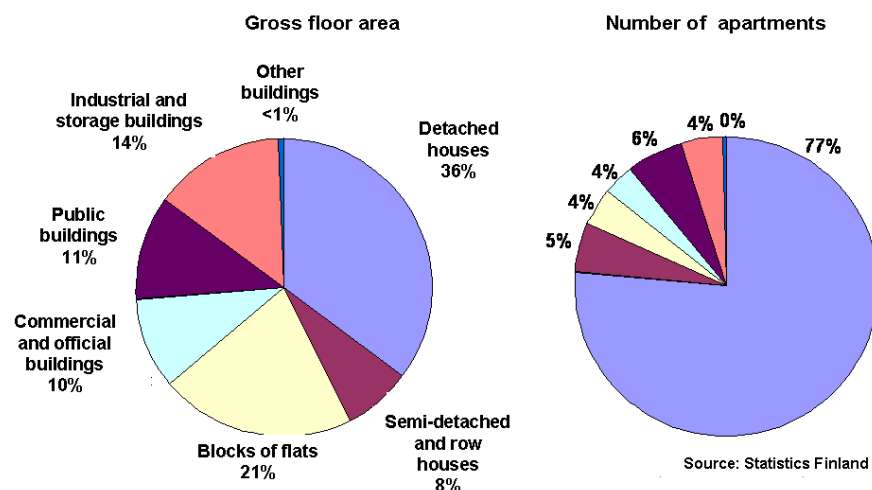


Figure 59. Share of different types of buildings according to total gross floor area (left) and number (right). Source: (Finnish Ministry of the Environment, 2007).

The average floor area per person is presently close to 40 m<sup>2</sup> (Table 12). Since 1970, the average area has more than doubled from about 19 m<sup>2</sup> to 39 m<sup>2</sup>.

Table 12. Floor area per dwelling by type of building 1970-2009, whole dwelling stock.

Year	Buildings in total	Detached houses	Attached houses	Blocks of flats	Other buildings	Floor area per person
1970	60.0	66.0	73.0	51.0	54.0	18.9
1980	69.3	83.6	71.7	54.8	55.5	26.3
1985	73.9	92.8	72.0	56.3	59.1	28.9
1988	73.8	93.8	70.8	55.8	60.3	30.5
1989	74.2	94.9	70.5	55.8	60.2	31.0
1990	74.4	95.3	70.2	55.8	59.7	31.4
1991	74.8	96.6	70.1	55.8	59.6	31.9
1992	74.8	97.1	70.1	55.8	59.6	32.3
1993	75.1	98.0	70.1	55.9	56.5	32.7
1994	75.3	98.7	70.1	55.9	56.5	33.0
1995	75.5	99.2	70.1	55.9	56.7	33.4
1996	75.7	99.7	70.2	56.0	59.0	33.7
1997	75.8	100.1	70.2	56.0	58.6	34.1
1998	76.0	100.6	70.3	56.0	59.0	34.5
1999	76.5	101.1	70.7	56.1	60.4	34.9
2000	76.5	101.9	70.0	56.1	59.8	35.3
2001	76.8	102.6	70.1	56.1	61.2	35.8
2002	77.0	103.5	70.2	56.2	59.9	36.3
2003	77.3	104.1	70.3	56.2	59.7	36.7
2004	77.6	104.9	70.4	56.2	59.6	37.2
2005	78.1	105.3	70.6	56.2	59.2	37.5
2006	78.4	106.5	70.7	56.3	60.4	38.0
2007	78.8	107.1	70.9	56.4	60.6	38.3
2008	79.1	107.8	71.0	56.4	60.8	38.6
2009	79.4	108.0	71.1	56.5	60.9	38.9

Source: (Statistics Finland, 2010).

Figure 60 presents building cost index in different European countries. Finland is located in the middle level.

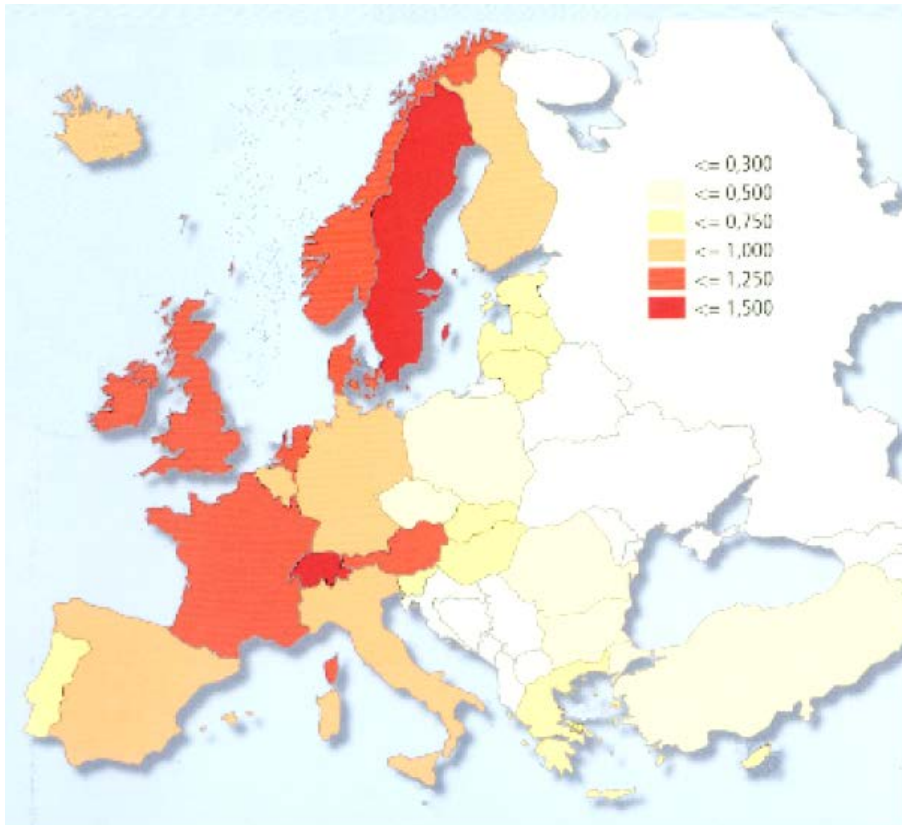


Figure 60. Building cost index in Europe in 2007. Costs without the cost of land. Source: (Nemry & Uihlein, 2008).

The level of housing production is high in Finland (6 dwellings/1,000 inhabitants), since the corresponding number is 3-4 dwellings in most West-European countries. Therefore it has been concluded that production should slow down in Finland, too. However, there are many reasons, which support active housing production also in the future (Lehtinen et al., 2005):

- Growth of population will continue during the coming decades.
- Finnish internal migration towards growth centres is active and seems to continue also in the future.
- The number of immigrants will increase.
- Population gets older and the number of elderly women living alone will increase.
- The number of unmarried persons will increase in other age groups.
- The number of young people living in their parents' house will decrease.
- Actual young age of the building stock implies decrease in housing units in the future when the building stock gets older.
- In the country side the proportion of vacant properties will increase when people continue to migrate to growth centres.
- More and more people own more than one dwelling.

## Impact of building stock on environment

### Energy production and energy use

Table 13 provides a comparison of the mix of energy consumption in Finland.

Table 13. Comparison of the mix of energy consumption in Finland.

	petajoule (PJ)									Annual change, %								
	2002	2003	2004	2005	2006	2007	2008	2009*		2002	2003	2004	2005	2006	2007	2008	2009*	
Oil	368	375	375	363	366	361	350	334	25	2	2	0	-3	1	-1	-3	-5	
Wood fuels	282	288	302	281	315	302	302	262	20	8	2	5	-7	12	-4	0	-13	
Nuclear energy	233	238	238	244	240	245	241	246	19	-2	2	0	2	-2	2	-2	2	
Coal	185	245	220	130	217	191	142	154	12	10	32	-10	-41	66	-12	-26	9	
Natural gas	153	169	163	149	159	147	151	135	10	-1	11	-4	-9	7	-7	2	-11	
Peat	90	99	89	69	94	102	81	70	5	4	11	-10	-23	36	9	-20	-15	
Hydro power	38	34	54	48	41	50	61	45	3	-18	-11	57	-10	-16	24	21	-26	
Wind power	0	0	0	1	1	1	1	1	0	-9	46	31	40	-9	23	38	6	
Other energy sources	20	23	25	27	28	31	39	41	3	6	12	10	10	3	10	25	5	
Net imports of electricity	43	17	18	61	41	45	46	44	3	20	-59	0	249	-33	10	2	-5	
<b>Total</b>	<b>1 412</b>	<b>1 489</b>	<b>1 483</b>	<b>1 374</b>	<b>1 501</b>	<b>1 477</b>	<b>1 414</b>	<b>1 331</b>	<b>100</b>	<b>3</b>	<b>5</b>	<b>0</b>	<b>-7</b>	<b>9</b>	<b>-2</b>	<b>-4</b>	<b>-6</b>	
Renewable energy sources 1), %	23.3	22.3	24.8	25.0	24.8	25.1	27.8	25.7										

Source: (Statistics Finland, 2010).

Figure 61 shows the energy production and related emissions.

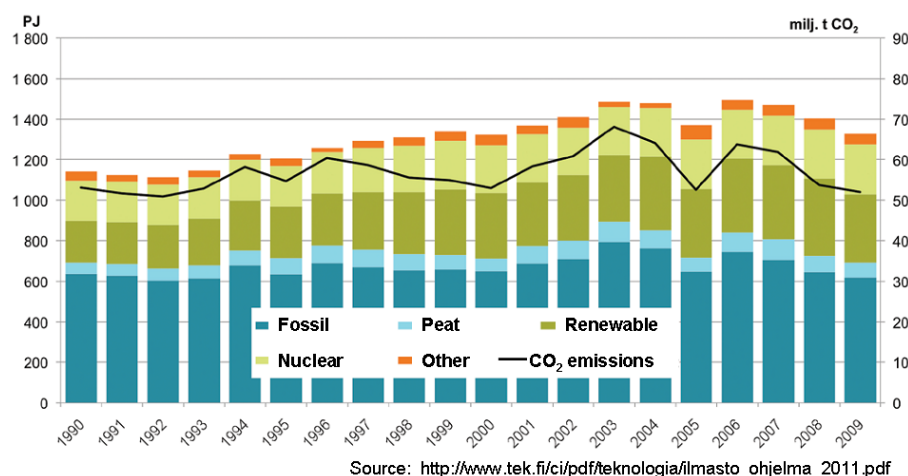


Figure 61. Energy production and related emissions.

The figures below show primary energy consumption and related emissions by sector by 2010:

- Energy consumption by sector (see Figure 62).
- Greenhouse gas emissions (see Figure 63).
- Greenhouse gas emission by Finnish building stock (see Figure 64).
- Greenhouse gas emissions by Finnish building stock distributed on energy source (see Figure 65).

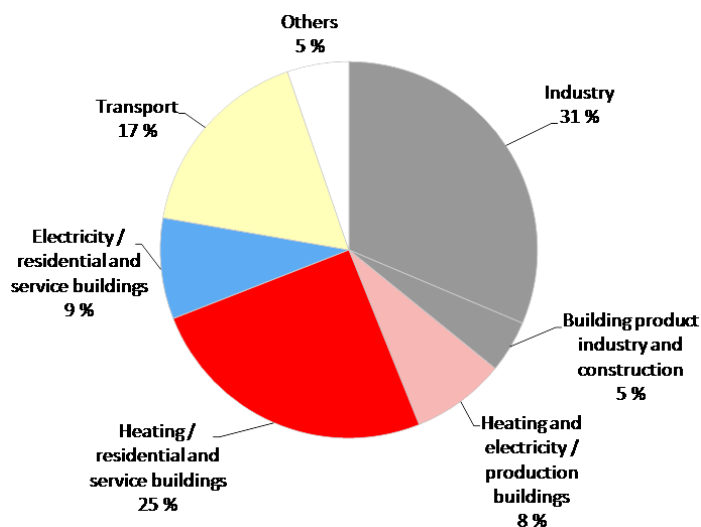


Figure 62. Energy consumption by sector in 2010, total 304 TWh. Source: (Statistics Finland/Energy Statistics and VTT).

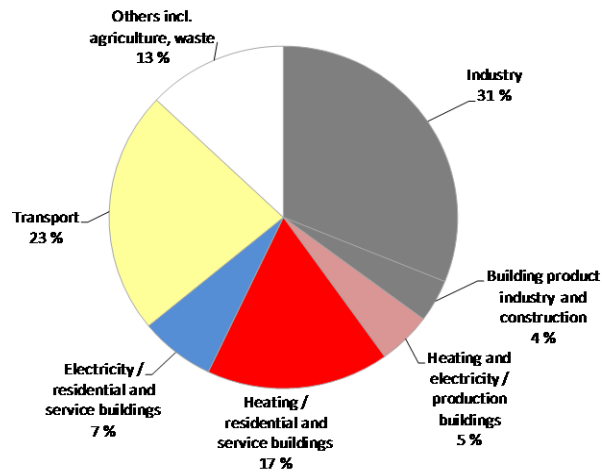


Figure 63. Greenhouse gas emissions by sector in 2010, total 75 million tonnes. Source: (Statistics Finland/Energy Statistics and VTT).

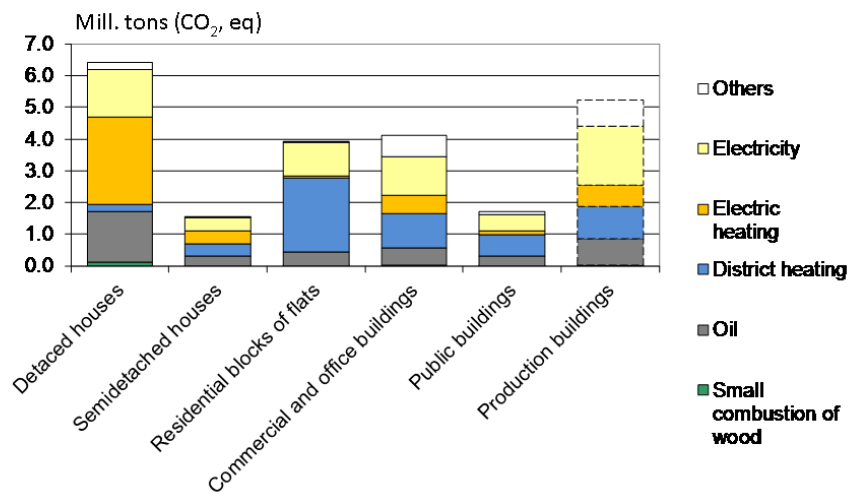


Figure 64. Greenhouse gas emissions by Finnish building stock in 2010. Source: (Statistics Finland/Energy Statistics, TUT and VTT).

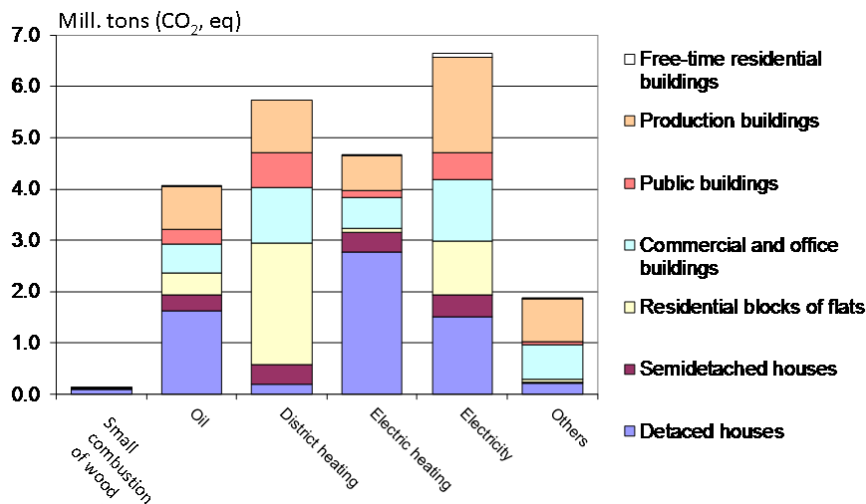


Figure 65. Greenhouse gas emissions by Finnish building stock in 2010. Source: (Statistics Finland/Energy statistics, TUT and VTT).

Table 14 shows electricity and heat production by production mode in 2009. In 2009, total electricity consumption in Finland amounted to 81.3 terawatt hours (TWh). Of this consumption, 85 % was covered by domestic production and the remaining 15 % by imported electricity. Electricity is imported to Finland from the Nordic countries, Russia and Estonia. Electricity is also exported from Finland to other Nordic countries and Estonia.



In all, 30 % of electricity was produced with renewable energy sources, 33 % with nuclear power and 30 % with fossil fuels. 18 % of electricity was produced with hydro power, 16 % with coal and 14 % with natural gas. Combined heat and power production remained as the most significant mode of electricity generation. It accounted for 36 % of all electricity produced in 2009.

Table 14. Electricity and heat production by production mode in 2009.

	Electricity, TWh	District heat, TWh	Industrial heat, TWh	Total fuels used, PJ <sup>1)</sup>
Separate production of electricity				
- Hydro power	12,6	-	-	-
- Wind power	0,3	-	-	-
- Nuclear power	22,6	-	-	-
- Condensing power <sup>2)</sup>	9,0	-	-	86,3
- Total	44,4	-	-	86,3
Combined heat and power production	24,8	26,6	40,2	399,2
Separate heat production	-	8,8	10,3	79,6
<b>Total production</b>	<b>69,2</b>	<b>35,5</b>	<b>50,5</b>	<b>565,1</b>
Net imports of electricity	12,1	-	-	-
<b>Total</b>	<b>81,3</b>	<b>35,5</b>	<b>50,5</b>	<b>565,1</b>

1) In calculating total primary energy used, hydro power, wind power and net imports of electricity are made commensurate with fuels according to directly obtained electricity (3.6 PJ/TWh). Total nuclear energy used is calculated at the efficiency ratio of 33 per cent from produced nuclear power (10.91 PJ/TWh).

2) Condensing power includes condensing power plants, shares of condensing electricity of combined heat and power production plants, and peak gas turbines and similar separate electricity production plants.

Source: (Statistics Finland, 2010).

## Health and indoor environment

Moisture damage in buildings is a severe problem in Finland. The major problem seems to be lack of knowledge on various refurbishment methods for healthy buildings. A government program for tackling the situation started in 2009. The aim of the program is a systematic reduction of moisture damages and their impacts. The Ministry of Environment coordinates the program.

The program includes a thorough survey of actual causes of the situation, origins of moisture damages and typical shortcomings in design and construction serving for damages. Best practices in renovating damages are collected and communicated towards the public and building professionals in an education program.

In addition to the programme, new design weather data for moisture safe design are available. The hour based weather file estimates the increase in rain and snowing and changes in wind conditions until 2050.

## Material use

The majority of the Finnish large buildings were built of bricks until late 1950s. These buildings have sloped roofs with wooden load bearing structures and roofing tiles or thin sheet steel roofing. Concrete sandwich panel technology was developed in early 1960s and buildings concrete frame and exterior walls with prefabricated concrete panels have dominated the market

until today. Concrete buildings have typically a low-sloped roof with bitumen roofing.

Building products' markets were in 2010 distributed on wood products 29 %, stone based products 20 %, metal products 34 %, and other products 17 %.

## Waste handling

Figure 66 shows the total amount of waste in 2009. Mineral wastes are the largest proportion corresponding to about 80 % of all waste. There is no actual statistics on material use in Finland.



Figure 66. Waste statistics 2009, total 85 million tons. Source: (Statistics Finland/Waste Statistics).

## Construction sector and the market

### How well does the building stock fulfil market needs

The Finnish building stock renews at 1.0 – 1.5 % per year. Table 15 shows the trend in construction 2008 – 2011.

Table 15. Construction indicators.

Construction indicators	2008	2009	2010	2011	2012
Construction. change of volume <sup>1</sup> , %	-2.7	-6.5	9.4	4.0	0.0
Building renovation and modernisation	3.7	4.0	4.2	3.0	3.0
Investment in construction	-1.6	-15.3	7.3	4.0	0.0
Buildings	-2.2	-16.5	10.2	7.0	0.0
Civil engineering	1.9	-8.3	-8.1	-3.0	2.0
Building starts, mill. m <sup>3</sup>	41.9	31.5	38.4	38.0	35.5
Residential buildings	10.6	9.2	13.6	12.9	12.0
Commercial buildings	8.5	5.8	6.4	6.7	6.0
Public buildings	3.1	2.9	3.1	2.5	3.0
Industrial and warehouse buildings	12.5	6.6	7.9	8.5	7.5
Agricultural buildings	3.5	3.6	3.7	3.5	3.5
Other buildings	3.7	3.4	3.7	3.9	3.5
Housing starts, number of dwellings	23,500	23,100	33,700	30,500	27,000
privately financed	19,600	13,100	22,500	23,000	22,000
state subsidized	3,900	10,000	11,200	7,500	5,000

Note 1: Value added in constant prices. Source: (Statistics Finland, Ministry of Labour, ARA, Bank of Finland & RT).

## Information available on the market

The Ministry of Environment opened a portal for refurbishment: <http://www.korjaustieto.fi/>. The portal aims at delivering expert-based information on refurbishment of houses and real estates. The intended users are private citizens, building owners, housing corporations, real estate owners and facility management experts.

The Ministry of Environment coordinated the Neighbourhoods program (2008-11), which is a partnership program producing information on neighbourhood development and refurbishment. The Housing Finance and Development Centre of Finland (ARA) are responsible for executing the program. The program web site [www.ara.fi/elavalahio](http://www.ara.fi/elavalahio) collects results of all the projects included in the program. The program also organised a series of seminars for the public.

The Aalto University's Aalto Pro in-service training program provides education for building professionals on refurbishment. There are also other education programs with various universities and universities of applied sciences as well as vocational institutes.

## Maintenance and refurbishment of facilities

### Refurbishment needs

The refurbishment market is growing in Finland (Figure 67). Improvement of a building's energy efficiency in renewal of technical installations does not always reduce the energy demand. In old buildings indoor air quality is often poor, and the energy savings by implementation of various technologies may cover up the increased energy demand of ventilation. The profitability of refurbishment depends also on the relationship between values and costs, and therefore, also improved durability, increased safety and healthiness, appearance and visual impacts of renovation need to be considered.

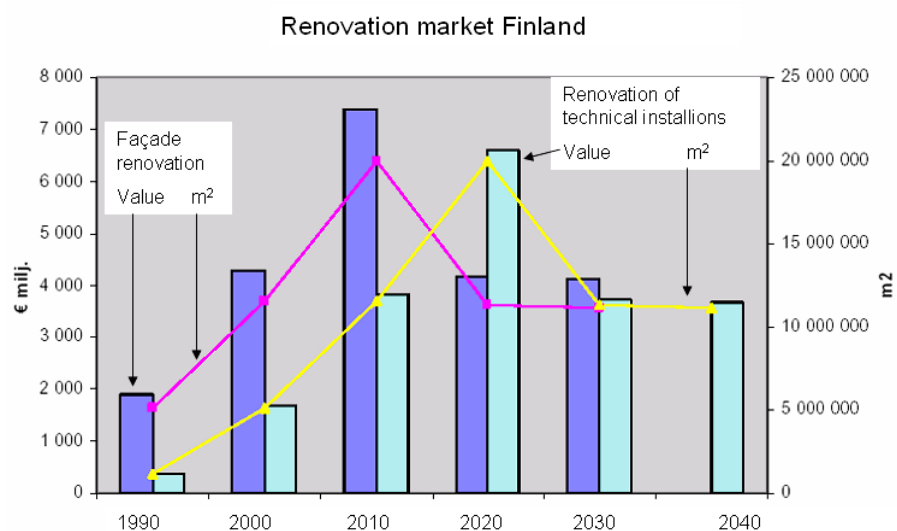
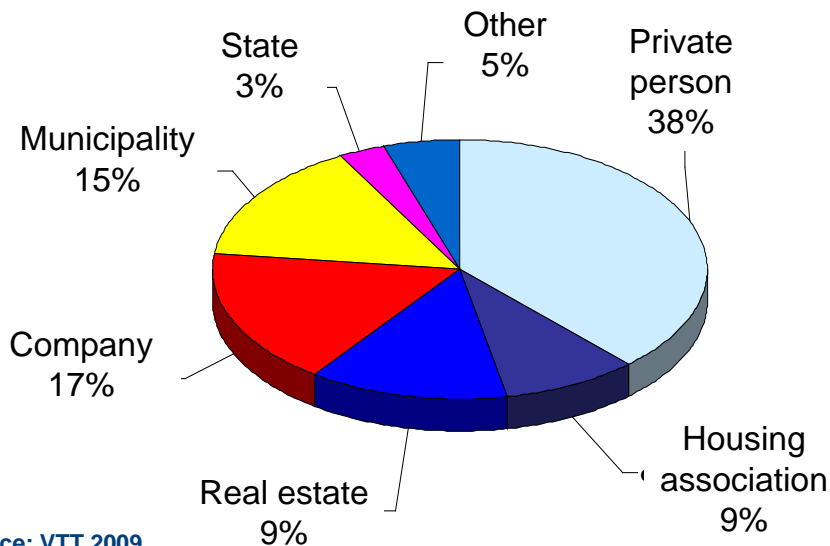


Figure 67. Estimated volume of renovation market in apartment buildings. Source: (Nieminen et al., not dated).

Building construction markets are divided into new buildings and refurbishment with close to equal shares of the total volume. A private citizen is the typical client in refurbishment. The total volume of refurbishment was roughly €10 billion in 2008 in Finland, and it is expected to rise to €20 billion by 2020 (Figure 68).



Source: VTT 2009

Figure 68. Renovation according to building owners in Finland in 2008, total €9,400 million. Source: (VTT, 2009).

Total refurbishment costs is the major driver in a private citizen's decision-making. However, cost optimization requires total costs to be separated into actions required by maintenance and prolonged service life, indoor air quality improvement, and energy efficiency improvement. The benefits, risks and impacts on the quality of life can then be analysed in a life-cycle perspective.

In the future, the asset value of a house can also depend on the energy-efficiency. The Energy-Efficiency of the Buildings Directive recast the requirements, and e.g. Finland's renewal process of the National Building Code requirements will change the present energy classification of buildings. As the renewed classification will be based on energy source dependent energy conversion factors, the present electrically heated houses with energy class A - C may drop to classes C - E. This may have an impact on the value of the house as well. The refurbishment of detached, semi-detached and row houses suffers from the lack of concepts for energy-efficient refurbishment.

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# Appendix 5: Policy and practices in municipal strategies for sustainable refurbishment

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## Introduction

The purpose of the case study is to analyse how municipal policy, understood as strategies for change, shapes the financing and practices relating to sustainable refurbishment strategies of a municipality. The actual municipality studied is the City of Copenhagen and its recent policy with respect to sustainability and construction. In continuation of this question, it will be analysed how City of Copenhagen acts and shapes strategies for sustainability. Further, the study endeavours to understand the web of regulations within which a large public client has to operate.

The study is based on qualitative interviews, two field cases (sustainable refurbishment) and desk studies on the policy regarding sustainability and refurbishment in the municipality. It operates on two levels: the systemic policy level (which is the main focus in this paper) and the level of the specific renovation project. The systemic level is combined with lessons learnt from the specific studies of two recent refurbishment projects in the municipality. The focus is on that part of the policy that deals with the built environment as a subdivision of the target areas for sustainability in the policy of the municipality.

Since the 1990s, City of Copenhagen has been engaged in local policies that focus on energy saving and renewable energy. Several generations of plans for the use of energy and the introduction of sustainability have been prepared, some of them as a part of national and international cooperation projects with other cities that work on the same agenda.

Earlier initiatives can be mentioned, for example "Agenda 21" dealing with intensified local environmental efforts regarding energy saving, separation and reuse of waste – an initiative that was a continuation of the UN Brundtland report from 1987. The UN stipulation in 2005 of the 2015 goals can be seen in same light. All in all, the initiatives can be perceived to move in a direction over the years that are getting both increasingly ambitious and specific.

At the level of the specific refurbishment project, two more recent refurbishment projects will be studied. The first is the "Osram house", a former factory for the production of electric bulbs built in 1953, taken over by the municipality in 1982. The second project is "Grøndal Centret", a former exhibition building from the 1960s meant for temporary use. It is the ambition to see how these concrete projects have been influenced by the (ambitious) general policy for sustainability.

The cases will take a look at which actors have been involved and how Copenhagen City Properties (Københavns Ejendomme, in Danish abbreviated KEjd) as a client has defined and planned the project. Factual information

about technical qualities, costs and (to the extent that it has been possible) energy consumption/savings has been noted.

It is concluded that as a change agent, the municipality acts on several levels. It acts directly with demands to contractors who want to bid on construction work and it acts as a very active network actor establishing new regional projects and for promoting the ideas to business, industry and the public and governmental institutions.

The City of Copenhagen has made a marked effort to ensure sustainability as a principle in refurbishment and construction, and the municipality is organising its efforts in a strategic way. The outset for the policy can be traced to the Brundtland agenda, but today the work with sustainability is arranged in a "strategic way".

A major problem for conducting sustainable refurbishment in practice in the municipality seems to be the calculation of payback periods. At the same time, the concept of "payback period" is functioning as a central instrument in the political decision process when talking about sustainable refurbishment and energy savings. The typical economic planning horizon seems to be far too short to accommodate ambitious, expensive energy-saving projects. Cooperation with a private or semi-private investor is a possible way of handling this problem and the City of Copenhagen is currently looking into this possibility.

Considering the move towards sustainability, original and more ideological agenda about climate initiatives etc. has internally been supplemented by translation to the economic dimension, which apparently enabled a broader political support for sustainability.

### **Purpose and scope of study**

The purpose of this case study is to analyse how municipal policy and practices shape the financing of sustainable refurbishment strategies in a municipality. The actual case is the City of Copenhagen and its recent policy with respect to sustainability and construction. In continuation of this, the questions in the analyses on client's actions and political announcements, pose a number of central questions (Hambrick & Frederickson, 2001):

- To which extent can a coherent strategy action be identified?
  - At which fields will the client be active?
  - How will he get there?
  - How will he win?
  - At what speed will he proceed?
  - How will he obtain returns?
  
- What kind of change management can we identify?
  - Type of change.
  - Processes.
  - Drivers.
  - Actors.

### **Methodology**

This case study is based on the combination of three methods: 1) An analysis of existing documentary material from the City of Copenhagen e.g. project reports, tools, websites etc., 2) a series of dialogue meetings in 2009 and 2010 with two key representatives from Copenhagen City Properties, and 3) visits at two project locations in the City of Copenhagen.

The documentary material includes the overall policy regarding sustainability in the City of Copenhagen, which is stated in two central documents: "Copenhagen Climate Plan 2009" and "Sustainability in Construction and Civil Works" (Danish version 2010, last English version 2007).

Further, the data material includes publicly available website information on:

- [www.bellacenter.dk](http://www.bellacenter.dk).
- <http://www.kubik.kk.dk/groendalcentret>.

The Grøndal Centret case has included website information on:

- NCC Construction Denmark A/S has been the main contractor on the renovation project. Web information was given through project chief Jesper Holst and press coordinator Niels Møller, both from NCC Construction Denmark A/S.
- Carl Bro A/S has been the main consulting adviser. Chief adviser Eric Kjærulff was responsible for web information.
- Taasinge Træ has developed and produced the roof sections. Sales officer from Taasinge Træ, Per Bo Larsen has been the contact person for public information.
- Today it is the division KEjd that is responsible for the building operation, key person Nikolaj Carlsson. Key person from the municipality during the renovation in 2005 was technical chief Torben Hjelm, Københavns Idrætsanlæg, Teknisk Afdeling.

The data material includes interviews and meetings with:

- Chief consultant Niels-Arne Jensen, Copenhagen City Properties on more occasions in December 2009 and in January, May, June and September 2010. KEjd has been involved in the design and procurement process for the municipality as the client.
- Information from property director Ole Kjær-Olsen responsible for the daily facility management of the Grøndal Center at a study visit in December 2010.
- Information from chief consultant Birgitte Kortegaard during a study visit in December 2010 at the Osram house project. She is architect and daily project leader, and she was heavily involved in both the design phase and in the operation phase.

Finally, the methodology included site visits at the two project locations in the City of Copenhagen. The full project team participated in the site visits in December 2010. The site visits included an introduction by the site responsible and a walkthrough of the facility.

## Contextual description of the case

### Introduction

This case study deals with a policy for sustainability formulated by the City of Copenhagen. Focus is on that part of the policy, which deals with the built environment as a sub-area. Analyses at the systemic level include two different specific studies of recent renovation projects in the municipality. The study operates in this way on two levels: the systemic policy level and the level of the specific renovation project.

At the systemic policy level, we look at the conditions for operating with a sustainable approach to renovation and energy-efficient improvements. We try to understand the web of regulations within which a major public client has to operate. For example, conditions are explored that relate to long-term loans and the trouble of defining and operating with a (new) long-term hori-



zon of investment. This applies to the clients' efforts to adapt new financial possibilities suitable for long-term renovation initiatives and to the clients' efforts to establish a new internal business process as well as to the clients' efforts to direct the attention of external parties (advisers, consultants etc.) to new methods and standards when working with renovation projects for the client.

At the level of the specific renovation project, the ambition is to examine how two concrete projects have been shaped by the (ambitious) general policy for sustainability. At the same time, how they have been streamlined, as more or less, like ordinary renovation projects. Internally in the cases, we find it relevant to get an understanding of how different actors (daily management staff, users etc.) interact with architects and engineers during the design of the refurbished building and how this cooperation can be extended to the operation phase. Some factual information about regulation of the renovation project and its technical qualities are also included in this part.

### **Copenhagen City Properties – the case organisation**

On behalf of the City of Copenhagen, the Copenhagen City Properties is in charge of all the traditional tasks of the client.

For a major municipality like the City of Copenhagen, several actors have relation to renovation and service of buildings. Copenhagen City Properties became the central organisation some years ago when the municipality decided to make a major organisational reform of the handling of buildings used by the municipality.

According to the Danish Association of Construction Clients, a municipality can basically choose to arrange its organisation according to four different models (Due, 2006). The four models are characterised by placing the local administration for each unit/building (schools etc.) at one end of the spectrum and at the other end of the spectrum, where the entire portfolio for service, new building and renting is centralised in a separate organisation that covers the whole municipality. Copenhagen City Properties is an example of the latter form, which is typically highly professionalised and applies economic models for calculating rent, investment and depreciation.

The organisation that administers one of Denmark's largest portfolios of properties, describes itself in this way:

".. a cross-sector unit in City of Copenhagen under the Culture and Leisure Administration. Copenhagen City Properties handles ownership, operation, development and administration of the City of Copenhagen's properties and tenancies. The property portfolio comprises some 750 properties and 570 tenancies and consists of administrative buildings, schools, leisure institutions, child day-care centres, cultural buildings, fire stations, etc." (*City of Copenhagen (2010a)*).

### **Case 1: The Osram house**

Two buildings owned by the City of Copenhagen have been in focus as different examples of the handling of renovation projects. Both of the buildings have KEjd as the client organisation and energy savings have been a significant objective.

#### *History of the area*

The Osram house is a part of a more comprehensive urban renewal project in the North West district of Copenhagen ([link in Danish](#) <http://www.kubik.kk.dk/osramhuset>). This part of Copenhagen was industrialised up to the early 1960s with major assembly plants ranging from light in-

dustry (electrical engineering) to car assembly. From the 1970s and up till today, the area has mainly served residential purposes as a buffer for urban transitions, temporary storage, automobile garages etc. Around 1980, some major urban renewal programs were introduced in Copenhagen. In the area where the Osram house is situated, it primarily took place along the former railway for freight (Larsen et al., 2011).

The overall “philosophy” of the urban renewal project is dedicated to sustainability. This is meant to be taken seriously, and besides the Osram factory, several other initiatives in the neighbourhood are stamped by this approach. For example, a dialogue has been established with the local filling station (next to the Osram building) on how they could facilitate people with bikes. As a consequence, air-pumps matching bikes, and light bicycle tools for cheap rent have been introduced. According to the daily leader of the Osram project, it has to be understood as a part of the overall environmental improvement of the neighbourhood, which has been going on for the last years.



Figure 69. First floor of the renovated Osram house. Note the thick walls and comparably small heaters (for the room size). Photo: (Velux A/S).

In spite of the overall neighbourhood initiatives, the client has mostly regarded the Osram project as a good opportunity to gain experience of several dimensions of sustainability in renovation beginning with just one building. Due to this, a lot of different solutions have been applied to just one building. In the following section, we will elaborate on some of those solutions (see Figure 69).

#### *Building physics*

The gross floor area of the building is 849 m<sup>2</sup>. It was renovated during 2009 and reopened early 2010. Due to the architectural value of the building, several compromises and innovative solutions had to be reached in the design process. This applies both to the façade including the windows and the entrance (see Figure 70).



Figure 70. A solution was chosen where the whole facade was placed behind a “glass wall” (from the inside) as the very special windows could not be renovated in ordinary ways. Photo: (Kim Haugbølle).

Before the renovation, the building was practically speaking without insulation. The walls were made of concrete, approx. 12 cm thick, without any further insulation. The windows had a single pane of glass in steel frames.

The renovated building is well insulated having walls with a total thickness of 41 cm insulated solely from the inside at the façade and from the outside at the backside of the building (see Figure 71). The windows are now triple-glazed low-transmission models with a heat transmission of  $1.1 \text{ W/m}^2$  (tentative data). For architectural reasons there has been a restriction on the possible insulation initiatives at the façade. Due to these restrictions the building as such is (only) rated as “low-energy class 1”.



Figure 71. Partly insulation of the back of the Osram building. Photo: (Kim Haugbølle).

#### *Implementation and innovation in technologically advanced renovation projects*

It seems relevant to have a discussion on the suppliers' role when designing a cutting-edge renovation. It is worth considering the potential issue of bias when accepting offers for technical equipment, and the dilemma of issuing tenders where advanced technology is expected. The latter is related to the fact that unproven design solutions and new techniques as such are in contrast to very well-defined demands and functional descriptions.

#### *The role of the contact person*

The communication demands from the local users to the client were handled by the daily manager of the house. Due to this role, she became an important contact person. During several years she had a personal network in the clients' organisation – the relationship was an important base for discussions on matters concerning design – this applied both to major issues like the choice of design solution for insulation of the façade and to minor design questions.

According to the daily manager, it could be regarded as an open question, whether the long and incremental design approach would have been appropriate had it not been for the continued presence of an educated local contact person on site. This is in particular relevant when it comes to the commissioning process, which have lasted for almost one year.

The process regulation technique in the house is sophisticated and according to both the client (KEjd) and the daily manager it is doubtful whether the house could be operated by normal users without a technical or architectural background. In the development phase it was also important with a frequent and detailed reporting on the function of new materials and design solutions. A technical insight proved to be essential in the communication with the client and directly with the suppliers' representatives. This applied to the design of both the ventilation and the light systems.

The supplier used the renovation case to test new – nearly prototype – models for low-energy stage-light lamps in practical use (see Figure 72). This illustrated that the renovation case turned into a development and test project, not only for the client but also for some of the suppliers. This situation was not anticipated at the beginning of the project and had not been possible in an ordinary procurement set-up (where specifications and responsibili-



ties had been specified at a detailed level, leaving only minimal room for improvisations during the building process).



Figure 72. Newly developed LED spot lamp. Photo: (Kim Haugbølle).

#### *Advanced automatic steering technology in the renovated building*

A new ventilation system with heat exchanger has been installed. The system is very advanced and has a broad range of configuration features, and is meant for fully automated operation. The system has nonetheless demonstrated several problems and it is not fully operational yet (in automatic mode as it was meant). Its interface with the heating system is complicated and especially in the more spacy rooms, it has been difficult to reach the right temperature. Apart from this, it has also been very noisy. According to the daily leader of the house (who happens to be an architect), the noise problems are mainly due to the use of square valves. This is currently discussed with the client who considers changing to circular valves.

#### *Barriers*

Zoning has not been an issue in the case, nor has special rules regarding taxation or parking issues. As described, listing has played a profound role for the choice of overall design.

#### *Economy*

The renovation costs amounted to DKK10 million (€1.3 million) in 2009. In addition to these direct costs, substantial effort and equipment has also been applied and installed at very low cost, since e.g. the suppliers considered the project to be an important showcase towards the COP15 meeting in Copenhagen in December 2009.

#### *Outcome with relation to energy savings*

One example is that district heating was changed on a regional scale from a high-temperature to a low-temperature system approximately 10 years ago. A new high-efficiency heat exchanger has been installed.

Another example is the large windows in the façade – as well as in the rest of the building – were originally one-layer. Note that it is possible to see the ice on the inside of outer pane, which now is behind a secondary window (Figure 73).

The planned reduction in energy consumption (KEjd, 2011):

– 191,500 kWh/year used for heat and electricity (a 66 % reduction).

– 29 t of CO<sub>2</sub>/year using the unity conversion factors from KEjd.

In early 2011, provisional data from KEjd indicate that savings will end up at approx. 60-70 % of the planned figures.



Figure 73. The impressive window ornamentation in steel frame at the entrance. Photo: (Peter Vogelius).

## Case 2: Grøndal Centret

As a renovation case, the sports centre Grøndal Centret is very different from the Osram house. It has been renovated over a long period of time on more occasions and it does not share the radical frontrunner position of a very advanced case with the use of highly innovative technologies like that of the Osram house. On the contrary, the sports centre case is highly relevant, because it demonstrates very good results based on a steady effort with known solutions.

### *History of the centre*

The sports centre was originally designed to be an exhibition building in the mid-sixties (link in Danish: <http://www.kubik.kk.dk/groendalcentret>). It was built with the intention of being only for temporary use for a maximum of 10 years, because the centre is located in a locality, which is among the listed areas of Copenhagen. It is situated some 5 km from the city centre of Copenhagen.

Today the complex is one of Northern Europe's largest sports and leisure centres hosting a lot of diverse activities in all kinds of sport, traditional as

well as unconventional ones like wall-climbing for disabled people (see Figure 74). It has approx. 3,000 daily users and 37,000 m<sup>2</sup> is under roof and it holds some 30 different functions related to all kinds of sport.



Figure 74. Team of disabled climbers are exercising at a climbing wall. Photo: (Peter Vogelius).

Although the main purpose is to provide the citizens of Copenhagen with sports facilities, it is also possible to rent meeting rooms and to use rooms for theatre activities and for minor exhibitions.

Formerly another cultural department in the City of Copenhagen was responsible for the maintenance and operation, but in 2002 the sports centre was handed over to the department, which later became part of KEjd.

#### *Technical condition before the renovation*

In autumn 2002, the new operator – KEjd – carried out a thorough building survey with internal experts as well as the external hired-in adviser COWI. The investigation included the different types of technical installations. As early as 2000, the municipality had asked the Danish Technological Institute to conduct a building survey. This investigation pointed out massive roof damages and resulting mould growth attacks.

The technical installations were described and assessed in an internal report by the municipality in 1997. The report concluded that the centre had a serious maintenance backlog. All technical installations were in a very bad condition – this applied to ventilation, electricity, and water installations. The old heating system is still working, but is part by part being renewed according to a constant evaluation of where the highest energy savings can be obtained for the invested money (see Figure 75).

Further, there were damages from leaking water pipes caused by frost due to pipes placed near the roof with no insulation. Further, a nearly flat roof construction, too few roof drainages and a missing vapour barrier contributed to a roof that had been leaking for many years, and consequently a comprehensive attack of mould growth had developed extensively in the roof construction.

Finally it was noted that due to low energy prices in the mid-sixties, the roof was built with only 50 mm insulation.





Figure 75. The old heating system is still working, but is part by part being renewed. Photo: (Peter Vogelius).

#### *New solution*

As a part of the layout and dimensioning process of the renovation, a series of goals was set up for the future use of the building. The goals included a definition of needs for spaces, rooms and functions. This was mainly to ensure that there was sufficient daylight in the different rooms and to ensure that the design of the new roof should not collide with the functions in the rooms/halls. Energy consumption also played a major role in the design, and it was a major priority to minimise the need for energy in the future. Finally some considerations regarding fire risk were included in the design.

The new construction was built with the insulation at the upper part of the roof sections with two layers of felt roofing. It was a high priority to avoid any cold bridges etc. that could cause moisture and mould growth, therefore a solution with a “warm construction” was chosen (e.g. the insulation placed on top of the timber). The new insulation measured 200 mm, which gave rise to a design problem. The load bearing of the basic construction was not designed for more weight, and to compensate a lightweight timber construction in the roof had to be designed.

A specialised supplier of laminated wood was used (as a sub-contractor for the development and production of the many sections). Although it was an industrialised concept, the sections proved to be (nearly) all different due to small differences regarding measures and lead-in's, partitions, top-lighting, drainages etc., which all had to be taken into consideration. The entire 20,000 m<sup>2</sup> of the roof had to be completely renovated. Each of the roof sections were built with a decline in two directions – a sophisticated construction ([http://www.wood-supply.dk/article/view/7349/20000\\_kvadratmeter\\_tag\\_til\\_sportens\\_mekka](http://www.wood-supply.dk/article/view/7349/20000_kvadratmeter_tag_til_sportens_mekka)).

In connection with the renovation of the roof, new lightning was installed everywhere, an initiative that was later followed by a sophisticated automatic light control system.

Later, in 2007 the centre got new insulated and tight gates at all entrances and many windows were renovated.



After the main renovation of the roof in 2005, the client has paid special attention to the centre. The ambition has been slowly to improve the energy efficiency. Due to the lack of major funding an incremental approach has been necessary in which the heating system etc. has been replaced and upgraded part by part (see Figure 76).



Figure 76. Circulation pumps are replaced mostly by low-energy models, which also facilitate and interface to the intranet. Photo: (Peter Vogelius).

#### *Construction process*

It was a challenge to change the large-scale roof without exposing the underlying area of the centre. An effective solution where most of the roof was stripped in one working procedure was therefore out of the question due to both weather conditions and the subsequent dismantling of installations (cables for electricity, telephone etc.). Instead some experiments were made, which indicated a solution where 430 m<sup>2</sup> was carried out per day. A couple of full-scale tests were carried out before the work started, and the procedures were adjusted. The major part of work had to be done in a 3-month period during the first 6 months of 2005, which the contractors succeeded in doing by working double shifts.

According to the contractor, one of the most complicated and unpredictable issues were to handle all the installations which over time had been placed on the old roof construction. The part of the roof that was removed during

the daytime was covered by a special temporary 250 m<sup>2</sup> roof made of aluminium and Plexiglas. In this way, this specially designed unit covered a new area each night – “travelling” through the entire roof area.

#### *Problems today*

The adjustment of the large complex with its multi-purpose activities is an on-going process and includes compromises between different issues, which the client has to consider.

The adopted policy on renovation is still functioning. Lately there has been an intensified awareness of the heating system. The system was marked by the difference between the single parts and their different ages. Some of the components could be dated back to the mid-sixties when the centre was built). Recent initiatives are acting on at least three different fronts:

- Tuning of a central, major PC-based control system.
- Re-allocation of heat flows (the halls are warmed by the circulation of heated air).
- New efficient pumps and heat exchangers.

Today most installations in the centre can be surveyed (and to some degree controlled) from a PC-based system, which constantly delivers main figures about operations and energy consumption (see Figure 77).



Figure 77. At the monitor, Ole Kjær-Olsen who is responsible for the daily facility management of the centre. Photo: (Peter Vogelius).

The heating system serves as an example. Over time it has been adjusted, and to some extent been replaced in an incremental way with a good result and small investments. However, they cannot with the basic layout manage

to control the temperature in different rooms placed adjacent to each other – this poses problems for users playing badminton or table tennis in one room while gymnastics is exercised in the neighbouring room. A solution points to a more radical change in design but that will be very expensive. With regard to this problem the old basic structure of the building is a problem for such a solution. Sometimes old structures raise concerns about where to stop the change in layout when doing renovations.

Even after nearly six years in use – and after the major part of the renovation had been finished – new renovation initiatives are still being planned (but not in the same scale as the roof). Nonetheless the overall perspective of the renovation is maintained, currently mostly in relation to improving energy effectiveness and flexibility of the installations.

Over the years, steady improvements have been noted regarding energy consumption. Recent figures indicate that from 2008 to 2010 the consumption of heat has been reduced by 29 % and the electricity consumption by 2 % (KEjd, 2011).

### *Economy*

Information about the economy in the Grøndal project is primarily based on figures from the City of Copenhagen (Københavns Kommune, 2003) and likewise the information about the technical condition of the centre before its renovation (Københavns Kommune, 2001 & 2003) and (NCC, 2005). Furthermore, the daily leader responsible for the facility management of the Centre has contributed with some information.

In the autumn of 2002, the client ordered a building survey from the largest Danish engineering consulting company COWI for the entire centre (Københavns Kommune, 2003). Together with the municipality's own investigations, the survey represented the initial input for the economic estimates for the fiscal year 2003 and the following years. The conclusion was that the entire cost of renovation needed for a period of 10 years would add up to DKK115 million (2003 level). However, DKK70 million was acutely needed in 2003.

The client had to be pragmatic with respect to the economic frames. A roof renovation of DKK32 million and technical repairs (primarily urgent renovation of water and ventilation installations) at a cost of nearly DKK20 million was approved.

The final contract for the roof was first signed in 2005, but now at price of DKK46 million. The contract was made as a full partnering arrangement, with special emphasis on user involvement. At the same time, a contract for improving the energy efficiency of the electrical installations was signed at the cost of DKK12 million.

### *Outcome related to energy savings*

Planned reduction of energy consumption (KEjd, 2011):

- 526,235 kWh/year for heat and electricity.
- 193 t CO<sub>2</sub>/year.

It is important to note that the above mentioned calculations do not include a major renovation of the roof; only the minor initiatives mentioned in the text are included. Unfortunately provisional data don't exist for the resulting savings.

### *Barriers*

There have not been any obstacles to the renovation efforts originating from zoning or parking restrictions.

## Summing up the two cases

Obviously the two cases are very different regarding size, building type etc., but they also represent very different approaches to sustainable renovation. Where the Osram house is an example of a spearhead project with the incorporation of the newest technologies over a relative short period of time, the Grøndal Centret case in many ways takes a completely different approach.

The Grøndal Centret case is a “low profile” project. It is made up of a major initiative launched some years ago, which is followed by a steady effort with a number of minor initiatives in subsequent years. This must not be conceived as an approach without planning and long-lasting considerations. On the contrary, we have seen that close and permanent attention (also from the local responsible for the daily operation of the centre, who has been dedicated to this task) has resulted in an incremental and innovative effort. This effort has apparently been driven by at least two major motives: the users’ demands and an on-going analysis of how to reduce energy consumption. If we take an isolated look at each of the steps, they do not seem impressive, but in the long run the result has been a considerable reduction of energy consumption along with a steady adjustment to user needs. Sometimes this approach can conflict with the ability to achieve more radical solutions, as we saw with the hot-air heating system, which basically caused trouble for badminton players and some other groups. However, the solution to this problem is deeply dependant on the hot-air heating system itself and it is probably not possible to solve within the existing heating design. We see here a limit to the incremental approach when it comes to user adaptation.

The Osram house project was fully designed from the beginning and the renovation process was comprehensive and completed in a relatively short time. Several new solutions were applied – some were advanced to a degree where solutions were concurrently developed as an integrated part of the installation e.g. the light solutions and energy management systems. For the same reason, it was difficult to carry out anything but rough estimates of energy savings in the planning phase.

With the financial models in mind, the two projects are not alike. Apart from the initial renovation of the roof, the Grøndal Centret project has developed year by year through discrete isolated initiatives depending on the financial frame. Each project has been selected with due respect for ordinary needs for renovation and calculations of energy savings. It has been possible to calculate pay-back time for most of the initiatives according to the policy of the municipality.

As already mentioned, the Osram project was a spearhead project with high initial costs and complicated solutions all the way from the insulation of facades and windows to the light solution. The idea and the political decision about the project is dependent on the fact that Copenhagen was host for the UN COP15 climate meeting in December 2009. City of Copenhagen wished to signal that it had decided to spearhead the climate agenda – the Osram project together with other spearhead projects should serve this purpose. The uncompromising approach of the Osram project showed some interesting points regarding a broader ambition regarding sustainability. The combination of the renovation task with the local urban planning made it possible to fit the Osram house into some more comprehensive initiatives regarding sustainability in the neighbourhood. The Osram house had a very devoted daily leader, who was an architect. She became an important partner in both the design phase and in the first implementation phase when the house went through a series of adjustments prior to operation. It is an open question, whether the project would have benefited from user response and demands

if it had not been for her enthusiasm. More generally, it raises the question of whether advanced renovation projects towards low energy consumption are possible to implement if there is not some coupling mechanisms to operation.

### Overall strategy of the case owner

At a national level, the principles of sustainability in Danish renovation and construction are outlined in the Building Act (LBK nr. 1185 af 14/10/2010) and the Danish Building Regulations (Danish Enterprise and Construction Authority, 2010). However, the existing Building Regulations (2010) defines no standards for sustainability as such, only detailed rules for energy consumption etc. The Building Act does not deal with sustainability but in paragraph 6 it is briefly mentioned that the minister has an option to specify regulations for recycling and excessive use of materials.

Principles of sustainability are incorporated in several town plans, but in urban planning, sustainability is primarily a declaration of intent, rather than a specific standard for buildings, design or construction. There is an overall objective in the national environment act (§1) stating that the development of society has to progress on sustainably in respect of both human living conditions as well as the conservation of plants and animals around us (Lov nr. 879 af 26/06/2010). However, this statement is intentional and general in its wording and does not give rise to any specific regulation of construction.

#### *The City of Copenhagen – its recent history on sustainability*

Since the 1990s, City of Copenhagen has been involved in local policies focusing on energy savings and energy policy. Several generations of plans for the use of energy and the introduction of sustainability have been prepared, some of them as a part of national and international cooperation projects with other cities working on the same agenda.

Former initiatives can be mentioned, for example "Agenda 21" for enforcing local environmental efforts regarding energy saving, sorting and reuse of waste – an initiative that was a continuation of the UN Brundtland report from 1987. The stipulation in 2005 of the 2015 goals (see overleaf) can be seen in same light. Over the years, the initiatives taken can be seen to drift in a direction that is at the same time getting increasingly ambitious and specific.

Today several web-based sources from the City of Copenhagen present plans and programmes related to energy savings, and more broadly sustainability. Below a current (by September 2010) extract is presented that states the municipality's policy on energy consumption:

*"Copenhagen is focused on the climate. The municipality is energy efficient with our district heating system, while nearly 40 % of our citizens cycle to work or their educational institution every day and the electricity-generating windmills, located in the sea outside the city, save 76,000 tons of CO<sub>2</sub> emissions annually.*

*Our vision is for Copenhagen to be the climate capital of the world, with a 20 % reduction in CO<sub>2</sub> emissions by 2015 compared to 2005. We even want to become completely CO<sub>2</sub>-neutral by 2025 as the first capital in the world. We are looking for joint initiatives from municipalities, the business world and the citizens as well as close cooperation across international borders.*

*More than 30 % of CO<sub>2</sub> emissions in Copenhagen come from residential and other buildings. It is our goal that in the future all urban development projects will contribute to reducing Copenhagen's total CO<sub>2</sub>*

*emissions, and that selected urban areas will become completely CO<sub>2</sub>-neutral.” (The City of Copenhagen 2010).*

#### *Two ambitious plans*

Some Danish municipalities' have chosen to go further than national regulation; among them is the City of Copenhagen.

For the City of Copenhagen, the plans are component parts in the on-going work on sustainability and their latest versions have become more detailed and specific, and at the same time they have also achieved a more binding status. All in all, this is very interesting seen from the point of what the practical possibilities are for introducing sustainability in construction and renovation. On the other hand, the more specific plans and regulations also have as a consequence that strategies, plans and regulations now are comprehensive documents. In this context, we can therefore give only some overall hints about the specific rules, regulations etc. – readers with an interest in the precise text has to follow the links (unfortunately, only a modest selection is available in English and the most recent editions are all in Danish). Nonetheless, in the following section we will give a brief introduction to the plans with focus on the parts that deal with construction and renovation.

#### *“Copenhagen Climate Plan 2009”*

In August 2009 (in light of the planned international UN Climate Summit meeting in Copenhagen, December 2009), the city council adopted a very ambitious and comprehensive climate strategy "Copenhagen Climate Plan", which – as one out of six policy areas – includes energy-efficient buildings. The plan operates with binding goals at all policy areas and the main plan is supposed to be followed by sector plans with a mapping of existing conditions and future detailed plans for actions and regulations. The sector plan for construction and renovation is titled “Sustainability in Construction and Civil Works”.

The targets of the Climate Plan and the roadmap for the follow-up are ambitious. In the introduction it is stated that:

*"Copenhagen's CO<sub>2</sub> emissions must be cut by 20 % between 2005 and 2015. This is the goal. Far more ambitious than those set by most big cities in the world. In Copenhagen we dare to aim high – and we are already well on our way."*

Further it is announced that:

*"... This requires a targeted effort each year. That is why the Climate Plan is an action plan with 50 specific initiatives. The initiatives are inter-related, and have been grouped into six action areas. As a result they are also presented thematically, not according to priority. The six areas are:*

- Integrating climate into energy supply 375,000 tonnes CO<sub>2</sub> per year.*
- Greener transport 50,000 tonnes CO<sub>2</sub> per year.*
- Energy efficient buildings 50,000 tonnes CO<sub>2</sub> per year.*
- Copenhageners and climate 20,000 tonnes CO<sub>2</sub> per year.*
- Climate in urban environment 5,000 tonnes CO<sub>2</sub> per year.*
- Adapting to the future climate.” (The City of Copenhagen 2009b).*



*"Sustainability in Construction and Civil Works 2010"*

The action plan gives a detailed follow-up on the Copenhagen Climate Plan in the 2010 edition of "Sustainability in Construction and Civil Works 2010". As a concrete paper on sustainability, the report is a remarkable public document due to its level of specifications for procedures and goals.

Thus it has binding status for companies that want to work for the City of Copenhagen, whether it concerns renovation, conversion or new building and for urban renewal or social housing with financial support from public sources.

*"The standards in this booklet are binding for construction, remodeling, renovation projects, and civil works that involve the City of Copenhagen as the developer or contractual user and for construction, remodeling, and renovation projects that are subsidized by the City under regulations on urban renewal and subsidized building or through municipal pools. The standards must be incorporated into the terms when tenders are invited for municipal construction and civil-works projects and when subsidies are approved for urban renewal and public construction." (City of Copenhagen 2010: 8).*

The report deals with nine main areas, which are:

- Sustainable project design.
- Energy.
- Materials.
- Water and drainage.
- The townscape and green spaces.
- Waste.
- Noise.
- Indoor climate.
- The construction site.

The plan prescribes a fixed structure for applications to the municipality concerning new building and renovation. For each of the nine areas, there will be an introduction to the theme, a demand/standard section, and a section for rules on how to formulate documentation.

The concept of "SUSTAINABLE PROJECT DESIGN" is implemented as a generic base for the other initiatives and it is defined as:

*"Sustainable project design is a work method that is intended to ensure optimal results for the environment in construction and civil works. This method is used to map out, evaluate, and prioritize all significant environmental impacts. Goals are set for how much environmental improvements are intended to achieve. In addition, care is taken that the relevant measures to promote sustainability are used in keeping with these goals. The aim is environmental quality control, with the environmental standards and measures used to meet them are carried through consistently in the project during production/extraction, construction, use, maintenance, and finally removal." (City of Copenhagen 2010: 14).*

Four planning steps are prescribed including mapping, prioritising, formulating of goals and gross listing of means. Means of achieving the goals have to be chosen. The identified means are then evaluated in a process of estimating total economic balance in contrast to traditional solutions (which are not defined) with the aim of identifying the means with the best payback time.

The plan also contains a line of specific new design requirements related to each of the nine areas. In the field of energy savings, the most important to mention are:

- Low-energy Class 1 as a new standard even if it is not included as a current requirement in the new Danish Building Regulations, which came into force in January 2011.
- In major renovations, the energy-saving measures with a payback time below 10 years have to be executed.
- Energy elements with a payback time between 10 and 20 years have to be evaluated in preparation for specific decisions about executing.
- For new and renovated windows the following U values are standard:
  - Double-glazed: 1.4 W/m<sup>2</sup>K (windows of more than 1 m<sup>2</sup>).
  - Triple-glazed: 0.9 W/m<sup>2</sup>K (windows of more than 1 m<sup>2</sup>).
- Colour of coating has to be transparent/colourless.
- Energy-related changes in the building envelope have to be carried out with respect for the existing architecture.
- Energy meters for both electricity and district heating have to be installed for each dwelling. For new building and for major renovation projects, meters have to be of a type that can handle remote read out.
- Blower door test and thermo photography have to be a part of the hand-over both in cases of renovation and new building.
- If installation of active ventilation is a part of the renovation project, the efficiency has to be 85 % as a minimum.
- Lighting (indoor and outdoor requirements).
- Stand-by consuming in the building.
- Specific requirements in installation of laundry (facilities for outdoor drying is required).
- The use of town gas.
- Obligatory connection to district heating and other mutual energy systems.
- Plan for education of service personnel that are responsible for running and installation etc. as a part of hand-over.

The list above is an ambitious example of the detailed design requirements affecting renovation on a broad scale in the City of Copenhagen.

### *Summing up*

If we have to sum up the “strategy of the case owner”, we have identified and described the documents which are the major tools in the unfolding of the strategy for sustainability in renovation in the City of Copenhagen.

Two central reports have been in focus: reports which act on different levels. The overall plan “Copenhagen Climate Plan 2009” stipulates the approach of how the municipality will deal with the CO<sub>2</sub> reduction agenda. One out of six areas for policy is construction, including renovation. How to reach the goals set up in each of the six areas of policy is described in separate reports. For construction we find the description in “Sustainability in Construction and Civil Works”. This document is remarkable due to its level of great detail, both regarding demands to actors in the building process and its technical design requirements with implications for sustainability (mostly but not only energy). It is important to note that at the time when these requirements were launched, they are ahead of the national regulation for the same field.

In the following chapter, we interpret the plans with respect to the concept of strategy. The purpose is to look into whether – or how – we understand the efforts of the City of Copenhagen as a part of a coherent procurement strategy with sustainability in focus.



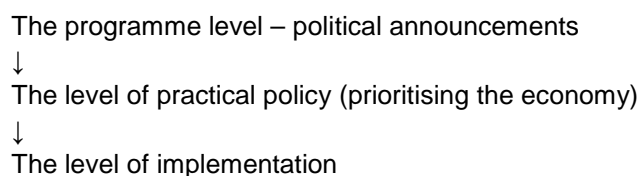
## Procurement strategies – or how to implement a strategy at municipality level

By nature initiatives concerning renovation and changes to buildings are bound to be evaluated in a long-term perspective – the life time and rate of turnover for different improvements are long.

### Embedded conflicts between specific goals regarding sustainability and major policy themes

An overall schism is therefore how to implement specific goals for energy savings and sustainability, when running budgets are slashed and major policy areas take over in the public debate. Especially themes like (un)-employment, lack of economic growth, lacking supply of kindergartens, schools that are worn down and stagnation in local business are important themes with strong public attention.

For the municipality it seems that the work with sustainability can be divided into three different levels:



At the programme level, the principal political decisions are taken about turning the municipality in a sustainable direction. Political compromises and negotiations are placed at this level. Often the input will be policy drafts from the civil servants in different administrations. In the case of sustainability and renovation, economic calculations regarding possible gains and energy cost have also played a major role as an instrument for creating political backing from a broad spectrum of political parties. You can say that a more ideological agenda about climate initiatives etc. was supplemented by translation to the economical dimension, enabling political support.

At the level of practical policy, the comprehensive reports are elaborated that describe how the City of Copenhagen will reach the goal for sustainability, and more precisely the achievement of Copenhagen as a CO<sub>2</sub> neutral city by 2025 (with a sub-goal for construction).

At the level of implementation, all practical efforts are made by the administration to ensure that the rules and procedures for handling sustainable renovation projects are followed. It covers all kinds of initiatives from informative contact meetings with contractors and advisers to internal training in the new formalities and new templates for bidding at the procurement stage. At the level of implementation, it is also possible to interpret the development initiative – Gate21 (<http://www.gate21.dk/>), which involves City of Copenhagen itself and the surrounding municipalities. The name “Gate 21” refers to the decisions taken at the UN summit in Rio 1992 (UN 1992). Primarily, the goal is to be a pivot for new climate and energy solutions. The initiative hosts projects for low-energy solutions for renovation with a very broad participation from different actors public as well as private.

### *Financing and horizons of investment*

Up till now the current practice regarding financing of renovation initiatives has often been similar to other municipal investments. This means that finances have to be allocated from year to year. Besides, a rolling budget model covering three more years (always four years in all), a time horizon of

1 – 4 years is often sufficient to plan improvements or renovations on a list of schools, or similar. If the problem becomes very pressing, we talk about calculation payback times for different initiatives in relation to sustainable construction, especially when initiatives are not any longer among the low hanging fruits. In such situations, payback time can be as long as 10 or even 20 years! How to calculate the cost of such initiatives? We return to this issue later.

Especially in the last couple of years, the Danish government has operated with a very limited "frame of cost" for the municipalities. In relation to the theme in this text, it is important to note that this kind of policy for public finances means that the municipalities constantly have to face serious dilemmas in their priorities; this applies to running costs as well as investments in new buildings and renovation.

Regarding investment in solutions that have a potential for saving energy, an exception for this principle exists ("Lånebekendtgørelsen", "the loan declaration"); in cases where the municipalities are allowed to take out loans for new projects without straining the overall cost frame. This opportunity is frequently used by the City of Copenhagen to realize its policy in the field of sustainability and energy saving.

The municipality has asked itself whether cooperation with major private (or semi-private) investors could be the answer to the difficulties of financing renovation. Cooperation (and specific agreements) with the earlier mentioned investment partners can be a way to prevent that day-to-day pragmatic policy erode goals and strategies over years. Consequently, the City of Copenhagen has engaged in cooperation with the worldwide financial institution "Carbon War Room" (see <http://www.carbonwarroom.com/>). In the municipality, this cooperation is regarded as important, and believed to represent a great potential, although there can be problems, owing to different core competences in the two organisations as well as different cultures between the organizations when it comes to negotiations and agreements. For example, architects and engineers are not trained to conduct economic negotiations concerning conditions and long-term regulation of loans on a multi-million DKK scale for new building and renovation. In spite of the size of the municipalities, this also applies to the Municipality of Copenhagen as the biggest municipality in Denmark. In spite of these difficulties, it is the plan to go further into the potential for long-term loan agreement. This kind of solution is quite new for the City of Copenhagen

Looking at the current political scene, solutions with long-term loans from investors with a special interest in CO<sub>2</sub> reduction (and to some extent in sustainability in general) seems to be a way of financing energy-efficient measures energy improvements. Recently (Mid-September 2010) the mayor for the Technical and Environmental Administration (Bo A. Kjeldgaard, in Licitationen) has commented on the completely new 2012 budget agreement, where he draws special attention to new possibilities for such loans as a part of the agreement.

But, as we have touched on in the former sections, there is obviously a challenge in balancing on the one hand the public client's governing principle for economic planning and budgeting, and on the other hand the need for long investment horizons. Of course this applies to some extent whether or not we talk about sustainability, but we will argue that mostly, the more ambitious sustainable renovation projects have long payback times and consequently they are especially vulnerable to the problem of balancing long-term investments in the budget.

### *Backlog and prioritising*

At present the backlog is DKK2.5 billion for the City of Copenhagen as an entity. With the existing budget at DKK200 million per year (excluding certain minor special contributions) for renovations (covering all renovations – not only energy efficiency improvements) it can quickly be calculated that there has to be some crosscutting strategies for sustainability, if not all funding is going to be monopolised by urgent, but traditional, renovation tasks.

Some general principles meant for supporting ordinary service has been defined for the prioritising of the DKK200 million. They are briefly outlined below:

- 1 Worst first.
- 2 Housing or buildings where people work on a daily basis. For example, it could be indoor problems related to moisture and/or mould growth.
- 3 Of the DKK200 million/year, DKK10 million are reserved for single well-defined projects to improve energy efficiency sustainably and an additional DKK10 million are reserved for what could be called extra (marginal) costs on traditional renovation projects where specific extra costs can be traced to new high energy standards. This raises some connected problems. In technical terms, it can be discussed what has to be included in the term "renovation", and further what is a "standard solution". The latitude of marginal costs is central both for the access to those special funds but more generally to advice on when to implement different energy saving solutions.

Obviously it can be a problem when limited budgets have to be distributed in the day-to-day practice. Currently, work is going on in the municipally with respect to this. To exemplify the problem, a new plan can be mentioned that calls for better coverage of institutions for children (especially kindergartens and day nursery) is sensible in the public debate, it has been discussed to stretch a point on energy demands for exactly those institutions – otherwise there is a concern whether the earmarked sum would be sufficient to fulfil the plan for new institutions. The city council is the only one to take this difficult decision.

As opposed to the calculated, prioritising model a new trend seems to gain a footing. That is, simply to make a political decision, in principle regarding a construction principle or similar. As an example, we can mention a recent decision by the city council about how to prescribe "green roofs" (on certain public and semi-public buildings) in Copenhagen. In those cases, the ambition about both to calculate the price on the initiative and compare the cost effectiveness with other initiatives has been abandoned.

### **Does the City of Copenhagen follow a strategy for its initiatives on sustainable renovation?**

It is possible to interpret the municipalities' handling of the development of sustainable renovation according to the scheme described by Hambrick & Frederickson (2005). With the overall plan for the City of Copenhagen as a CO<sub>2</sub> neutral city by the year 2025 and a planning history in the field of sustainability going back to Agenda 21 initiatives at municipality level, the municipality has pinpointed the arena for where and how to do policy with respect to sustainability. Or with the expression of Hambrick & Frederickson (2005), they "know where to be active".

The defining of nine focus areas for activities (construction/renovation is one), where each area is the subject of an analyses, equals the strategic ambition of stating where and how to proceed.

Furthermore, the criterion on “speed and sequence of move” is covered by the time table for goals in the years of 2015 and 2025. We saw that the municipality had a number of initiatives aiming at the procedures for cooperation with advisors and contractors. New mechanisms for procurement have to ensure changed calculations in the bids. Finally, standards have been introduced for how to document that as a contractor you do in fact follow the initiatives prescribed in the procurement documents.

### Change management

The initiatives taken both at the level of practical policy, and at the level of implementation, reveal that the City of Copenhagen has had in mind the importance of “change management” (Kotter, 1996) when considering how to transform plans to reality. The guidelines and courses for advisers and contractors who participate in bidding for municipal properties and the plans for training caretakers in sustainability and energy management systems are all good examples of strategies for embedding changes in the mind-set of important actors who becomes vital links if the change towards higher sustainability is to succeed. Apparently the City of Copenhagen has with the described initiatives addressed several of the issues Kotter (1996) point out as eight often seen fails when it comes to implement major changes in organisations.

### Discussion and conclusions

The City of Copenhagen has made a marked effort to ensure sustainability as a principle in renovation and construction. The outset of the policy can be traced to the Brundtland agenda. Today the work with sustainability is organised in a “strategic way”.

As a change agent, the municipality acts on several levels. It acts directly with demands to contractors who want to bid for construction work; it acts as a very active network actor both with efforts to establishing new regional projects and for promoting the ideas to business, industry, public and the state. In other words, the City of Copenhagen is applying a well-organised change management in order to achieve its goal when it comes to sustainable renovation.

The two renovation cases described in the text show two very different approaches to sustainable renovation. Both are clearly in harmony with the overall strategic goals but do on the other hand follow two different paths within the strategy of sustainable renovation in Copenhagen.

The Osram case tells a history of a high-profile spearhead project that transforms a former industrial and very energy-consuming building into a building with low-energy consumption without violating the special architectural expression of the building. The renovation was expensive and involved state-of-the-art solutions. It can be difficult to calculate payback time for the project. However, it certainly has a value as a prominent showcase illustrating that even the most difficult, non-insulated buildings from the 1950s can be renovated in a sustainable manner and with respect for the architectural expression.

The Grøndal Centret case tells a completely different story, but not a less important one. Compared with the Osram house project, it is not ambitious in the short term; however this must not be conceived as an approach without planning and long-lasting considerations – on the contrary, we have seen that a thorough and permanent attention has resulted in an incremental and

innovative effort. This effort has apparently been inspired by at least two major motives, the users' demands and an on-going analyses of how to reduce the energy consumption. Over the years there has been remarkable and steady result in energy savings.

A major problem for conducting sustainable renovation in practice in the municipality seems to be the calculation of payback periods (internal interest rate). At the same time, the payback period is a central instrument in the political decision-making process when talking about sustainable renovation, which in this connection is mainly identical with "energy savings". Furthermore, the standard economic planning horizon is far too short to accommodate ambitious, expensive energy-saving projects. Cooperation with a private or semiprivate investor is a possible way of handling this problem and the City of Copenhagen is currently looking at this possibility.

Looking at the political and strategic move towards sustainability, one can say, that inside the municipality, the original more ideological agenda about climate initiatives, was supplemented by a translation to the economic dimension (with considerable attention to calculations of payback time). Apparently this "translation" enabled a broader support for sustainability at the political level in the City of Copenhagen.

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# Appendix 6: Implementing health and safety strategies in refurbishment

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## Introduction

The second Danish SURE case will analyse how a public construction client implements health and safety in refurbishment projects and reversely how the lessons from implementation shapes the health and safety strategy of the client. This study is based on business strategy analysis and draws on three sets of methods: An analysis of documentary material from the client and the refurbishment project, qualitative research interviews with project participants and a site visit. In conclusion, this paper has illustrated the challenges of embedding new sustainable procurement policies and practices in a construction client organisation.

## Background

The Danish Working Environment Authority (in Danish: Arbejdstilsynet) annually publishes statistics on the number of accidents at work and work-related diseases. Although a significant under-reporting is likely, the figures give an indication of the state of the working environment. Table 16 shows the total number of reported accidents at work in the period 2004-2009 due to their seriousness and year of registration. The seriousness is aggregated from 28 categories into three main types: 1) Fatalities, 2) serious accidents (amputation of body parts, bone fractures or other injuries involving several body parts or large areas of the body), and 3) other accidents.

Table 16. Reported accidents at work 2004-2009 by type (seriousness) and year.

	2004	2005	2006	2007	2008	2009
Fatal accidents	45	59	61	66	44	44
Other serious accidents	5,007	5,249	5,778	5,537	5,666	4,847
Other accidents	38,627	41,798	42,866	43,216	43,811	37,670
<b>Total</b>	<b>43,679</b>	<b>47,106</b>	<b>48,705</b>	<b>48,819</b>	<b>49,521</b>	<b>42,561</b>

Source: Arbejdstilsynet (2010).

When taking the number of employees in the construction sector into account, the incident rate is about twice as high as the average incident rate among employees in all industries.

The number of reported work-related diseases broken down by category of main diagnosis in the period 2004-2009 is given in Table 17 below. The incidence rate of reported work-related diseases is stated as the number of reported work-related diseases per 10.000 employed persons at the year of registration. In the period 2004-2009 the incidence rate of reported work-related diseases varied between 46 and 61. The incidence rate among construction workers is close to the average for all industries. It is worth noting that among construction workers the prime reported work-related disease is muscular skeletal diseases.



Table 17. Reported work-related diseases 2004-2009 by category and year.

	2004	2005	2006	2007	2008	2009
Muscular skeletal diseases	5,909	6,922	7,607	7,455	7,076	6,489
Hearing impairment	1,689	1,597	1,908	1,736	1,901	1,883
Psychosocial diseases	1,230	1,229	1,468	2,039	1,703	1,720
Airway diseases	487	549	649	716	598	535
Nervous system diseases	470	540	511	511	459	471
Cancer	215	214	315	563	715	701
Other diagnoses and unknown	655	569	1,677	926	898	866
<b>Total</b>	<b>12,604</b>	<b>13,967</b>	<b>17,119</b>	<b>17,265</b>	<b>16,763</b>	<b>15,596</b>
<i>Incidence rate</i>	<i>46</i>	<i>51</i>	<i>61</i>	<i>60</i>	<i>59</i>	<i>55</i>

Source: Arbejdstilsynet (2010).

Given the figures above, construction sites are generally acknowledged to be dangerous work places. Despite tight public regulation, frequent control by inspectors specialized on construction from the Danish Working Environment Authority, elaborate information material on preventive measures, paradigmatic exemplars of construction projects to follow etc., construction still holds some of the highest rates of accidents and injuries among all industries in Denmark.

In recent years, health and safety on building sites has gained increased political focus and existing governmental rules have been intensified. More specifically, the construction client has been urged to play a more active role and has been obliged to take responsibility for the enforcement and improvement of health and safety on construction sites. Accordingly, new governmental regulation was issued in 2008 (Bekendtgørelse nr. 1416 af 27. december 2008), which among others made it mandatory for construction clients to take responsibility for coordinating the health and safety efforts on the construction site through a health and safety coordinator for planning and projecting (a so-called H&S Coordinator (P)).

As a governmental construction client, the Danish Palace and Properties Agency (abbreviated SES)<sup>2</sup> decided to strengthen its work with safety and health in the wake of a new governmental building policy urging the public clients to become pioneering construction clients (Regeringen, 2003) along with the new requirements on health and safety. The strategy was to comply with the rules from the Danish Working Environment Authority in a coherent and thorough way, to go a little further with a proactive approach and to be visible for the contractors and other clients for the agency's work with health and safety.

### Purpose and scope

This study will analyse how a public client implements health and safety in refurbishment projects and reversely how the lessons from implementation shape the health and safety strategy of the client.

In the actual case, focus is on the implementation of a new strategy for health and safety on building sites and how it is transformed from a decision on management level in a client organisation to the individual projects. The case looks especially at the efforts to introduce a prioritisation of health and

<sup>2</sup> With the change of government in September 2011, the Palace and Property Agency has been reorganised. The activities on cultural heritage have been moved to the Ministry of Culture, and the property business has been merged with the agency for university buildings to form the new Bygningsstyrelsen (for more information, please visit [www.bygst.dk](http://www.bygst.dk)). The content of this report refers to the period before the merger.

safety amongst project leaders and the cooperation with the involved companies in a building project.

## Methodology

This case study is based on the combination of three sets of methods: First, documentary material from the public client along with project material, photos etc. from the architect office will be analysed.

Second, a number of qualitative research interviews have been conducted with participants in the refurbishment project. These include 1-2 hours long qualitative research interviews (Kvale, 1996) with:

- The project director of the client.
- The building coordinator of the client.
- The H&S coordinator (P) from the architect firm.
- The contractors' project manager and H&S coordinator (B).
- The head of administration of the user organisation.

Third, the study will draw on a site visit to the refurbished court house in Odense.

## The public construction client

### About the public construction client

The Palace and Property Agency (or in Danish abbreviated SES) is one of the three main governmental building agencies. The agency is part of the Ministry of Finance.

In 2010, the agency employed some 330 employees (Slots- og Ejendomsstyrelsen, 2011). The annual turnover in 2010 was around DKK1.4 billion including both offices and cultural buildings (castles and gardens).

Besides the internal administrative department, the organisation is divided into four professional departments:

- Department for office buildings.
- Department for castles and gardens.
- Department for building projects.
- Department for finance, including property portfolio management.

Below, the agency is described in further detail. The description is primarily based on information available at the website of the agency.

### Historical development of owner and ownership

In 1990, the Danish Properties Directorate (Ejendomsdirektorat) being part of the Ministry of Housing and Building was abolished and resurrected as the national Palace and Properties Agency (SES). Simultaneously, the rules on administration of the state's office properties and premises changed. While the Properties Directorate of the Ministry of Housing and Building placed office properties and premises and a wide range of services at the disposal of ministries and agencies free of charge, the new rules implied that the users now were to pay in order to use the premises, and thus became tenants.

The new status as a national enterprise involved a larger financial margin, including permission to offer consultancy and certain kinds of property services to tenants, municipalities and counties (Slots- og Ejendomsstyrelsen, 2011a).

In 1995 the agency were given new business goals. The majority of the performed activities within facilities management such as security and cleaning

were outsourced, and focus was instead directed at the agency's core services: To provide appropriate office premises for the central government administration and to administer the operation and maintenance of office buildings and the cultural heritage (royal castles and gardens) included in the agency's property portfolio (Slots- og Ejendomsstyrelsen, 2011a).

Further, a new set of activities in the form of presentation of culture now arose. The agency was to present the cultural heritage actively and systematically to the public. The purpose was to increase the knowledge of the cultural values and establish an understanding of why it is important to preserve these in the future (Slots- og Ejendomsstyrelsen, 2011a).

By 1 January 2001 the so-called SEA reform entered into force based on a report drafted by an inter-ministerial work group (By- og Boligministeriet et al., 1999). The purpose of the reform was to create a market oriented property administration that could work on roughly the same terms as the private letting market. The reform implied more freedom to act to both the lessee and the lessor, and to SES the reform opened up the possibility to rent out the state property of office buildings now in the portfolio of SES to government tenants, the portfolio including both existing buildings and new constructed buildings according to the tenants needs (Slots- og Ejendomsstyrelsen, 2011a).

Within recent years the agency has added a number of new tasks to its portfolio. In 2004 it was decided that SES should have a coordinating role with regard to the buildings in relation to the local government reform, and in January 2005 the handling of the Danish court buildings was transferred from the Danish Court Administration to SES. By 1 January 2007 SES also took over the properties of the police. A task that added approximately 170 police stations and other buildings in Denmark, Greenland and on the Faroe Islands to the agency's property portfolio (Slots- og Ejendomsstyrelsen, 2011a).

### **Portfolio and tasks**

Today, the Palace and Properties Agency has the responsibility on behalf of the state for a portfolio of some 789 properties, 20 castles and 13 larger gardens. The agency owns a portfolio of around 180 office properties and premises covering a total of approx. 1,000,000 m<sup>2</sup>. These are rented out to ministries and agencies in Greater Copenhagen and to a number of state institutions throughout the country. The agency also draws up plans for maintenance of the buildings and make sure that they are in good repair. Further, the agency rent premises in around 150 private properties, covering approx. 1,100,000 m<sup>2</sup> that are sublet to state institutions (Slots- og Ejendomsstyrelsen, 2011a).

A key aspect of the office-property services provided by the Palace and Properties Agency involves the advisory services offered to customers in conjunction with localization in the properties managed by the agency. Thus, if a customer is about to relocate or undertake major modifications of its physical framework, the Palace and Properties Agency can provide guidance to the institution in question. For example the agency provides advisory services to state institutions and other customers in the area of flexible office layout and design based on the 'New Ways of Working' concept, which the agency also has implemented within its own organisation (Slots- og Ejendomsstyrelsen, 2011a).

The Palace and Properties Agency preserves and develops the majority of Denmark's known castles, palaces and gardens, e.g. Kronborg Castle, Amalienborg, Christiansborg Palace, Koldinghus and the King's Gardens in Co-

penhagen. This cultural heritage must furthermore be presented to the public both on site and through books, brochures and electronic media (Slots- og Ejendomsstyrelsen, 2011a).

### Overall strategy of the client

According to the website of SES (Slots- og Ejendomsstyrelsen, 2011a), the mission of the Palaces and Properties Agency is:

*“to provide the state with future-oriented office premises and to maintain and utilise the state’s palaces, castles and gardens.”*

The vision of the agency is to:

*“be an innovative and professional state property agency as the natural place for carrying out tasks relating to state properties. The Palaces and Properties Agency also aims to optimise societal use of the state’s palaces, castles and gardens.”*

The strategies that are needed to realise the mission and vision of the agency is specified in the balanced scorecard model, which have been used by the agency since 2002 (for an introduction to the model, see Kaplan & Norton, 1992). Case Appendix A shows part of the balanced scorecard. The scorecard contains four elements: 1) owner relation, 2) customer/user relationships, 3) business processes, and 4) learning and growth. For each of the four elements four core tasks are defined. Thus, the balanced scorecard defines 16 strategic focus areas, which are essentially the same over time, whereas the priorities and actual measures initiated may vary from year to year.

## Procurement strategies in practice: refurbishing a court house

The actual case is the refurbishment and modernisation of the city court building in Odense, which is part of the portfolio of the Palace and Properties Agency.

### Background: The court reform

In 2007, the court system in Denmark was reformed (for further information, please visit Domstolsstyrelsen, 2011a). The objectives of the reform were to:

- Shorten the case processing time.
- Create less vulnerable and more efficient courts.
- Improve leadership and management of the courts.
- Improve uniform application of law through increased knowledge sharing and specialisation.

According to the Danish Court Administration (Domstolsstyrelsen, 2011a), the reform introduced a number of changes with respect to legal procedures, organisation and localisation:

- The number of district courts was dramatically reduced from 82 to 24.
- Virtually all legal cases were to be tried by the district courts as the first tier.
- Civil cases in district courts could be tried by a panel of judges or by a judge assisted by experts.
- The Supreme Court would only review cases of principle.

Consequently, the Danish court system is now composed of the Supreme Court, the two high courts (one high court for the eastern part of the country and one high court for the western part of Denmark), the Maritime and Commercial Court, the Land Registration Court, 24 district courts, the courts of the Faroe Islands and Greenland, the Appeals Permission Board, the

Special Court of Indictment and Revision, the Danish Judicial Appointments Council and the Danish Court Administration (Domstolsstyrelsen, 2011a).

The centralisation of the district courts and the strongly reduced number of district courts created a need for more space in fewer locations. Part of the reform was the transfer of property management of the courts to the Properties and Palaces Agency. This transfer also implied a transformation of the relation between the actors in which the Properties and Palaces Agency was now constituted as the letter of properties, the Danish Court Administration as the lease-holder and the district courts as the actual users of the court buildings (Slots- og Ejendomsstyrelsen, 2011a).

### The court house in Odense

One of the newly extended district courts was the district court in Odense. The tasks of the district court include among others probate court, enforcement court including compulsory sale, criminal court and civil court. With the reform, the number of employees increased to close to 100 persons. In 2010, the employees included some 25 lawyers, 55 clerical workers, 4 trainees, 6 in temporary job training and 5 others (Domstolsstyrelsen, 2011).

The district court in Odense is located in two adjacent buildings: the old court building and a newer rented office building administrated by a private property manager. The old court building is further connected to the local gaol, which is situated right behind the old court building (see Figure 78).



Figure 78. The City Court in Odense (with red roof). The grey building in the back is the associated gaol. The grey roof in the bottom right corner belongs to the neighbouring office building with the rented office space of the district court. Source: [www.krak.dk](http://www.krak.dk) and COWI (published with permission).

The court building in Odense was built in 1861 along with the construction of the new gaol (the grey building in the back). In 1919-20, the original court building went through an extensive alteration and extension with the addition of a complete new building (the red building in the front). Thus, the court house is actually two buildings in one. It is an old masonry building three storeys high with a fully used basement and a fully used loft. In relation to the jurisdiction reform in 1973, the roof of the original court building was extensively renovated and replaced with a new flat roof top extension with a terrace along with offices to accommodate the new president of the court, library and other offices (Retten i Odense, 2002).

On the other side of the side road Tinghusgade, the city court has rented additional office space from a private property manager (the building with the grey roof in the bottom right hand corner). The rented office building is a typ-

ical office building from the 1980s with a concrete load-bearing structure and masonry facades.

The old court house has repeatedly been renovated over time to accommodate for legal reforms, new space requirements etc. Today the city court houses 13 court rooms with associated waiting rooms in the old court house. The court rooms and waiting rooms have undergone renovation in the 1990s except for the main court room, which is used for the court sitting with a jury. The main court room is located at the second floor underneath the roof tower (see Figure 79).



Figure 79. The court house viewed from the opposite side of the main street Albanigade. Photo: Kim Haugbølle.

### Defining the scope of the refurbishment

When SES formally took over the court houses around the country in 2007 as a new part of their portfolio, the first thing to attend to was to get an overview of the technical condition of each of the court houses and the need for maintenance and refurbishment. First, SES gained hold of all relevant documentation on the court houses and stored it in the digital project library of SES. Second, site visits and condition surveys were carried out. Third, SES and the Danish Court Administration together with the local users initiated consultations on the need for refurbishment and the financial conditions etc.

As a consequence of the court reform, the district court in Odense was looking for more office space. The solution to the increased need for office space was threefold: 1) refurbish the old court building, 2) rent more space at a private property manager, which in turn led to 3) an agreement with the private property manager to build an extension to the rented office building.

The actual case represents a typical refurbishment project of the agency, when it comes to:

- The type of work undertaken (refurbishment of old office buildings).
- The budget (DKK10-20 million, €1.5-3 million).
- The procurement protocol (main contracting).

This type of refurbishment projects is not only typical of the agency, but also constitutes the majority of the construction works done by the agency.

### Framework agreement: selecting the consultants

The refurbishment of the old court house was initiated in 2007, but not concluded until 2010. SES had decided to organise the refurbishment in accordance with the usual procedure in which the first step was to select a design team consisting of an architect and a consulting engineer and step two was the selection of a main contractor.

The client has earlier established a so-called framework agreement for project designs in accordance with European regulation. The framework agreement run for 4 years and are effectively separated into two geographical agreements – one framework agreement with four design teams east of Storebælt and one framework agreement with three design teams west of Storebælt. Only teams selected for the framework agreements will in principle be able to bid on projects tendered by SES as client. The selection of the winning design teams was based on economically most advantageous tender with a weight of 35 % on price and 65 % on qualifications. Qualifications concerning health and safety have not been a part of the selection of the companies in the framework agreement, but are expected to be included in the next round of tender for framework agreements.

A client's consultant helped SES in the initial stages of the project and prepared the tender of the consultancy tasks as full-service consultant. The tender procedure of consultancy tasks is based on the following:

- Call for tenders among the three prequalified design team, who had signed up in the framework agreement. The winning team of the competition was to execute the design work and the supervision of the construction work at the building site, including the preparation of the plan of health and safety.
- A division of the qualifications into four groups with the weight of each in brackets: curriculum vitae including knowledge on health and safety (40 %), design work (20 %), communication (20 %) and management (20 %).

The winner was a team led by the architect firm Claus Bjarrum Arkitekter. The firm is a small firm with some 15 employees and based in the metropolitan area of Copenhagen.

### **The refurbishment project: topics and coverage**

When it came to the refurbishment of the old court house, the needs were identified and three preliminary objectives were set:

- Upgrading of the main court room.
- Relocation of the canteen from the basement to the top floor (loft).
- Relocation of the archives to the basement.

During 2008 the architects developed their proposal on how to refurbish the old court house. The proposal rested on three metaphors:

- The theatre (in Danish "teatret").
- The tower (in Danish "udkigstårnet").
- The cave (in Danish "grotten").

The metaphor of the theatre was meant to draw a parallel from the court room to the stage of a theatre with its actors, screenplay, more or less rehearsed roles to play etc. Below, Figure 80 shows the main courtroom before and after the refurbishment. Following this metaphor, the architects set out to design a new main courtroom, which would place the accused person in the centre of the room with the defence and the council for prosecution at the left and right respectively, the judges and secretaries in front of the accused, and the audience at the back. The white circular element at the top is the new lighting fixture, which frames the stage. Besides the relocation of the positions of actors and the obvious physical changes of furniture, interior walls, surfaces etc. a number of intelligent features was also included like computer networks, electronic controls of lighting etc.





Figure 80. Main courtroom before and after refurbishment. Photos: Left picture: Provided by Torben Kristiansen (used with permission). Right picture: Ib Steen Olsen.

The second metaphor of the tower symbolised the outlook from high above ground, which would become more readily accessible by moving the canteen from the basement to the top floor (the loft). The canteen had previously been located in the somewhat damp basement with inadequate ventilation, worn down surfaces etc. and with too little space for the new number of employees at the district court. Instead of retaining the basement as canteen, the canteen was moved to the top floor, which allowed for a room with a view, more direct daylight, improved ventilation, more space etc. (see Figure 81).



Figure 81. The canteen was moved from the cellar to the top floor as part of the renovation of the building. Photo: Ib Steen Olsen.

The third metaphor of the cave was related to the renovation of the basement. The cave or basement with its typical character of being dark, moist and hidden away from the public eye was to be transformed to an inviting, open and light space. Figure 82 below shows the refurbished hallway in the basement. Besides this a number of storage rooms for the archives of the district court, handbook library, bicycle parking etc. were also renovated.





Figure 82. The refurbished hallway in the basement. Photo: Provided by Torben Kristiansen.

### Technological solutions

Although the renovation turned out to be quite challenging with respect to among other things health and safety (see later), the majority of the technological solutions applied during the renovation were familiar solutions. One notable exception is an ingenious ventilation solution developed for a meeting room (see Figure 83). The ventilation system is integrated in the wall – previously a door, now blinded – where the curved recess around the picture is effectively the ventilation shaft.

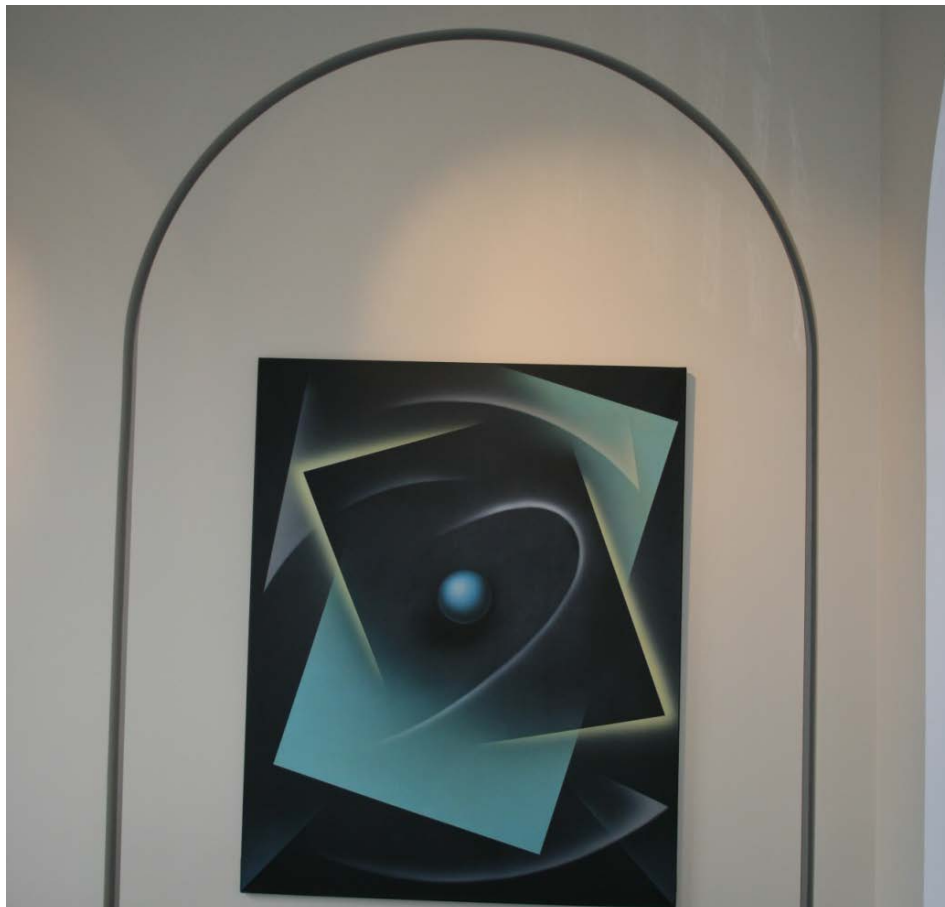


Figure 83. Ventilation system integrated in the wall. The painting on the wall is "From space to space" by Finn Mickelborg in 1995. Photo: Kim Haugbølle.

## Procurement protocol: main contracting

For the construction work on the building site the client decided to select a main or general contractor in line with the usual practice of the client. Five contractors were invited to deliver a bid on the basis of the drawings and descriptions worked out by the design team. The award criterion was based on lowest fixed price.

Out of the five invited contractors, only three handed in a tender. The tenders were ranked according to their bid on lowest fixed price. The winner of the tender was ranked number three. The top two tenderers were rejected since they did not fulfil the formal requirements concerning mandatory key performance indicators registered in earlier projects. This requirement is stated in a directive concerning governmental construction projects by 1 January 2004 (Bekendtgørelse nr. 1135 af 15. december 2003), which was replaced by 1 January 2010 (Bekendtgørelse nr. 1469 af 16. december 2009).

The winning tenderer Nordisk Klima A/S happened to be the company who was already doing the main part of the daily maintenance of the building. Nordisk Klima A/S is a 90 years old firm mostly operating on a local scale. The firm employs up to 100 people depending on business cycles. The firm specialises in HVAC solutions and sprinklers, but do also do plumbing, carry out building maintenance and build or renovate roofs and facades.

Later the winning company engaged number two as subcontractor for approximately 25 % of the offered prize, mostly on carpentry. It was due to an overload of work in the company and a good acquaintance and previous working experience with the actual persons of the subcontractor Hans Jørgensen & Søn, a previous subsidiary of the Nordic contractor Skanska.

In sum, the organisation, the procurement process and the collaboration between project participants followed traditional forms besides the somewhat curious exclusion of two contractors for not fulfilling statutory requirements.

## Financing the refurbishment

The agency basically has two ways of financing its activities depending on whether it is related to the cultural heritage or office buildings. In the first case, refurbishment of the cultural heritage is financed through the grant system. In this case, the agency will ask the standing committee on finances in the Danish parliament for a grant to do a refurbishment. In the second case, office buildings are subject to the so-called SEA scheme, which implies that the tenants pay a market-based rent for letting the office buildings. Thus, the case in question is following the second scheme.

When an office building becomes part of the agency's property portfolio, an appraisal is being made of the relevant market-based rent level. This appraisal includes an assessment of what is needed to upgrade the property to the market standard for comparable office buildings in that area. The cost for this upgrade is labelled "the upgrading cost" and the financing of this cost is done by loan-taking in the Danish National Bank.

It is mandatory for the agency to upgrade the building to the market standard within four years. The value of the property at this standard is called the market value. The market value forms the basis for the calculation of the rent level for the tenant. The tenant will have to pay this market-based rent level from the beginning, even though the building has not yet been upgraded.

If the tenant wishes a modernisation or new location, the best possible option is determined between the tenant and the agency, and a project (refurbishment or new built) with the agency or a PPP supplier as client may be initiated, where the tenant will then pay the rent after completion. Until the project is finished, the agency will take out a building loan, which will be converted to a new ordinary loan when the tenant takes over the property. Whether the project is financed by loan or not, projects for office buildings with a budget over DKK60 million will need to prepare a document for approval by the standing committee on finances of the parliament.

The maintenance of the exterior and technical installations is managed by the agency. It is financed through the income, which the agency generates through its property business, primarily the rent paid by the tenants.

Before the design and refurbishment process was started, the rent was negotiated and determined between the Properties and Palaces Agency, the Danish Court Administration and the actual user.

Figure 84 illustrate the financing of the refurbishment. The renovation was budgeted at DKK15.5 million excluding VAT, but including a reserve of 10 % for unforeseeable costs.

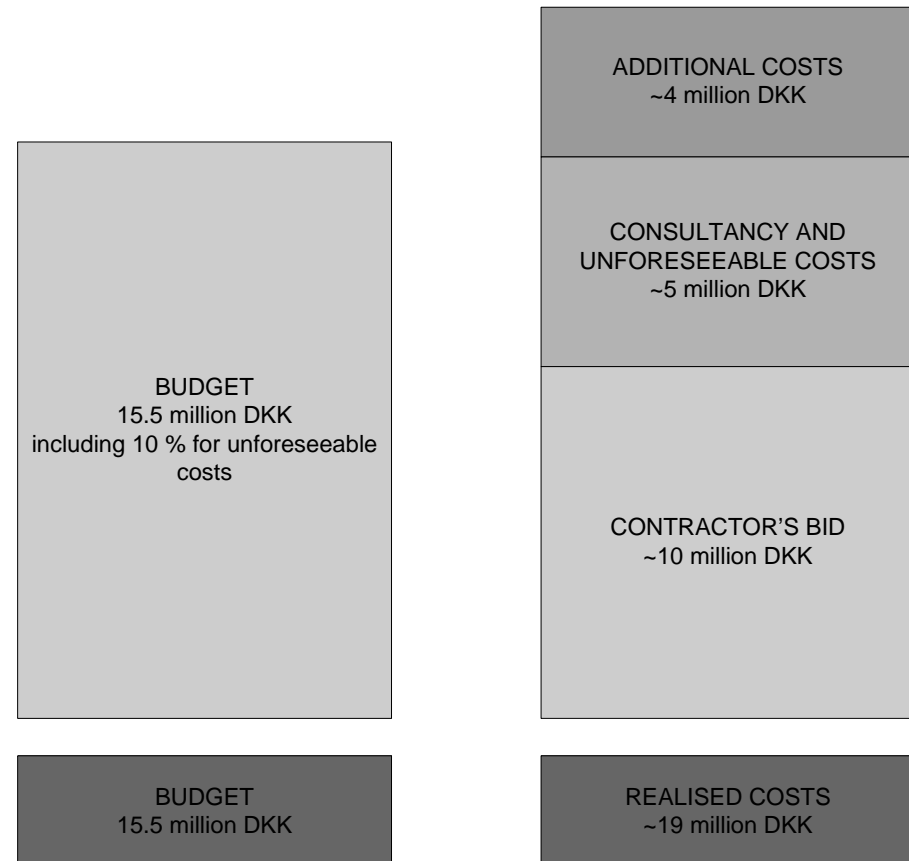


Figure 84. Illustration of the budget and realised costs for the refurbishment (without VAT).

The lowest bid of the winning contractor was however just below DKK10 million due to the financial crisis, which led to a reduction of the tender prices with some 30 % compared to the calculated costs as estimated by the consultants. The resulting costs landed on some DKK14.8 million including approximately DKK5 million for consultancy costs and unforeseeable costs due to hidden problems in the existing sewage system, the timber constructions and more asbestos in constructions than expected. In addition, some DKK4 million went to additional work and other costs related to problems with the sewage system, the need for a new floor in the basement and the exchange

of waste water pipes, partly paid by an additional contribution by the agency partly by a renegotiation of the rent level.

## Tools and technologies: Health and safety

### General obligations of a construction client

According to executive order no. 1416 (Bekendtgørelse nr. 1416 af 27. december 2008), the construction client has four obligations when it comes to health and safety:

- Demarcate the health and safety measures in the common areas.
- Prepare a health and safety plan for the conditions on and operation of construction sites.
- Coordinate the health and safety work at the design phase and on the construction site.
- Notify the Danish Working Environment Authority of the establishment of a construction site.

The client may engage other persons or enterprises to carry out the tasks laid down in accordance with the client's responsibilities. The client is under an obligation to appoint others to carry out the coordination work if he does not himself possess the qualifications required or has a competent person for the task at his disposal. However, the client is still responsible towards the Danish Working Environment Authority for the satisfactory performance of the work tasks.

The coordination of health and safety of construction projects entails the appointment of two separate coordinators: 1) health and safety coordinator (P) for design and projecting, and 2) health and safety coordinator (B) for the building activities.

### Core tool: Plan for Health and Safety

The core tool to manage health and safety on construction sites is the Plan for Health and Safety, abbreviated PHS (in Danish: "Plan for Sikkerhed og Sundhed" or commonly abbreviated PSS).

Clients shall always prepare a written plan, if two or more employers concurrently employ more than 10 people on the site. On construction sites with several employers and fewer than 10 people simultaneously on site, a plan for health and safety is only demanded if the work is particularly dangerous. It is however recommended that there always be a PHS, apart from very small building sites.

The plan must be available before the work starts on the construction site and be kept updated. PHS over the entire construction period shall be available for employees and employers on site.

In the ensuring guideline on the client's duties and responsibilities, the content of the PHS includes (Arbejdstilsynet, 2008):

- An organisation chart with contact information of the involved parties.
- A site plan showing the location of among other things the identified risks in the area and the character of the risks; access, transport and escape routes; cranes, hoist and scaffolding; space for materials, workshops and waste containers; sheds, toilets etc.; electricity, water and sewage connections; and equipment for alarm, fire, rescue and first aid.
- A detailed time schedule including identification of periods of hazardous work on site.
- Indication of traffic areas.

- Indication of areas with work conducted by more employers and their employees.
- Indication of common health and safety measures, and who is responsible for providing, maintaining and removing the measures.
- Definition of areas with special risks.
- A procedure for continuous monitoring of installations etc.
- Indication of who is responsible for plans of evacuation etc.

### Working with health and safety

An overview of the work with health and safety in the refurbishment of the City Court in Odense is shown in Figure 86. The figure points out how the practical work with health and safety is based on descriptions from the tendering process, the organisation of the construction work, the monitoring of the work from client and contractor, public regulations and best practice.

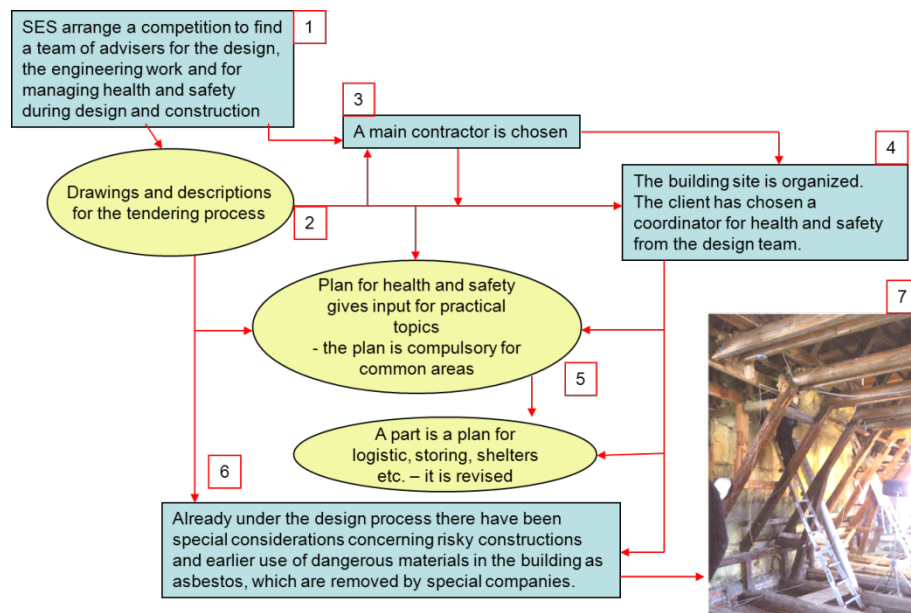


Figure 85. Overview of the process.

As a general principle the client asked the consultant to take care of the health and safety coordination. Thus, the coordinator for health and safety (P) was appointed from the design team (see Figure 85, mark 1).

A plan for health and safety (PHS) was worked out as part of the procurement documents – drawings, descriptions, contract etc. The site plan and the PHS were developed by Claus Bjarrum Arkitekt. The agency applied its own template for the PHS based on the standard template developed and provided by the Industrial Working Environmental Council for Building/Construction (“Branchearbejdsmiljøråd for bygge og anlæg”). The template followed the general requirements, but in certain paragraphs the requirements had been tightened from voluntary (“could”) to mandatory (“shall”) requirements.

The PHS contained a long list of practical information for the building site. For example addresses, contact information, the organisational chart, a plan for the building site, logistic, shelters, storing areas, the safeguards, special risky areas, and cleaning of the site.

Except for the site plan of the building site the information in the PHS is normally not altered/revised during the construction work. Meanwhile it is used as a checklist at meetings during the construction work. PHS is compulsory when more than one contractor is working in the same area. Therefore an area can at a certain moment be included in the PHS and later kept

outside the PHS. It will be reflected in the site plan for the project. The site plan will and has in the actual case been updated several times during the project.

The general policy of the agency was to have the health and safety coordinator (P) to be the coordinator all the way through the project on behalf of the client. After tendering, the consultant still had the responsibility for the regular update of the PHS, but the winning contractor was required to contribute to the update of the PHS (see Figure 85, mark 3).

The building site was organised with a clerk of work from the design team for monitoring of the progress in the construction work appointed by the client (see Figure 85, mark 4). The clerk of work was also appointed as coordinator of health and safety (H&S coordinator P). The clerk of work arranged the so-called health and safety meeting with the main contractor, which in this case were held every second week. In some cases the subcontractor(s) participated.

The procedure was to have the health and safety meeting first, then followed by the building site meeting and concluded with a walk around or inspection at the site. Typically the health and safety coordinator (P) from the architect firm participated in all of the meetings and the walk around together with the main contractor. The building coordinator from the client organisation was typically participating in only every second meeting or so. The frequency of participation by the building coordinator was somewhat higher in the actual project since this was the first building project she was involved in after having recently being employed. Coming from a job within civil engineering works on railroads, the building coordinator of the client had limited experience in building projects and used the actual refurbishment project as a kind of training-on-the-job. Still, the building coordinator in the actual case and in general is exhibiting an arm's length principle of leaving over the responsibility to the appointed coordinators. Thus, the client organisation relies on the competence and scrutiny of the safety coordinators of the consultant and contractor.

The plan for health and safety was an important focal point for the practical work (see Figure 85, mark 5). As mentioned above the plan contained day to day information and essential guidelines for the right behaviour when working in common areas. The coordination of the health and safety within each contractor's own work was nonetheless the sole responsibility of the individual contractor.

During the construction work the contractor and the coordinator had to make decisions on how to reduce and in some cases execute risky operations and if necessary call special companies to remove dangerous materials (see Figure 85, mark 6 and 7). This also happened on more occasions in this case. The PHS had to be revised several times during the refurbishment. The refurbishment was being complicated due to 1) the extensive changes of the layout, 2) the execution of the refurbishment in parallel with continued use of the building, and 3) the discovery of asbestos to a much larger extent than anticipated.

The changes of layout included the demand for tearing down some party walls, moving the canteen from the cellar to the top floor; and the unforeseen expansion of the refurbishment of the cellar due to problems with moisture from the underground. Further, the layout changes implied a rather complex logistical relocation of people, space, files and equipment. Add to this the curiosity of particularly the employees, making it at occasions difficult to separate construction work spaces from office work spaces.

Despite an early survey of the building to identify the use of asbestos in the building, the project was caught by surprise when it was discovered that a more extensive use of asbestos for piping had been used in the walls of the main court room. As a result the main court room and neighbouring areas had to be sealed off to avoid pollution of the rest of the building during the removal of the asbestos by certified specialist firms.

### **Technological solutions**

The technological solutions applied in the case are typical tools and methods, mainly written documents. SES is using digital drawings, descriptions and other documents in correspondence with the requirements on digital construction as laid out in the executive order (Bekendtgørelse nr. 1381 af 13. december 2010).

### **Achievements: performance and costs**

The work with health and safety succeeded as there were no accidents on the building site and the local division of the Danish Working Environment Authority did not have any remarks at its regular two meetings on the site. In fact the site received a green smiley by the Danish Working Environment Authority as a so-called exemplary site ("mønsterarbejdsplads"). This is not to say that the site did not elicit any challenges. During the construction it was necessary for the coordinator to reprimand some workers concerning breaches of safety procedures. Normally he would go through the boss for the gang but in acute cases directly to the worker.

As the practical work with health and safety in a building project in accordance with the governmental rules is divided between the client and the companies – in this case also the users – cooperation is very important. Here the PHS plays an important role as common basis and understanding among the involved companies for health and safety and a starting point for information of the employees and for exchange of experiences. An example illustrates the value of early and close collaboration between the contractor and the health and safety coordinator of the design team. During the contractor's planning of the refurbishment the idea arose that the planned installation of a prefabricated unit for ventilation under the roof not should be executed as expected by moving away a part of the roof tiles, but instead by assembling prefabricated parts of the unit at the storey.

### **Barriers and incentives**

It is compulsory for all design and construction companies in Denmark to follow the governmental rules concerning health and safety (HS) on building sites and for example use HS coordinators for the design process (P) as well as for the construction process (B) and to make a plan for HS (PHS, in Danish abbreviated PSS – Plan for Sikkerhed og Sundhed). Still, it is commonly recognised as problematic to ensure implementation and follow-up.

### **End user engagement**

Persons and representatives from the end user, the City Court in Odense, participated in the planning process and showed huge interest and curiosity in the practical renovation work. As explained by the health and safety coordinator (P), the major challenge when it comes to health and safety was not so much related to the construction workers, but rather to the office workers due to the simultaneous execution of two very diverse set of job functions.

## Client as change agent

### At which fields will the client be active?

The agency has defined lower energy consumption for tenants and users as one of the target areas in the balanced scorecard strategy. Following this, the agency has formulated a more targeted energy policy for reducing energy consumption. Further, the agency has also initiated a number of development activities and published various reports on open space offices and new ways of working in office buildings taking into account noise etc. However, the agency has so far not been prepared to issue a broader policy on sustainability.

Health and safety on building sites is not dealt with separately in the balanced scorecard strategy. Rather, health and safety is part of the business processes, the third “leg” of the balanced scorecard. More specifically, health and safety is part of the fourth target of business processes, namely the target “optimal processes and processes along with efficient financial controlling” (see Case Appendix A).

### How will he get there?

The starting point for the agency is the general requirements concerning health and safety on building sites and the governmental building policy. The building policy underlines the responsibility for state agencies with building activities to act in an advanced way. In framing the agency's own building policy, it has been decided to work on two platforms: an internal and an external platform.

As for other targets concerning the businesses processes in connection with design and construction, the work with health and safety is anchored at top management level with the project director. This responsibility has not been taken lightly by the project director but has extended beyond the agency itself. Due to his previous employment in the defence building agency he has had a long term commitment towards health and safety as the public employers' representative in the Industrial Working Environmental Council for Building/Construction (“Branchearbejdsmiljøråd for bygge og anlæg”). The council is composed of an equal number of representatives of both employers and employees.

Further, he is also strongly engaged as the chairman of the Working Environment Committee of the Danish Association of Construction Clients (DACC). In particular, DACC has debated the content of the services of architects and consulting engineers with their respective trade associations. In December 2010, DACC finalised a paper with recommendations for the responsibility at the client side for coordination of the working environment at building sites. The aim is to give clients guidance for the individual contracts with architects, consulting engineers and contractors.

As such he has been deeply involved in shaping the future path of health and safety within building/construction. Within the agency itself, the project director has been instrumental in setting focus on health and safety. In his own organization the client will take initiative to organizational changes with the following characteristics: appointment of special knowledge leaders, issuing of guidelines and templates, workshops for project leaders, information meetings, criteria for selection of external partners in a building process – designers as well as contractors – and general briefing of the employees. More specifically, the agency has tightened several of the requirements from “can” to “shall” in its own template for the plan for health and safety.



An overview of the implementation of the target for health and safety is shown in Figure 86 below. The figure shows the transformation of the governmental legal requirements concerning health and safety to the daily work in the client organisation and especially the procurement process.

A strengthening of the culture concerning health and safety in practice and a new procurement strategy for the individual projects has been under development for some time. They have been anchored at management level and consist of several activities (see Mark 1).

A building policy for health and safety has been worked out. On that basis some general documents, for example templates for plan for health and safety have been established (see Mark 2).

In different building or renovation projects new ideas have been tested and key persons with special responsibility for keeping up to date with the development have been appointed as key resource persons (see Mark 3).

Special efforts have been allocated to educate and motivate the employees and on the basis of the testing projects the templates have been revised (see Mark 4 and 8). It also worth noting that all building coordinators employed with the agency are required to be trained as health and safety coordinators.

New projects are at an early phase assigned to building coordinators (see Mark 5). They are in charge of the procurement process (see Mark 7), and ensure that the companies are chosen on the basis of several criteria where not only the prize plays a role but also the companies' qualifications concerning taking care of health and safety. The agency nominates health and safety coordinators for the design and construction processes (see Mark 6). In this way the client has to evaluate, which criteria are important for the work with health and safety.

After each project the experiences are evaluated and the conclusions are channelled into the existing templates, which are revised. In this way the experiences are used and not just placed in an archive (see Mark 8).

Although the agency is pushing for improved health and safety through the above described process, it is also evident from the actual case study that the agency at the same time applies an arm's length principle to the building site and coordination of construction work.

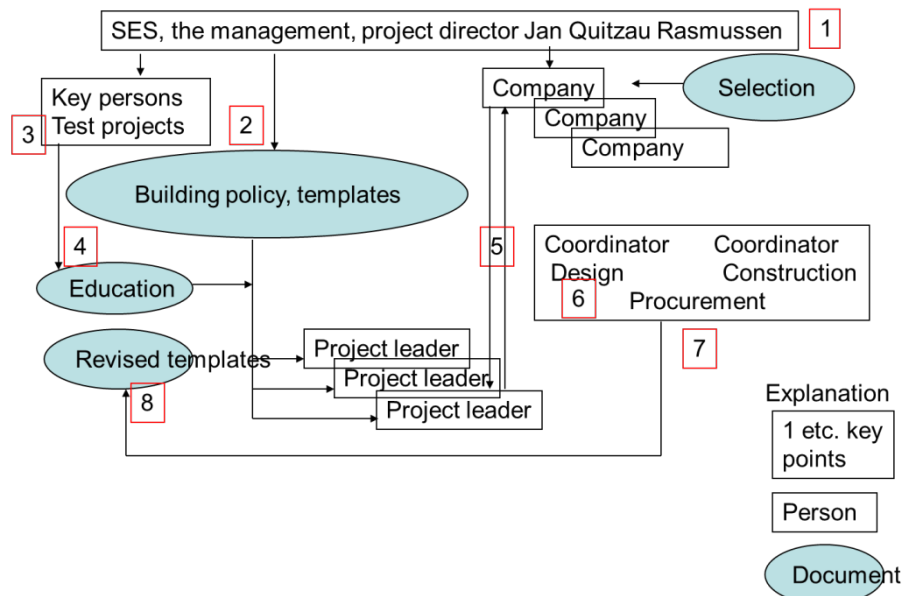


Figure 86. Important activities, persons and organisations in the implementation and use of the chosen policy.

### How will he win?

What are then the differentiators of SES? The client is a public agency operating under market-like conditions and exposed to private competitors. Consequently, the services delivered by the agency need to match those delivered by private competitors with regard to e.g. price, quality and delivery time.

Being a public agency also entails being embedded in a political environment of various and sometimes divergent or even contradictory political aims. On one hand, the drivers of change are the political wish and requirements of the Danish Parliament to reduce the number of accidents on building sites. This places a special obligation on the client as a governmental agency to live up to these ambitions and to follow governmental regulations as a minimum. On the other hand, the agency is expected to stay out of the public eye and not run any risks that may jeopardise the financial frame.

### At what speed will he proceed?

The staging of moves forward has three characteristics: 1) advancement as a front-runner, 2) expansion of requirements on health and safety capabilities in future framework agreements, and 3) the pursuit of an incremental approach.

First, the actual case study dates back before the public requirements on clients' duties and responsibilities were tightened from 2009. The case originates back to 2005 with the design process starting in 2007. A number of changes came into existence with the revision of the executive order on the client's responsibilities for health and safety. Two of the important changes were: First, it was stated that the responsibility for coordinating health and safety lies solely with the client. Second, it became mandatory to appoint a health and safety coordinator for the design process, not just for the construction process as previously. Having first-hand knowledge on these changes being on its way, led the project director of the agency to install a range of internal changes as described above in order to be ahead of the new requirements. The general strategy of the agency in this case was to increase the pressure on own building coordinators and the involved companies concerning the work with health and safety before the changes of requirements came into force.

The second characteristic of the staging process is related to the tender of new framework agreements to be installed by the beginning of 2012. Based on the experiences from the previous four-year period of framework agreements and the tightening of the demands on health and safety, the client was planning to include requirements on health and safety capabilities among consultants as part of the qualifications for tendering for new four-year framework agreements. Thus, the client wanted to send a signal that companies interested in working with the client had to make health and safety important topics in construction projects.

The third characteristic of the staging process is improvement through the pursuit of an incremental approach. The developed templates and the different activities for internal motivation will be monitored and the experiences used to strengthen the efforts. It is the intention of the agency to further develop the strategy and tools in an incremental way and in this way prevent and reduce risks concerning health and safety on the agency's building sites. The intention mirrors a decision to work with change management in a step by step approach.

### **How will he obtain returns?**

Being a public entity means that the classic profit-oriented motive is not the driving force. Rather, the economic logic is to gain as much value out of the available resources as possible. Being a public entity operating under market-like conditions does however entail that the agency would need to generate an income to pay the cost associated with building, managing and operating facilities. As such the agency will need to maintain a balance-of-cost principle.

Income for building and operating facilities comes in two different forms. The first form is a grant from the standing committee on finances of the Danish Parliament, when it comes to buildings of cultural heritage. The second form is related to the property business of renting out office buildings where the agency negotiates the future rent level with the tenants based on the tender results. This way of financing also calls for approval in the standing committee on finances of the parliament when the budget exceeds DKK60 million. Some gain or loss for the individual project is acceptable by the discretion of the agency as long as the overall project portfolio remains in balance.

The agency views improved health and safety as beneficial in the form of an improved reputation and a better cooperation with external partners and on the building sites. The agency considers that there is a positive connection between efforts to reduce accidents and the cooperation with companies and furthermore the mutual collaboration between the involved companies. Thus, health and safety activities can pave the way for returns in for example fewer defects and a better logistic on the building site.

## **Discussion**

The discussion below will address the six core questions on the appropriateness and coherence of the strategy of the client as they have been formulated by Hambrick & Fredrickson (2005).

### **Does the client's strategy fit with what's going on in the environment?**

The strategy of the client is clearly aligned with public policies on health and safety. Efforts are being made to ensure compliance with existing and impending public regulation, but the efforts do not go further than that. Compliance with other public policies, in particular budgetary discipline, plays a

crucial role to the agency (and other public building agencies). Thus, the ability to manoeuvre in the crossfire of divergent and sometimes even contradictory public policies is an extremely important strategic skill to master for a public building agency.

### **Does the client's strategy exploit your key resources?**

The key internal resources are linked to property management and client management. Most of the design and construction work is effectively outsourced to either full-service consultancies or contractors, leaving the building coordinators of the agency primarily with the task of procuring services. Thus, the key resources to actually carry out the design and construction work, including health and safety issues during design and construction, are located outside the client organisation and within architects' firms, consulting engineering firms or contracting firms.

As the strategy is laid out presently, the necessary internal resources seem to be in place. But to base client leadership primarily on procurement of external resources may not be the strongest strategy. There do seem to be a number of resources or roads not yet taken, which could contribute to an improvement of health and safety. Although, the agency is likely to use its purchasing volume through the renewal of the framework agreements to enforce a stronger focus on the improvement of health and safety, it will only be workable to some extent. For example economic incentives and/or sanctions do not seem to play any significant role. Further, the potential of setting a higher threshold for tenderers when it comes to health and safety could be explored and exploited. A more proactive use of the already existing benchmarks or grade books provided for clients, consultants and contractors by the Benchmark Centre for the Danish Construction Sector could potentially pull the construction sector towards higher standards on health and safety. Whether these resources could and would be mobilised by the agency really depends on the level of ambition, which will be addressed below.

### **Will the client's envisioned differentiators be sustainable?**

Looking back 20 years in the history of the agency reveals a range of changes having taken place over time. There seems to be no reason to believe that changes will not continue in the future to come as well. In fact the recent change in government has already led to a reorganisation of the governmental building agencies along with a shift in political focus towards having the public building clients become drivers of energy-efficient refurbishment.

Despite these changes of public policies and organisational structure, there does not seem to be a fundamental change of the way governmental building agencies are supposed to operate. Thus, it seems unlikely that governmental building agencies will be adopting a less risk-averse attitude towards change due to the constraints of budgetary discipline etc. unless they are directly ordered to by the political system and supplied with the necessary financial guarantees or safety net to deal with the increased risk taking.

### **Are the elements of the client's strategy internally consistent?**

The strategy for change in the client organisation seems to be internally consistent. The strategy for changing the culture concerning health and safety on building sites is based on the best possible knowledge acquired during external cooperation and an active participation in the development through external committees and councils. The strategy and knowledge is implemented from top level management in the client organisation by use of a variety of different methods. These include efforts to establish common rules, guidelines and templates to be used in the day-to-day work along with meet-

ings and courses to upgrade the employee's individual qualifications. In addition, increased qualification requirements to consultants and contractors are being set.

### **Does the client have enough resources to pursue this strategy?**

Whether the client has enough resources to pursue his strategy depends on what the client is believed to execute. This in turn depends on the degree of outsourcing versus insourcing of tasks. Within other industries a vivid debate is taking place on the benefits and drawbacks of outsourcing versus insourcing. A similar debate is not taking place within construction, where there is a yearlong tradition of outsourcing, in particular within public sector construction. Although much could be said for and against in/outsourcing, it is perhaps more worth noting that it is almost taken for granted that outsourcing is superior to insourcing without questioning the impact on fragmentation and specialisation in construction and the subsequent consequences positive or negative for productivity.

Taken note of the given situation of extensive outsourcing, the question of how clients deal with procurement and control of delivered services in a proper manner becomes critical. Obviously the building coordinators will need to know what to procure, how to procure, when it is most appropriate to procure etc. The procurement is effectively divided into three separate parts: 1) framework agreement for consultancy, 2) tender for consultancy on actual projects, and 3) tender for construction works on actual projects. All three ways of procuring follows quite conventional routes.

The other aspect to consider is the execution of control of delivered services. In the specific case, the building coordinator participated in safety meetings, site meetings and site inspections every two weeks. This was twice as often as is typically the case. Clearly, the building coordinators of the client are not only involved in the project in relation to site meetings, but also responds to phone calls, email correspondence, other types of meetings etc. Pursuing new issues and policies on e.g. health and safety will therefore need to find its way through the thicket of competing agendas and issues to be dealt with by building coordinators with multiple projects, tight schedules and a professional orientation towards other issues.

The arm's length principle towards the construction site and the project may raise challenges to the role of the client as change agent. On the one hand, the arm's length principle demarcates tasks and responsibilities without the client getting morally or legally too involved in the project. Setting strict requirements to the supply network may potentially stimulate change in the industry. On the other hand, exercising client leadership may ironically enforce and deepen the existing fragmentation of the industry because the client organisation will become even more dependent on the care and duty of the professionals to pursue new targets in an officious manner.

### **Is the client's strategy implementable?**

In its present form, the strategy of the client seems to be implementable, but then on the other hand it is not overly ambitious. If the ultimate goal is to improve health and safety on construction sites, the question remains if the agency will also succeed in contributing to a change of the culture in the industry towards health and safety and how this is best done. Clearly one single client organisation cannot do the job on its own.

## Conclusion

This case study shows how a client can implement a new strategy on health and safety through renewal of procedures, alterations of the organisation, and providing guidelines with templates. An essential factor is high-level decision in the organisation to implement the strategy and thereafter acquire knowledge and translate it into practical means. Parallel it is important to engage the employees and establish new forms of cooperation and selection of partners in a building project.

## Procurement

The agency has decided to upgrade the way activities concerning health and safety are handled in practice in building projects – new ones as well as refurbishment projects. The target of the health and safety strategy is the persons acting as building coordinators in the client organisation and in the engaged companies. The challenge is how the normal work procedures can be altered.

The new approach has been started with the drawing up of guidelines and templates, which have been prepared in cooperation with the Danish Association of Construction Clients and debated within the Industrial Working Environmental Council for Building/Construction in accordance with a framework of rules from the Danish Working Environment Authority.

As the client in many cases – as in the actual project – will use private companies to execute the work with health and safety, the experience is that qualifications concerning health and safety must be given a higher priority in the tendering procedures and/or in general framework agreements.

## Innovation

The innovation process has three characteristics: 1) advancement as a front-runner, 2) expansion of requirements on health and safety capabilities in future framework agreements, and 3) the pursuit of an incremental approach.

An essential part of a new strategy is the anchoring of the change process at top-level management in the client organisation.

A realisation of the priority of health and safety in a client organization means a change in the organisation. Such a change can be implemented in practice by use of different means. In this case the client has applied a variety of methods like mandatory participation for all employees in courses as health and safety coordinators in order to build knowledge capacities, regularly internal information meetings, development and adaptation of guidelines and templates, appointment of key resource persons and testing in actual projects.

## Guidelines

The client has adapted a national guideline and template on Plan for Health and Safety for its own use. In accordance with national regulation, the guideline and template is a planning instrument, which is to be regularly updated throughout the execution of the refurbishment project. The wording of the guideline and template for the PHS is in Danish, and it is for use in Denmark only.

The PHS contains an extensive amount of primarily qualitatively information in written form, as drawings etc. Some examples of the information included in the tool are: contact persons with phone number and mail address, name and roles of key persons as coordinators and clerk of works, the structure of

meetings, proposal for agendas, the logistic on the building site, places for storing, site huts, areas with special risks, cleaning of the site, use of mechanical tools, accidents facilities and schedule for the work.

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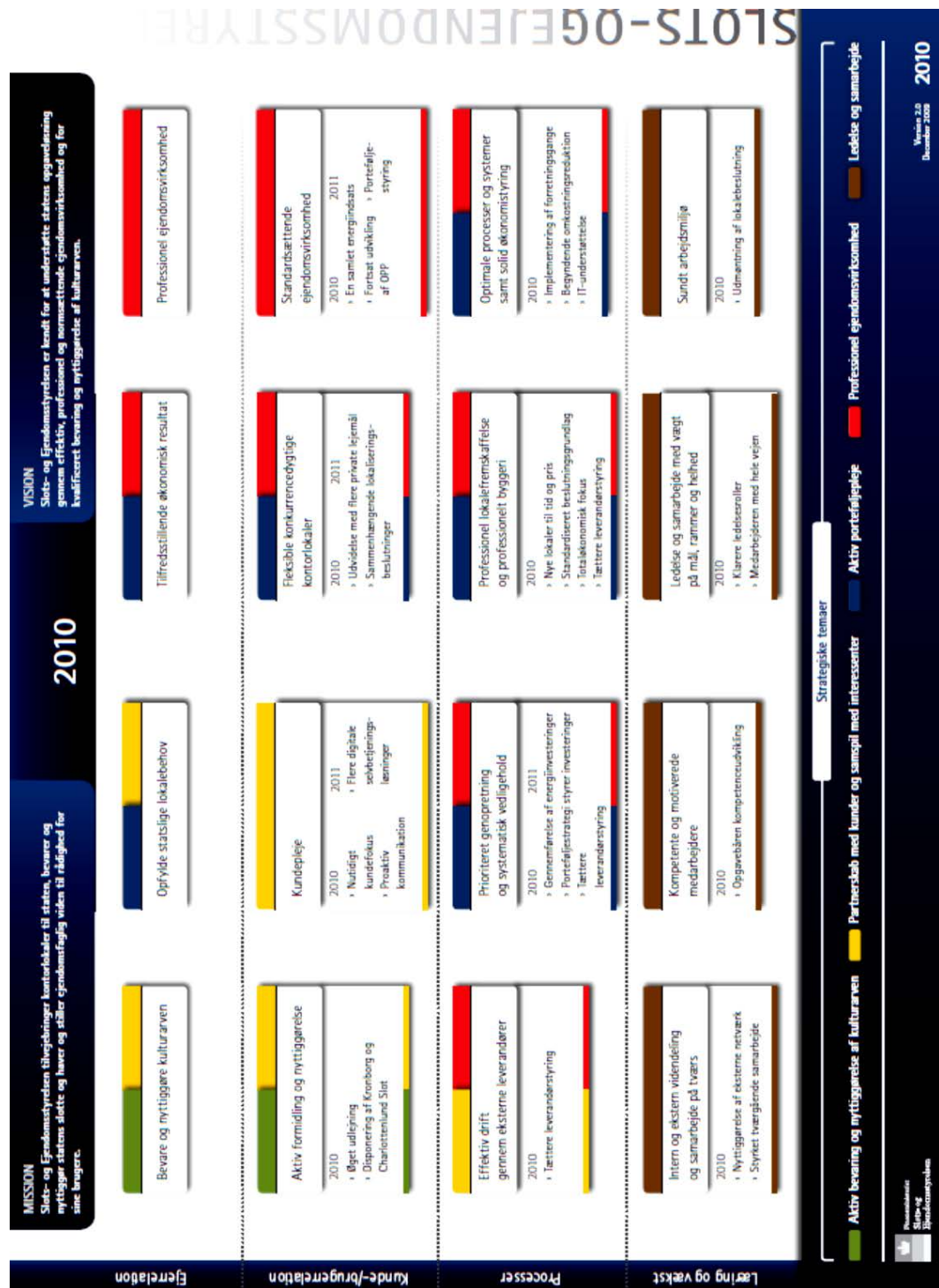
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# Appendix 7: Revisiting a construction client as change agent – the case of a social housing company

*By Kim Haugbølle & Ib Steen Olsen, SBI – Aalborg University*

## Introduction

The third Danish case is revisiting a construction client in the shape of a social housing company that participated in a major European research and development project in the beginning of the 2000s. This study will analyse how the lessons learned from participation in a sustainable development project some five years ago may be implemented and sustained over time in a social housing company. This chapter is based on a conference paper by Haugbølle et al. (2011).

## Background

In Europe, more than 170 million people are living in some 80,000 post-WWII residential areas containing about 56 million flats. The need for refurbishment of these residential areas is enormous.

Sustainable refurbishment of the existing building stock requires the implementation of new procurement strategies and methods in order to succeed. The issue of developing sustainable procurement strategies and methods were addressed by a group of social housing companies within the European project SUREURO (Sustainable Refurbishment Europe) in 2000-2004.

Following a successful sustainable refurbishment project in the mid-1990s, the Swedish social housing company Kalmarhem took the lead on initiating SUREURO. With a total budget of close to €10 million, the four-year research and development project SUREURO was launched in 2000 funded partly by the partners partly by the European 5<sup>th</sup> Framework Programme within the action of City of Tomorrow.

The objectives of the SUREURO project were (Kalmarhem, 1999):

- To provide housing organisations with practical management tools for integrating sustainable development and tenant participation in their refurbishment management process without exceeding the normal costs for the tenants.
- To develop 1) systems and methods for construction companies, designers, architects and engineers; and 2) models for better planning, design and technical specifications of refurbishment projects.
- To test and implement new, flexible technical concepts for sustainable transformation of existing housing areas.

The SUREURO project included twelve housing organisations from nine countries: Sweden, Denmark, Finland, the Netherlands, United Kingdom, France, Germany, the Czech Republic and Italy. The consortium also included fourteen research organisations, two consultancy companies and two construction firms, who collaboratively worked on the ten national pilot projects.

## Purpose/scope

This study will analyse how the lessons learned from participation in a sustainable development project some five years ago may be implemented and sustained over time in a client organisation in the frame of a social housing company.

## Methodology

This case study is based on business strategy analysis (Hambrick & Fredrickson, 2001) and draws on the combination of three sets of methods: First, some of the extensive documentary material from the SUREURO project has been re-analysed. Second, a number of qualitative research interviews (Kvale, 1996) have been conducted with previous project participants in the Danish national pilot project. The interviewees include the former CEO of the housing company, the former property manager of the residential area Taastrupgaard and the coordinator of the national development projects within the housing company. Third, we will draw on the experiences gained by one of the authors of this article, who was also involved in the SUREURO project.

## Contextual description of the case

### Owner and ownership: social housing company

Social housing is developed and managed by social housing associations on a non-profit basis. Denmark holds some 750 housing associations with a total of some 7,700 housing estates. Social housing includes three types of dwellings for families, elderly people and young people. The number of social housing dwellings is about 550,000, which accounts for some 20 % of the total housing stock in Denmark. The majority of housing is managed by housing companies (administration companies). Most of the housing companies are rather small, but a handful of them are relatively large (Social- og Integrationsministeriet, 2012).

One of the larger housing companies is Boligselskabet AKB s.m.b.a. (Limited Liability Company), which was established in 1913. Boligselskabet AKB s.m.b.a. – in short AKB – is a Danish co-operative, non-profit social housing company administrating some 17,000 rented homes in the metropolitan area of Copenhagen. By 1 January 2007 AKB merged with another housing company KAB – Bygge- og Boligadministration s.m.b.a. to form the new social housing company KAB. The newly formed housing company rents out some 50,000 homes in the metropolitan area of Copenhagen (for further information, please visit: <http://www.kab-bolig.dk>).

At the start of SUREURO in 2000, AKB had some 280 employees, of which 90 worked in the central administration and 190 worked locally as managers and caretakers in the individual residential areas. AKB provided management services to 10 local social housing associations consisting of about 80 autonomous estates.

A social housing company includes several functions like management, financial support, administration, information systems and so on. Social housing companies also develop training programs for tenants and employees.

### Taastrupgaard: Building type, present use and current users

The residential area Taastrupgaard was the Danish pilot project of SUREURO. Taastrupgaard is situated some 20 km west of the city of Copenhagen. The area consists of a total of 38 buildings. Eight long blocks each four storeys high are built together to form a 700 m long main building

(see Figure 87). Behind the main building, the area houses 30 detached blocks each three storeys high. All in all, the residential area comprises some 1,000 housing tenancies plus 53 garages and 3 tenancies for commercial use. The gross floor area is 83,547 m<sup>2</sup> with an outdoor area of about 150,000 m<sup>2</sup>. 40 employees are taking care of the residential area (KAB, 2010).

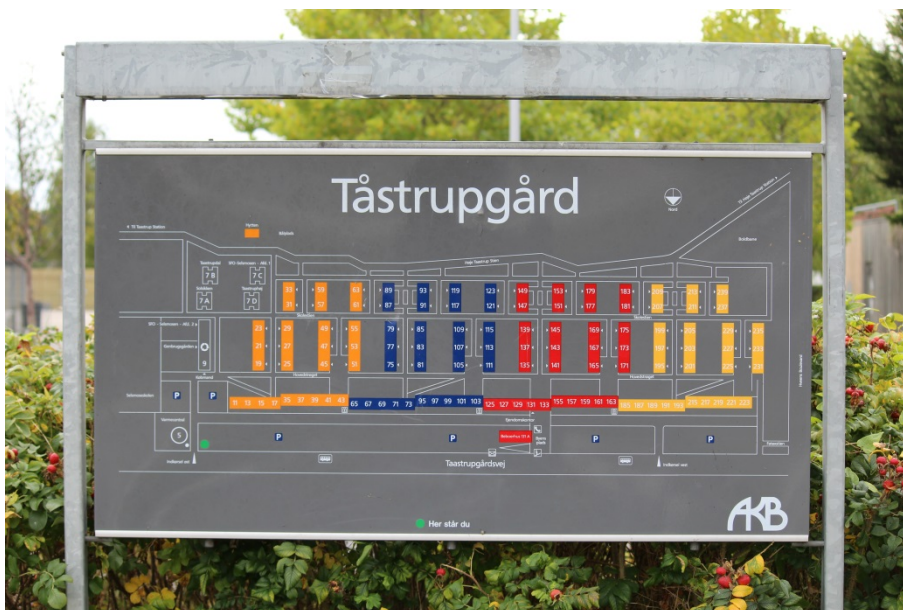


Figure 87. Layout of Taastrupgaard. Photo: (Kim Haugbølle).

Some 2,500 people live in Taastrupgaard of which about 45 % is under 25 years. Half of the tenants hold Danish citizenship, and more than two-thirds of the tenants are immigrants or descendants of immigrants from non-Western countries. The area is marked by a number of social problems linked to the mixed composition of the tenants: people on low incomes or social benefits, unemployment, mental illness, drug and alcohol abuse etc. (KAB, 2010).

#### Year of construction, representativeness

The residential area Taastrupgaard was built in 1970-72. It is one of the last examples of the grand scale type of residential areas, which was highly influential in social housing construction in the 1960s and 1970s. The main construction system consists of prefabricated concrete elements arranged in a monotonous architectural expression (Figure 88).

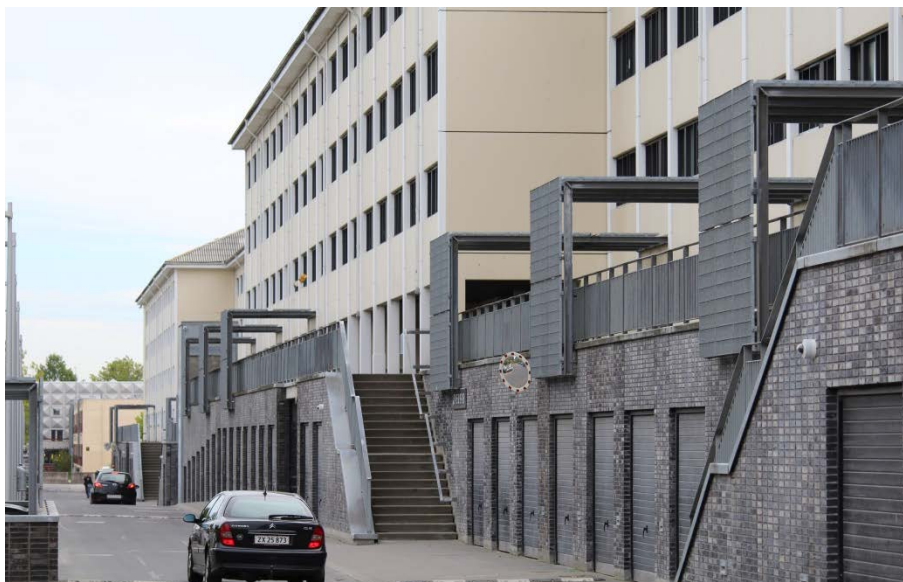


Figure 88. View of the main building in Taastrupgaard. Photo: (Kim Haugbølle).

## Procurement strategies

### Renovation topics and coverage

An overview of the renovation topics and coverage in the refurbishment project are given in Figure 89 below.

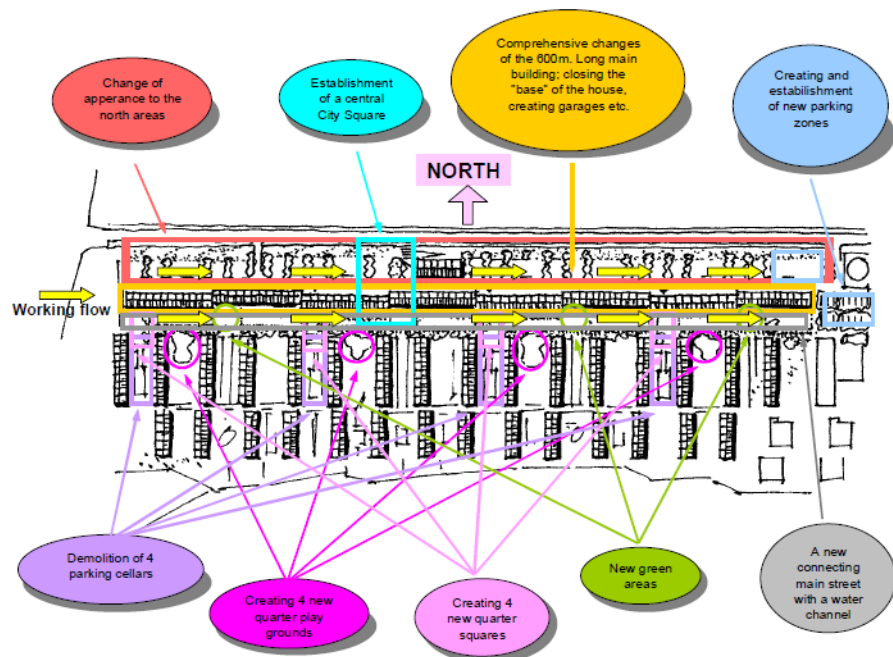


Figure 89. Overview of the renovation topics and coverage. Source: (Jacobsen, 2004: 15).

At the outset, nine development projects were defined in the Danish pilot study Taastrupgaard as part of SUREURO. Due to practical circumstances and financial constraints, the number of development projects was later reduced to seven. The seven development projects included:

- Environmental declaration of building materials – sustainable owner requirements to building process, construction and materials.
- Development of requirements for new sustainable bathrooms.
- Development of low energy outdoor lighting systems.
- Development of a natural ventilation system.
- Waste sorting and handling.
- Information strategies and empowerment of tenants.
- Establishment of green jobs on the estate for young people with social problems.

### Intended future use and users

Through the pilot project, it was the main objective for AKB to change the image of Taastrupgaard and thereby make the area more attractive to resourceful people and to young families with children. This success criterion for the area was to be assessed after some years by looking at whether the waiting list had grown longer and if the number of people wishing to move in was greater than the number of people moving out.

### Refurbishment strategy

Due to heavy wear and building defects dating back to the original design of the buildings, the residential area underwent two comprehensive refurbishments in 1981-1983 focused on repairing building defects and again in 1985-1991 focused on removing part of the underground parking. In the mid-1990s, AKB initiated a third comprehensive refurbishment, which the Danish SUREURO pilot project later became part of.

In 1995, a comprehensive refurbishment plan was agreed between the housing company AKB, the local property management and the tenants' representatives. Negotiations were undertaken with the National Building Fund, who agreed to finance the major part of the refurbishment on the basis of the plan. The Municipality of Høje-Taastrup also accepted to cover part of the costs. In 1996, the plan was presented at the tenants' annual general assembly and the general outline of the plan was accepted. The core elements of the plan were:

- 1 Physically, it was suggested to remove the remaining underground parking, to renovate the exterior of the buildings and to establish a main passage along the backside of the main building with smaller shops and a combination of tenant activities, institutions and clubs. It was also proposed to demolish the middle section of the long main housing block, which constitutes the front of the area. By making an open passage in the middle of the block, the intention was to improve access to the estate and make it more appealing to the public, thus improving the image of the estate.
- 2 Socially, the objective was to deal with social problems of residents and improve the social life in the estate by employing social workers as tenants' advisors and intensify co-operation with local government and other relevant parties in the social domain.
- 3 Organisationally, AKB and the local housing management proposed a de-centralisation of the section boards' prerogatives by setting up four local tenants' committees. The housing professionals argued that because Taastrupgaard is a large estate, residents would feel more committed to the refurbishment in a more de-centralised structure (Engberg & Haugbølle, 2005 & Haugbølle & Engberg, 2005).

The overall timeline of the third refurbishment project is shown below in Table 18.

Table 18. Timeline of the third refurbishment project.

Time	Activities
1995	A first proposal for a comprehensive refurbishment plan for Taastrupgaard is put forward by the housing administration, which is discussed and accepted by the tenants in 1996. A design phase with tenants' involvement begins.
1996	Architectural competition is held and the winning project is chosen.
1998	The Building Committee with tenants' representatives is set up.
1999	The Total Refurbishment Plan is put to a vote in Taastrupgaard at a general assembly, and is rejected by a majority of the tenants, primarily due to resistance against demolishing a small number of the small flats. Negotiations on a revised plan start.
2000	The SUREURO project begins.
2000	Tenants agree to a revised plan.
2001	The tenants' assembly rejects the division of Taastrupgaard into four separate sections with four new local tenants' committees. The design phase of the planned refurbishment on Taastrupgaard ends.
2002	The Building Committee is abolished.
2002-04	Demolition and construction is carried out.
2003-07	Phase I: Test of three types of bathrooms in six flats. Refurbishment of some 300 bathrooms (the long block facing Tåstrupgårdsvej).
2007-10	Comprehensive action plan for the social housing estate ("Tåstrupgård – et skridt videre") on crime prevention, outreaching children and youth activities, employment and rent support for Phase II of bathroom refurbishment.
2010-	Phase II: Refurbishment of some 600 bathrooms (remaining blocks of flats).

Source: Adapted after (Engberg & Haugbølle, 2005: 4), Høje-Taastrup Kommune et al. (2007a & 2007b) and KAB (2011).



The construction phase of the planned refurbishment on Taastrupgaard started in May 2002 and was concluded in spring 2004. The result was a number of physical improvements of the residential area, which among others included restoring building defects, installations of meters for measurement of water consumption, the establishment of a central square and the main passage with a water channel and ponds. The demolition of parking cellars freed up space for more green areas, new playgrounds etc.

### **Implementation of the strategy**

The overall approach to the implementation of the strategy was based on two parallel tracks. The first track was the general financing primarily from a special national fund for renovation work, the so-called Landsbyggefonden. This fund is established by contribution from all housing associations in Denmark in accordance with rules of rent payment. The financing from the fund was based on an application with a specific program for the refurbishment of Taastrupgaard. The different elements in the first track were procured and executed in accordance with the program and after the normal rules for tender procedures for public construction clients.

The other track was the participation in SUREURO and the financing of the development projects from primarily Realdania, a private Danish foundation operating within the built environment. The financing covered only analysis and writing of testing programs, not the execution on the building site.

### **Procurement protocol/project delivery system**

In the refurbishment project, the procurement took place as general contracting following the usual standards for contracting. Individual contracts were made with the consultant (HaCaFrø) and the main contractor.

The majority of work and participation in SUREURO took place through the work packages on organisation and management (WP1), construction and design (WP2) and technical service systems (WP3) along with the national pilot projects (WP4) and project management (WP0). The Danish partnership played a less pronounced role in the two additional work packages on implementation in other countries (WP5) and the SUREURO toolbox (WP6) (Kalmarhem, 1999). For the national part related to Taastrupgaard, AKB employed a project manager to take care of the actual development activities.

### **Technological solutions**

In general, well-known technological solutions were applied to execute the actual refurbishment.

Due to mismatch of timing of funding from Landsbyggefonden and the European Commission, it proved difficult to implement most of the national development activities without having to reopen the contracts with the consultants and contractors. This was not a solution favoured by the social housing company as it would increase costs and delay the project. Thus, only the development activity related to information strategies and empowerment of tenants came into direct question in Taastrupgaard. Most of the other development activities like environmental declaration of building materials and development of low energy outdoor lighting systems did not get implemented in Taastrupgaard.

### **Funding models and solutions**

All in all, AKB executed 34 different "refurbishment activities" under the same umbrella project with a budget near €32,000,000.

The funding for the refurbishment project came from different sources:

- Landsbyggefonden.
- An increase in the rent paid by the tenants.
- The Municipality of Høje-Taastrup, where Taastrupgaard is situated.

The international part of the pilot project was funded by the European Union through the 5<sup>th</sup> Framework Programme and equally co-financed by the involved organisations: The social housing company AKB, the consultancy Byfornyelsesselskabet Danmark and the Danish Building Research Institute.

The seven national development projects were partly funded by the partners partly by the private foundation Realdania with DKK3,000,000 (some €400,000).

### Barriers (e.g. zoning, taxation, parking places)

See below in next chapter on “vehicles”.

### Zoning constraints

In the Danish planning system, the local plan for a specific area describes the requirements etc. for the development of that area. In this case, the social housing company did not exceed or challenge the requirements set in the local plan.

### Incentives

See below in next chapter on “economic logic”.

### Achievements: performance, costs, sustainability

In relation to the SURERO project the following measurements were carried out (see Table 19): Waste (household rubbish exclusive waste for recycling), water and energy (exclusive the tenants' individual electricity consumption).

Table 19. Achievements.

	1999	2000	2001	2002	2003
Energy					
- Electricity (kWh)	1,138,282	1,151,497	1,151,497	1,062,102	1,126,566
- Heat (MWh)	13,301	14,158	14,158	13,654	14,271
Water (m <sup>3</sup> )	179,260	177,712	163,825	159,320	159,439
Waste (litres/week per apartment)	136	126	134	144	144

Source: (Jacobsen, 2004).

Overall, the resource consumption during the SURERO project did not decrease except for water consumption. In the annual resource statistics of the housing company, the resource consumption of Taastrupgaard has later been shown to be decreasing (KAB, 2010):

- Annual electricity consumption (in kWh/m<sup>2</sup>) has decreased by 6 % in 2007-2008.
- Annual heat consumption (kWh/m<sup>2</sup>) has decreased by 14 % in 2004-08.
- Annual water consumption (m<sup>3</sup>/m<sup>2</sup>) has decreased by 7 % in 2004-08.

### End user engagement

By law, each residential area or housing estate in a social housing company is required to have its own tenants' board. Each board has a minimum of 3 members elected at the annual meetings. In sum, the tenants' boards of AKB included some 300 persons in 2000. The local associations elect members to the central board of the housing company (the administration company).



The board of the housing company draws up the policy framework for overall company management. In social housing companies, the tenant representatives and the staff of the housing company will collaborate to decide on objectives, overall strategy and policies for information to the tenants, employees' etc. At the local estate offices, the employees work with the elected board management of the local estate and prepare the budgets and accounts for the estates.

The organisation of the decision-making process is described below in Figure 90.

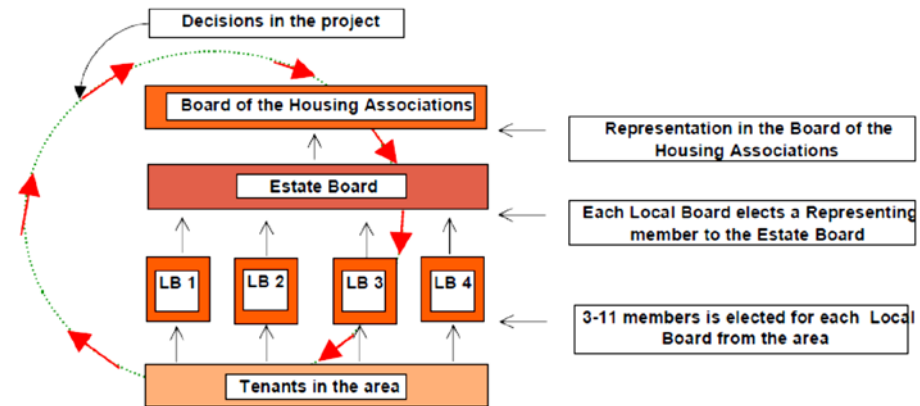


Figure 90. Tenants' democracy in social housing. Source: (Jacobsen, 2004: 9).

## Client as a change agent

### Arenas: At which fields will the client be active?

Judged by the social, cultural, economic and environmental dimensions of sustainability, the social housing company AKB had years of experience with sustainable development before entering SUREURO. For a number of years, affordable housing, tenants' democracy, waste handling, energy and water savings in buildings etc. had been an integral part of the daily and political practice of housing companies in Denmark. Even before entering SUREURO, the housing company AKB had an environmental policy as part of its vision, mission and action plans. However, the environmental policy was not considered to be comprehensive. Thus, the housing company decided to develop a new environmental policy for the period 2003-2005.

In early 2002, a proposal for a new environmental policy was debated at the annual assembly of the housing company and adopted as new policy. The environmental policy covered seven goals that were broken further down to another 18 specific targets to be aimed for by the social housing company. The seven goals of AKB were:

- To work for an increased focus on sustainable planning and development of urban and residential areas.
- To inspire tenants and employees to be environmentally conscious in everyday life.
- To include sustainability in building and refurbishment activities.
- To continue to work for a resource efficient organisation.
- To further develop environmental accountancy.
- To develop local partnerships to ensure sustainable development and profiling of residential areas.
- To emphasize the use of new technology in the housing sections in order to create new services.

Along with the development of the new environmental policy, the top management decided to initiate a development project in relation to the national pilot project Taastrupgaard with the purpose of developing a new environmental guideline to be used in future refurbishment projects. Thus the housing company hired a consultant company to develop the environmental guideline. During an intensive period of less than 3 months in the late summer and beginning of autumn 2001, the development of the guideline took place. The work was undertaken in close cooperation with a group of employees from the housing company and participants from the other Danish partners in the SUREURO project along with researchers and consultants working on associated development projects in Taastrupgaard.

Based on the principles of environmentally sound design (BPS, 1998a & 1998b), the environmental guideline set out to describe how AKB as a construction client could integrate environmental concerns in its procurement of refurbishment projects.

First, the new environmental guideline contained a survey of information sources and a general survey of existing initiatives, tools, procedures and barriers to the inclusion of environmental concerns in refurbishment projects. Second, the environmental guideline described the environmental targets, procedures for choosing measures to be taken, and requirements to the process of planning, designing and executing the refurbishment project. Four prioritized targets were set and for each of the four targets, a detailed list of specific measures was suggested. The four targets were:

- Indoor climate.
- (Hazardous) waste.
- Energy consumption.
- Resource consumption including consumption of materials during refurbishment, water consumption during operation, and noise and vibration during refurbishment.

Thus, parts of the environmental policy were translated into a guideline on how to include environmental objectives in building or refurbishment projects. The requirements form an environmental brief that is included in the tendering documents for building and refurbishment projects. Furthermore, the environmental policy is included when AKB competes with other housing companies on being responsible for new social housing building projects. At that time it was mandatory to tender the client role in Denmark for social housing. This competition has now been replaced by individual dialogues between the housing organisations/companies and the local authorities. But also within this new procedure the companies can benefit from an environmental policy.

#### **Vehicles: How will the client get there?**

With the new environmental policy and guideline, the housing company had strengthened its strategic and tactical abilities. Legitimacy for an improved sustainable effort had been granted from the general assembly, targets had been set for the housing company, and some of the elements of the environmental policy and guideline had been turned into practice. They were used as an environmental brief in relation to procurement of products and services from consultants and contractors.

Moreover, the environmental policy and guideline was expected to provide the housing company with a competitive advantage, when the housing company entered into tenders for the role as client on new social housing projects.

The feasibility tool developed within the frame of SUREURO was praised as a critical tool that would make it possible for the housing company to identify negative trends in a residential housing area well in advance in order to take the necessary steps to counteract an unwanted development. With the analysis conducted by using the feasibility tool, the housing company would be able to address negative trends before they actualised as problems. This in turn was believed to improve the image of the individual residential housing areas and more overall the image of the housing company as such.

For the employees at the headquarters of AKB, SUREURO meant a boost to them. They were proud of participating in something that went beyond their usual tasks. Visits were paid in other countries. This gave a kick to the involved participants, which in turn spread to other employees. But frustrations kicked in when ambitions could not be fulfilled in daily practices as the distance between principles/policies and practices became too wide.

The subsequent merger between the two social housing companies has potentially strengthened the policies and practices of sustainability. However, the merger has in the short term made it necessary to focus efforts on the many practical issues related to a merger. In particular the differences in organisational culture have demanded attention. AKB was based on a decentralised model where the property manager is placed locally in the estate and with each estate having extensive autonomy. KAB is based on a more centralised model where the property manager is placed centrally at the main office and focusing on the housing association.

#### **Differentiators: How will the client win?**

One of the core characteristics that differentiate the social housing sector from its private counterparts is the tenants' democracy described above. Thus, the formal and practical powers installed in the tenants' democracy creates a set of conditions, which to a high degree shapes the politics and practices of social housing companies for better or worse.

Another core characteristic of the social housing sector is the professionalism of the housing companies related to the size of the sector (and some of the companies) and the long life of companies. Thus, the social housing companies have extensive experience based on their frequent and recurrent building and refurbishment activities.

A third core characteristic is the extensive and detailed public regulation of the operation and financing of social housing companies. This regulation specifies a range of responsibilities, duties, procedures etc., which have to be met by the companies.

#### **Staging: At what speed will the client proceed?**

At the closure of the SUREURO project, the social housing company formulated its ambition on the implementation of the project results. In sum, these included (Jacobsen, 2004):

- To convert certain SUREURO tools into operational and practical Danish versions.
- To share knowledge from the project and train AKB staff in tools obtained during the project period.
- To develop further some of the tools based on a prioritised list of relevant tools.
- To continue networking with some of the contacts and partners through SURNET – the voluntary network extension of the SUREURO project.
- To document and analyse own experiences in order to implement new working methods in the organisation.

- To study in detail some of the concrete inspirational examples (e.g. 3-liter house from Germany) and implement lessons learned from these examples in new cases in AKB.
- To share experiences and lessons learned with other housing companies in Denmark through existing networks.

At what speed the client wanted to proceed with the implementation and further development of SUREURO tools and methods is very difficult to assess, since there was not an explicit action plan in place at the end of the development project besides the above formulated ambitions.

### **Economic logic: How will the client obtain returns?**

Since AKB/KAB is a non-profit housing company, the issue of obtaining returns on investment is somewhat different from a pure market-oriented firm for which the analytical framework of Hambrick & Fredrickson (2005) was originally developed. Still, the housing company is facing three main challenges when it comes to economic return on investments.

First, the social housing company is competing not only with other social housing companies but also with private property owners on attracting tenants along with private home-owners.

Second, the social housing company has to finance all of its activities in the individual residential areas on a balance-of-cost basis, which means that the social housing company is not generating a profit for investors but still needs to generate an income to finance its activities. The same principle of balance-of-cost also applies to the individual residential areas, where the tenants' representative in the tenants' board and at the annual meeting will have to sanction rent increases or not. Thus, the social housing company can't on its own initiate costly refurbishments without the explicit consent of the tenants.

Third, the building costs for new buildings are tightly regulated through a maximum limit on the building cost. The maximum limit can't be exceeded and is strictly monitored through reporting into a national database. Although there does exist a maximum limit for refurbishment costs, these are however also effectively regulated tightly through reporting to a national database if support is obtained from Landsbyggefonden. Thus, social housing companies in general including AKB are frequently complaining that the maximum limit on building costs is hampering investments in sustainable measures.

## **Discussion**

The overall criteria for the evaluation of the strategy of the housing company are consistency and adequateness. Consequently, Hambrick & Fredrickson (2005) proposes that it is insufficient to simply make five sets of choices regarding arenas, vehicles, differentiators, staging and economic logic. Thus, some strategies are clearly better than others, and to test the quality of the strategy the following key evaluation questions can be applied:

- Does your strategy fit with what's going on in the environment?
- Does your strategy exploit your key resources?
- Will your envisioned differentiators be sustainable?
- Are the elements of your strategy internally consistent?
- Do you have enough resources to pursue this strategy?
- Is your strategy implementable?

### **Does AKB's strategy fit with what is going on in the environment?**

The sustainable strategic orientation of the social housing company is well in line with international policies on sustainability as well as with policies on the construction client as a change agent. However, with the change to a conservative-liberal government in 2001 the issue of sustainability dropped low on the political agenda. This changed around 2007 when it became clear that Copenhagen would host the climate summit COP15 in December 2009. This sparked off new political commitment towards sustainability, or rather energy and climate change. Thus, it may be expected that a more positive general political opinion and more costly operational costs for energy at the tenant level in the coming years will make it possible to promote an interest for sustainability.

At the local level, several municipalities including the City of Copenhagen are pursuing ambitious strategies on sustainability. These ambitions also spill over to social housing, since the municipalities are providing part of the funding for new building of social housing, oversees the activities of the social housing companies etc. Consequently, it is important for the AKB to show the local authorities that they work in accordance with and try to promote sustainable construction.

### **Does AKB's strategy exploit their key resources?**

Whether the strategy of the social housing company exploited its key resources over time may be judged along two dimensions. First, knowledge is in general personified and carried by individuals. At the end of the SUREURO project, the project manager lost her heart to another participant in the SUREURO project and decided to move to United Kingdom. Thus, the social housing company lost one of its key personnel resources and with her also the intimate knowledge and insights gained in the development project.

Further, the close working relation with the research and consultancy group evaporated after the project closure. To the benefit of the housing company, this loss of key resources was partly counteracted by the institutionalisation processes of lessons learned in SUREURO most notably through the environmental policy.

The same also applies to the international cooperation through the network SURNET established by the social housing companies in continuation of SUREURO. It has however proved difficult to maintain the interest and commitment for exchange of information in the network over a longer period due to different conditions in the participating organisations.

The other dimension is related to the acquisition of *new* key resources. Partly by chance, partly by design the social housing company got access to a range of new key resources through the merger with another social housing company KAB Bygge- og Boligadministration s.m.b.a., which was effectively put in place by 1 January 2007. KAB had for years been highly active and visible in the sustainable arena through participation in a number of predominantly Danish research and development projects. Through this participation, KAB Bygge- og Boligadministration had developed extensive knowledge and experience on sustainability. So far it has not been possible in the short run to benefit fully from this merger. But in the wake of settling a range of organisational issues in relation to the merger, AKB expects that the results will go into KAB's continuous work with sustainability.

### **Will AKB's envisioned differentiators be sustainable?**

One of the core differentiators of social housing companies in Denmark is their professionalism obtained and maintained through their very persistence

in the market. Social housing companies have been around for decades and they have been executing refurbishment activities on a frequent and recurrent basis. Despite changes over time like outsourcing of consultancy tasks etc. they still hold considerably higher professionalism and competence-building on a general scale than most private clients on sustainable building and refurbishment (see e.g. Jensen et al. (2008)).

The main question is whether social housing companies will stay in place as we know them. There has been a strong political pressure by the previous government to privatise social housing through selling off flats. This political and ideological ambition of privatisation may turn out to be a serious threat towards the professionalism and the very existence of the social housing companies.

### **Are the elements of AKB's strategy internally consistent?**

The question implies that a strategy is in place. This assumption may be questionable in the case of AKB. A very overall plan or rather catalogue of ideas was presented at the closing of the SUREURO project. But a fully formed strategy and action plan to be implemented did not exist in the housing company after the closure of the development project. Some of these ideas have been carried out, others not.

However, the subsequent merger between the two social housing companies has potentially strengthened the policies and practices of sustainability. Meanwhile it seems that KAB is focusing on another strategy than AKB did. The KAB strategy is based on offering services on sustainability where the housing associations have to pay for offered packages of knowledge if they wish to acquire these.

### **Do AKB have enough resources to pursue this strategy?**

The issue of having enough resources to pursue the strategy touches on three dimensions: 1) access to resources, 2) linking business and project processes, and 3) agency or structural constraints.

First, having or gaining access to resources, in particular finances, is crucial. The funding model of social housing is basically based on a balance-of-cost principle, which implies that refurbishment costs will usually be directly reflected in the rent level of the tenants. Each residential area is by principle a self-governed and self-contained financial entity. In certain cases like Taastrupgaard additional funding can though be achieved from the common savings fund (Landsbyggefonden) for extraordinary refurbishment, but the pressure on these funds is high. The housing company is not allowed to generate a profit, and the social housing company do not have any funds to distribute between different residential areas. Consequently, the social housing company will usually not have the opportunity to make increased or even aggressive investments in sustainable refurbishment due to their very sparse financial resources as a limited company.

The second dimension relates to the mobilisation and use of knowledge on a continuous and recurrent basis. On one hand the professionalism and recurrent refurbishment activities of the housing company ideally provide the opportunity for continuous improvement of policies and practices. On the other hand, the project-based nature of construction and the variation in the existing building systems from one area to another make it difficult to link the business processes of the housing company with the project processes of the individual refurbishment project as pointed out by among others Gann & Salter (2000). This is a problem that is further accentuated when it comes to linking development projects to specific refurbishment projects as pointed

out by (Clausen, 2002). Thus, the development activities have a tendency to become drowned in the day-to-day project-oriented practices, which challenges the embedding of new procedures and practices internally.

The third dimension relates to agency or structural constraints, or in other words, what is the open negotiation space for the social housing company to navigate within. Current regulation of the social housing sector in general is very tight and with limited degrees of freedom to navigate within. This regulation provides the tenants with certainty, transparency and influence through the legal rights on decision-making power, notably the extensive tenants' democracy. Therefore the tenants can exercise considerable influence on the technical methods and solutions. The drawback is that the management and professionals of a social housing company are left with rather limited degrees of freedom to act.

### Is AKB's strategy implementable?

Whether a social housing company is or can become a change agent for sustainable construction, will to a large extent rest on the ability for a social housing company to implement its sustainable strategies in environmental policies, supporting tools and procedures etc. For the clients to make a difference they will need to turn their potential purchasing volume into buying power. Due to the dispersed and autonomous decision-making process of the tenants' democracy of social housing in the individual residential areas, it may be difficult to align the various purchasing wishes into buying power.

The social housing company itself is fully aware of the constraints (and benefits) imposed by the tenants' democracy as well as the financing model of social housing. Thus, consultations, negotiations, information etc. or in short persuasion of the individual boards and annual meetings of the individual residential areas are constantly being practiced by the housing companies to ensure a sustainable direction of refurbishment projects. The outcome of this shaping process is not settled in advance, since the sustainable ambitions of the individual autonomous residential area may be very divergent. Consequently, the tenants' democracy becomes a doubled-edged sword, which can both support and hinder the turn of sustainable policies into sustainable practices.

## Conclusion

This study has analysed how a social housing company as construction client may act as a change agent in the construction and real estate industry cluster with respect to improving sustainability of housing provision. Figure 91 summaries AKB's strategy according to the five elements of the business strategy model.

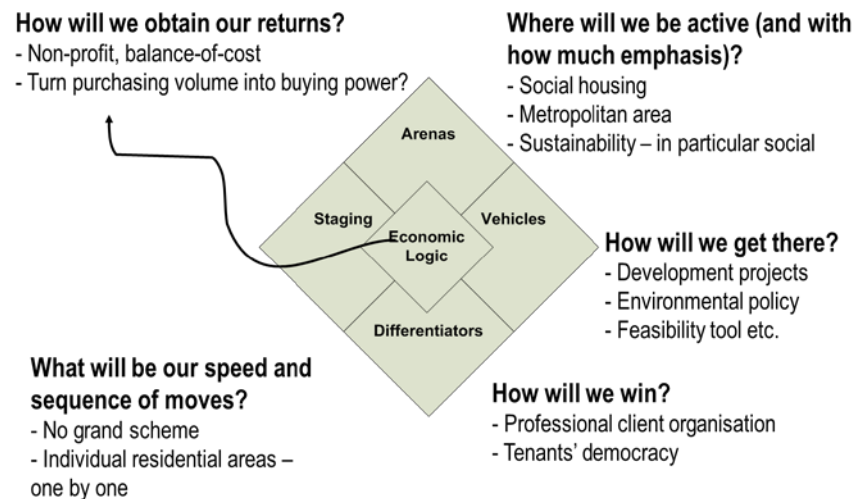


Figure 91. Summary of the strategy of AKB.

The study has shown that a social housing company as construction client *may* act as a change agent in order to improve sustainability in housing, but not all strategies and tools are equally successful and appropriate. The appropriateness of the strategy of the social housing company in relation to the overall mission and objectives can be judged along the following criteria:

- The strategy of AKB is well aligned with what is going on in the environment, but the political and ideological ambition of privatisation of social housing may turn out to be a serious threat towards the very existence and the professionalism of the social housing companies.
- Despite the resignation of key personnel, some institutionalisation of environmental policy has taken place and new resources have become available through the merger with another housing company. Meanwhile, it looks like the new housing company in the short run will have to handle development activities differently due to its organisation and the possibilities to get financial benefit from its housing associations.
- Although the level of awareness among employees has been heightened, the absence of a concerted and comprehensive business strategy and action plan hampers the internal implementation of lessons learned and tools developed.
- Due to the primacy of ordinary construction activities, careful planning and proper organisation of development and testing activities in advance of the actual refurbishment project is required.
- Pursuing a sustainable strategy depends on the ability of the housing company to 1) gain access to resources, 2) linking business and project processes, and 3) strategize agency to circumvent structural constraints.
- The dispersed and autonomous decision-making process of the tenants' democracy in the individual residential areas may impede social housing companies from turning their purchasing volume into buying power, which may in turn transform the construction industry.

In sum, this paper has illustrated some of the challenges of embedding new sustainable procurement policies and practices in a construction client organisation.

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# Appendix 8: Conversion of a school

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## Introduction

The first Norwegian SURE case is on the conversion of the abandoned Strømsø School in Drammen, some 30 km southwest of Oslo.

## Background

Drammen Eiendom KF contacted Multiconsult regarding sustainable refurbishment of an old school built as a brick building in the municipality of Drammen, Norway. Strømsø School is located in Strømsø district in the city of Drammen, Norway. Strømsø School consists of several buildings, but this case study only concerns the main building of the school.

## Purpose/scope

The scope of this case study is to develop a concept for sustainable refurbishment of an old, listed brick school building situated in Norway. The results and experiences from this case study are implemented in the SURE procurement guidelines for sustainable refurbishment.

## Theory

The theory is mainly based on issues of sustainability, refurbishment, heat transfer, air flows, energy and economic issues.

## Methodology

The methodology is based on a “strategic analysis”, which is an early stage evaluation of the whole building. First, a survey is conducted. Then, based on the survey, different concepts for refurbishing the buildings are evaluated. Risks, energy demand, future use and a range of other aspects are taken into account trying to give the client alternatives for refurbishment and at the same time show the consequences of the choices. A “best solution” is also presented to show i.e. how far it is possible to lower the energy demand without running too high risks when also taking cost issues into account.

## Contextual description of the case

### Owner and ownership

Drammen Eiendom KF (Drammen Properties) is an inter-municipal company established by the Municipality of Drammen in 1995. Their responsibility is to act as both facility manager responsible for operation and maintenance, and as building owner in municipal building projects on behalf of the Municipality of Drammen.

### Overall strategy of the case owner

With the ownership in mind, it will be necessary to look at the overall strategy of the Municipality of Drammen. Regarding strategies for further development, the Municipality of Drammen sees the importance of political guidelines (Hansen, 2008). The past years the municipality has had an active strategy with high focus on development, which contributes to the city in a

positive way, but at the same time having a low negative impact on the environment. To succeed, the municipality cooperates with governmental and local players on the real estate market.

As a part of the strategy, Drammen Eiendom KF was established, so that the role as developer is covered by a professional. An important element of the strategy is that Drammen Eiendom KF has the competence to ensure the environmental profile, which the municipality seeks.

In August 2009, Drammen Eiendom KF agreed on a strategy for future energy use in buildings owned by the municipal (Drammen Eiendom KF, 2009a). This was stated in an energy strategy document, which focuses on both quantitative and qualitative goals for reduction of energy use and use of renewable energy sources. The strategy document also states how the goals should be reached. In total, the 300,000 m<sup>2</sup> of facilities that is owned by the municipality consumes about 43 GWh of energy every year (Drammen Eiendom KF, 2009a). The overall goals that are stated in the strategy document are:

- Reduce the existing buildings energy demand (2008 level) with at least 15 % within 2012.
- 50 % of the supplied energy has to come from renewable energy sources.
- All new buildings larger than 500 m<sup>2</sup> shall have a heating system that is based on a renewable energy source.

Further, the document states qualitative goals for energy management, energy sources and reduction of energy use. In summary:

- By 2012 a complete energy and environmental analysis will be carried out for all buildings.
- Measures that are identified in 2009 will be recorded in an action plan with a budget for the suggested measures.
- All larger buildings will be connected to Drammen Eiendom KFs energy monitoring system by 2010.
- All buildings will be fully automated and connected to Drammen Eiendom KFs building management system by 2012.
- By 2012 all heating systems in buildings are converted to water heating system.
- When refurbishment is planned, energy use and environmental aspects will be focus areas.
- The energy demand of all new buildings larger than 500 m<sup>2</sup> should be at least 20 % lower than what is required by the building regulations of 2007.

### Zoning constraints

Strømsø School is located in Strømsø district in the city of Drammen, Norway. The refurbishment of Strømsø School is part of a project in Drammen, in which the district of Strømsø will be fully refurbished. The main part of the refurbishment area is the town square in proximity to the train station. The project also includes the developed area close to the town square. The intention of the refurbishment project is mainly to lower the buildings energy demand and improve the districts impact on the environment by reducing the emission of greenhouse gases.

Another reason for the refurbishment project is to improve the reputation of the district of Strømsø and the city of Drammen. The city was earlier known as a place of traffic jam and a contaminated river. By 2010 the traffic situation has improved and a popular riverside promenade has been established along the river, which no longer is contaminated. The city of Drammen wants growth in the business sector as well as becoming more attractive among existing and new inhabitants. The Municipality of Drammen aims at a future population growth of 1.5 % per year.

### Building type, present use and current users

The case building has served as the main building of one of Drammen's many lower secondary schools. The building contained both classrooms and the education department of the municipality. On 18 August 2010 all functions of Strømsø School moved to a new school building of passive house standard – Marienlyst School. The main building is therefore currently not in use (see Figure 92).



Figure 92. The main building of Strømsø School. Photo: (Drammen Eiendom KF).

### Year of construction, representativeness

Strømsø School was constructed in 1891 and is a typical brick building from the late 19<sup>th</sup> century. The facade of the building is listed and a renovation of the building will have to follow restrictions on changes to the facade. Considering the age, the building is in good condition. The building has three floors in addition to cellar and attic. The size of the building is approximately 3,000 m<sup>2</sup>. The building has an internal load-bearing structure, which reduces the flexibility of the building. A floor plan of first floor is presented in Figure 93.

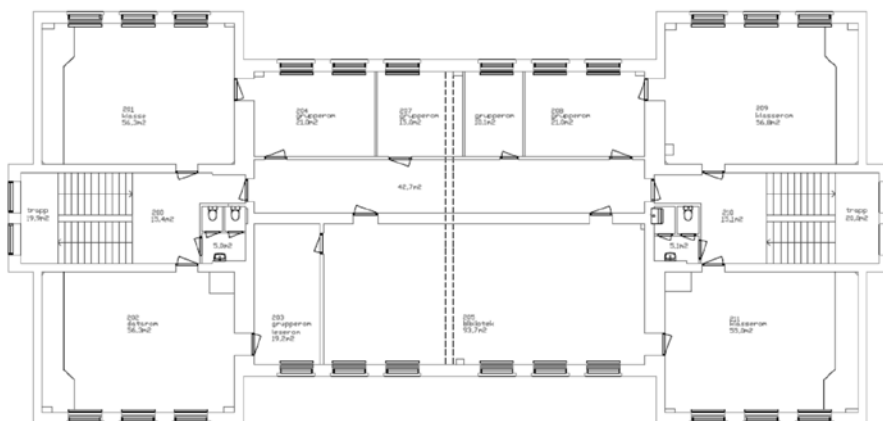


Figure 93. Floor plan of first floor. Source: (Drammen Eiendom KF).

In the following Table 20, a description based on a condition survey conducted in 2009 will be presented.

Table 20. An overview of the condition survey.

Building assessment	
Outer walls	The outer walls of the building are brick walls. The walls are not insulated, and there is a major heat loss from the outer walls of the building. The facade has some frost damages.
Roof	The roof is a structural wooden roof, which is in good condition. The attic is unheated, and the beams are only partly insulated.
Cellar	The walls are not insulated, and most likely there is no insulation in the floor construction. There are moisture problems in the cellar.
Windows	The windows in the building are of different age. The windows in the south facade are from 1997, and are two-layer glass windows. The rest of the windows are old, coupled windows.
Ventilation systems	The existing ventilation system serves approximately 60 % of the building with fresh air. The rest of the building is naturally ventilated. The ventilation system has no heat recovery unit, and the condition of the valves is poor.
Energy systems	The energy system of the building is hot water heating based on district heating. The radiators and pipes are in poor condition.

### Funding models and solutions

The building will most likely be rented out after the renovation providing a rental income. The Municipality of Drammen also looks into the possibility of moving into the building itself.

The Municipality of Drammen is involved in different national programs such as “Future Built” and “Fremtidens byer” (The cities of the future). Drammen Eiendom KF wishes to include the case building as a pilot project in the program “Future Built”. If Strømsø School is accepted as a pilot project, the project will most likely benefit from allocation of additional funding. More information about the programs will be presented later in the case report.

### Refurbishment topics and coverage

The important refurbishment topic is to reduce the energy demand of the school building. Calculations with energy simulation model software shows that the school building before refurbishment has an energy demand of 221 kWh/m<sup>2</sup>. If the building of today’s standard was used as an office building, the energy demand of the building is simulated to be 268 kWh/m<sup>2</sup>.

Drammen Eiendom KF hired Multiconsult to do a strategic analysis of the building. A strategic analysis identifies the potentials of the building. The strategic analysis evaluates the building’s technical condition, flexibility and adaptability. The technical condition of the case building was evaluated through a condition survey performed on a visual basis, and the assessments from this condition survey were presented in the previous section. The buildings energy distribution system was also evaluated in the strategic analysis, and measures to lower the buildings energy demand was recommended.

There has as well been a master thesis looking at four different refurbish concepts for Strømsø School. Concept one is to upgrade the building to today’s building regulation standard. Concept two and three looked at the possibility to upgrade the building to respectively passive house standard and carbon neutral building standard. Based on these three concepts, a fourth concept was recommended with measures that would reduce the energy demand of the building, but still be cost-effective.

With the recommendations from the fourth concept, the energy demand of the building will be reduced to 108 kWh/m<sup>2</sup>. The concept fulfils the requirements of a Low Energy class 2 according to the Norwegian Passive House and Low Energy Standard NS3700. In the following, the recommendations in concept four are presented. The concept as described in Table 21 gives a calculated need of supplied energy of 68 kWh/m<sup>2</sup>.

Table 21. Recommendations of concept no 4.

Measures of interest	
Outer walls	To add external insulation is not recommended because of the restriction regarding changes of the façade. To add internal insulation could lead to building physics related problems. No insulation of the walls is recommended.
Roof	Insulation should be added to the beams beneath the attic. 300mm is recommended.
Cellar	Insulation (200mm) might be added to the cellar walls in connection with control and renovation of the drainage system.
Windows	All windows should be replaced with new 3-layers glasses with a U-value of 0.8 W/m <sup>2</sup> K. The windows may not change the façade expression. A solar control system has to be installed for all windows.
Ventilation systems	A new ventilation system with an energy efficient (80-90 %) heat recovery unit has to be installed for the whole building air volume.
Energy systems	Refurbishment of today's energy system, new piping and radiators.
Air tightness	Measures for air tightness on walls, windows and transition zones.
Water heating	Solar hot water system to be installed.
Energy source	Ground source heat pump to be installed.

### Refurbishment strategy

Drammen Eiendom KF has not made any final decision regarding the refurbishment strategy of Strømsø School. The strategy will be based on the strategic analysis conducted by Multiconsult and the concepts presented in the master thesis. Drammen Eiendom KF wants to include Strømsø School as a pilot project in "Future Built", which will require a refurbishment strategy with high ambitions.

### Intended future use and users

The suggested future use is as an office building (Drammen Eiendom KF, 2009b). Our concept also recommends constructing an extension to the building, which will contain meeting rooms, canteen, changing facilities and other service functions. The building extension should be of passive house standard.

### Procurement strategies

The SURE project has investigated a random tender document of a typical refurbishment project of the school of Svensedammen (Drammen Eiendom KF, 2011). The SURE project group has not been given access to other tender documents.

### Implementation of the strategy

A new kindergarten is recently built as passive house standard, so the strategy is to some extent followed. But the procurement documents of the investigated tender documents are in lack of requirements regarding ambitious energy goals. Energy is barely mentioned. Therefore, the implementation of the strategy has a long way to go.



### Technological solutions

The tender documents aim for a standard fulfilling the national technical requirements (TEK10), which is the lowest energy performance possible. There is, though, focus on the use of heat pump as energy source. One of the statements in the procurement document is as follows: *“It is emphasized that the facilities will provide a good indoor climate as well as it should be based on energy-friendly and flexible solutions”* (Drammen Eiendom KF, 2011).

### Barriers (e.g. zoning, taxation, parking places)

The study of this specific case shows that the city planners have a positive and ambitious will to lift the buildings to a higher technical and energy standard. But at some level in the organisation, the breaks are on. Most likely, the financial situation is not clarified. The lack of focus on energy in the investigated tender document also reveals a distance between strategy and action.

### Incentives

Their incentives are to fulfil the goals stated in the energy strategy document. Also, public funding models for low energy refurbishment are available.

### Procurement protocol, project delivery system

The project delivery system is not known, since the refurbishment project has not been initiated.

### Achievements: performance, costs, sustainability

The achievements are not known, since the refurbishment project has not been initiated.

### End user engagement

The client has a well-established monitoring system for their buildings. To ensure that this also can be implemented in a refurbishment project, one of the statements found in the procurement documents is as follows:

*“To ensure that the delivery is of such a nature that the building has satisfactory solutions that give low operating costs, energy costs and environmentally friendly solutions, the client (Drammen Eiendom KF) will thoroughly review the proposed solutions to ensure that all functions, interlocks, regulations and data communications are addressed.”* (Drammen Eiendom KF, 2011).

### Client as a change agent

While Drammen Eiendom KF is an agent on behalf of the Municipality of Drammen, it is necessary to look at both Drammen Eiendom KF and the municipality as change agents in this context.

### At which fields will the client be active?

The Municipality of Drammen acknowledge the importance of an urban development, which makes Drammen attractive to both inhabitants and the business sector. They seek a sustainable development, which has low impact on the environment. The main focus areas are reduction of the buildings' energy demand and emission of greenhouse gases. To reach the goal concerning reduction of greenhouse gases, carbon footprints from materials, transport and energy use have to be in focus.

### **How will he get there?**

The Municipality of Drammen participates in two different national programs in order to succeed with a sustainable city development, "Future Built" and "Fremtidens byer". Both programs will contribute to better knowledge through transfer of experience between the program participants.

"Fremtidens byer" means "cities of the future" and is a program started in 2008. In this project, 13 of the largest cities in Norway work together to reduce the emission of greenhouse gases (Miljøverndepartementet, 2009). The program is a co-operation between the government and the 13 cities. Through the program, the 13 cities will learn from each other and valuable experience will be exchanged. Actors in the building industry, both contractors and suppliers, also contribute to the program. This is another important success factor. The municipality of Drammen has through the program completed two pilot projects, a school and a kindergarten, both of passive house standards.

The "Future Built" program is a part of "Fremtidens byer". The participants in "Future Built" are the Municipality of Drammen and the Municipality of Oslo, in addition to both governmental and private actors (FutureBuilt, 2010). The main intention of the program is to complete pilot projects, which in the short term reduce the emission of greenhouse gases with a minimum of 50 % from today's emissions. "Future Built" is established to be an arena for innovation and transfer of expertise between developers, architects, consultants, contractors, municipalities and users. The refurbishment of Strømsø District is a part of "Future Built", and Strømsø School might be included in the program as a pilot project.

### **How will he win?**

Drammen Eiendom KF participates in the two programs "Fremtidens Byer" and "Future Built" with the aim of being among the most environmental cities in Norway in the future. In turn, this will make Drammen an attractive location for new residents and companies.

### **At what speed will he proceed?**

The programs they are a part of today have different time spans. The program "Fremtidens byer" will end in 2014, but "Future Built" will continue until 2018. During this period, new pilot projects will be established.

### **How will he obtain returns?**

Pilot projects are partly supported by the state-owned enterprise Enova. Enova allocates funds on behalf of the government to projects, which aim at reaching high energy standards. Through the projects, the municipality will build up their competence of sustainable development, which will be useful in all future projects.

For the Municipality of Drammen, it is also important to enhance the reputation of the municipality. Population growth and growth in the business activity will contribute to the municipality's economy.

### **To which extent can we see a coherent strategy action?**

The participation in different programs, as well as development of pilot projects with high levels of ambitions, gives the impression of a coherent strategy action. Drammen Eiendom KF has established a strategy for reduction of energy use, as mentioned above. But the focus is mainly on new buildings, so the actor has a major challenge in refurbishing their buildings in a sustainable way. The client has been asked the following 6 questions, but has unfortunately not provided any answers:

- 1 Does your strategy fit with what's going on in the building sector? How?
- 2 Does your strategy exploit your key resources? How?
- 3 Will your envisioned differentiators be sustainable? How?
- 4 Are the elements of your strategy internally consistent? How?
- 5 Do you have enough resources to pursue this strategy? How?
- 6 Is your strategy implementable? How?

### **What kind of change management can we identify?**

There is no doubt that the focus on sustainable issues for both new and refurbished buildings has increased. Stricter technical requirements, national programs for low energy buildings and contractors aiming for ambitious projects all contribute to push the actor to focus on sustainability. But the focus is mostly on new buildings. Lack of knowledge and economic barriers for refurbishment projects seems to slow down the progress of refurbishing buildings. It seems like there is no clear overall strategy on sustainable refurbishment of buildings. The challenges are often much larger for refurbishment of existing buildings than for building new buildings. With the new and strict requirements on energy, the need of knowledge in both technical, economic and social issues are of great importance. It seems like Drammen Eiendom KF is not able to implement their sustainable strategies into existing buildings at this stage. Guidelines and tools for sustainable refurbishment of buildings would probably be of great help.

## **Guidelines**

### **Which guidelines is the client using for green refurbishment of buildings?**

As mentioned earlier, a strategic analysis has been carried out in order to secure a sustainable refurbishment. The strategic analysis was carried out following the Norwegian guideline EMROB – Energy efficient, environmentally friendly and robust refurbishment of buildings. EMROB was developed by Multiconsult A/S in cooperation with Norwegian University of Science and Technology and SINTEF Building and Infrastructure (Almås, 2009). The guideline is developed as a tool and check list for decision makers, property managers, building owners, architects and consultants.

### **Is the client using qualitative or quantitative descriptions in the green procurement documents?**

As mentioned in the chapter "Procurement strategies" there is a lack of ambitious goals regarding energy performance or other green indicators.

### **Is the client using any kind of green classification system for refurbishing (LEED, BREEAM etc.)?**

Classification systems as LEED and BREEAM have not yet been used for the actual case building. Other projects, which are part of the Future Built programme, have been evaluated with respect to reduce greenhouse gas emissions. To calculate the emission of greenhouse gases from the buildings, the Norwegian tool Klimagassregnskap.no was used. This tool looks at emissions from the building materials, energy use during operation of the building and transport related to the building (Klimagassregnskab.no, 2010).

No other projects by Drammen Eiendom KF are BREEAM or LEED-certified. In these days, a Norwegian version of BREEAM (BREEAM-NOR) is being developed and will be completed during 2011. The classification system will after completion be an important guideline to sustainable refurbishment, which Drammen Eiendom KF can make use of.

Drammen Eiendom KF will make sure that all of their buildings, which need an energy certificate will be certified. The Norwegian calculation methodology, which evaluates a building's energy performance was implemented 1 July 2010. All public buildings of a size larger than 1,000 m<sup>2</sup> should have an energy certificate. An energy certificate is also required when buildings are to be sold or rented out.

“Miljøfyrtårnsertifisering” is a Norwegian certification system which certifies companies, organizations etc., which fulfils certain criteria. The criteria are all related to energy demand, emission of climate gases and other aspects related to the environment. According to the energy strategy document, Drammen Eiendom KF is going to assist all companies and organizations under the municipality of Drammen with the certification process (Drammen Eiendom KF, 2009a).

### **Are the guidelines used by the client international (in English) or country specific?**

Klimagassregnskap.no, which is used in some projects owned by Drammen Eiendom KF, is developed for evaluation of building projects situated in Norway. The certification systems “Miljøfyrtårnsertifisering” and BREEAM-NOR are systems developed for Norwegian conditions. The EMROB guideline is as well developed in Norway, but is not country specific.

### **Which “green parameters” are usually described in the clients procurement documents for refurbishing?**

The client Drammen Eiendom KF describes parameters related to energy use in buildings in their procurement documents. The parameters described are in accordance with the energy strategy document that Drammen Eiendom KF implemented in 2009.

## **Conclusions**

Drammen Eiendom KF has a fine strategy for sustainable building management, but there is a lack of green procurements in real life. The tender documents are mostly focusing on safety, national requirements and standards. There are few, or none, ambitious goals, e.g. when it comes to energy performance. The client therefore need guidelines for how to implement the right sustainable measures in the refurbishment projects, and how for them to be measured.

The client has definitely changed the past 10 years, revealing the need for ambitious projects to be an attractive city to live in. Anyhow, the ambitious projects usually focus on new buildings and installations. There is a lack of strategic plans for refurbishing the existing buildings. There is also a need for a strategic tool for sustainable refurbishment so that the municipality can easily and on an early stage find out what to do with the buildings and assess the consequences. Focus on surveys and performance profiles of the buildings combined with a tool for deciding whether to refurbish or tear down the building is also missing.

The use of guidelines and certification systems varies between the different projects. There is a rapid development of new requirements, programs and certification systems regarding sustainable buildings. Therefore, the client needs a tool to make the right strategic choices in an early phase of the projects. There is also a need for a method or a tool to reveal the challenges in the building stock in order to aim at the right measures for refurbishing.

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# Appendix 9: Energy refurbishment of residential buildings

*By Anders-Johan Almås, Christian Listerud & Svein Bjørberg, Multiconsult/NTNU*

## Introduction

The second Norwegian SURE case is a refurbishment project of a residential area in the city of Drammen, some 30 km southwest of Oslo.

## Background

Drammen Eiendom KF contacted Multiconsult regarding sustainable refurbishment of a series of smaller pre-WWII residential buildings in the Municipality of Drammen, Norway.

## Purpose/scope

The scope of this case study is to develop a concept for sustainable refurbishment of old, residential buildings situated in Norway. The results and experiences from this case study will be implemented in the SURE procurement guidelines for sustainable refurbishment.

## Theory

The theory is mainly based on issues of sustainability, refurbishment, heat transfer, air flows, energy and economic issues.

## Methodology

The methodology is based on a “strategic analysis”, which is an early stage evaluation of the whole building. First a survey is conducted. Then, based on the survey, different concepts for refurbishing the buildings are evaluated. Risks, energy demand, future use and a range of other aspects are taken into account trying to give the client alternatives for refurbishment while at the same time showing the consequences of the choices. A “best solution” is also presented to show i.e. how far it is possible to lower the energy demand without running too high risks and taking the cost into account.

## Contextual description of the case

The case consists of five residential buildings located in the Strømsø area in the city of Drammen. The main focus in this case has been one of the five buildings, Stibolts gate 13.

## Owner and ownership

The five residential buildings are owned by Drammen Eiendom KF, which is an inter-municipal company established by the Municipality of Drammen in 1995. Their tasks are to act as both facility manager responsible for operation and maintenance and as building owner in municipal building projects on behalf of the Municipality of Drammen.

## Overall strategy of the case owner

Drammen Eiendom KF is a building owner and administer on behalf of the municipality of Drammen. With this in mind, it will be necessary to look at the overall strategy of the Municipality of Drammen.

Regarding strategies for further development, the Municipality of Drammen acknowledges the importance of political guidelines (Hansen, 2008). The past years the municipality has had an active strategy with high focus on development, which influences the city in a positive way, and at the same time with a low negative impact on the environment. To succeed, the municipality cooperates with governmental and local players on the real estate market.

As a part of the strategy, Drammen Eiendom KF was established, so that the role as developer is covered by a professional. An important element of the strategy is that Drammen Eiendom KF has the competence to ensure the environmental profile, which the municipality seeks.

In August 2009 Drammen Eiendom KF agreed on a strategy for future energy use in buildings owned by the municipal (Drammen Eiendom KF, 2009). This was stated in an energy strategy document, which focuses on both quantitative and qualitative goals for reduction of energy use and use of renewable energy sources. The strategy document also states how the goals should be reached. In total, the 300,000 m<sup>2</sup> of facilities that is owned by the municipality consumes about 43 GWh of energy every year (Drammen Eiendom, 2009). The overall goals that are stated in the strategy document include:

- Reduce the existing buildings energy demand (2008 level) with at least 15 % within 2012.
- 50 % of the supplied energy has to come from renewable energy sources.
- All new buildings larger than 500 m<sup>2</sup> shall have a heating system that is based on a renewable energy source.

Further the document states qualitative goals for energy management, energy sources and reduction of energy use. In summary:

- By 2012 a complete energy and environmental analysis will be carried out for all buildings.
- Measures that are identified in 2009 will be recorded in an action plan with a budget for the suggested measures.
- All larger buildings will be connected to Drammen Eiendom KFs energy monitoring system by 2010.
- All buildings will be fully automated and connected to Drammen Eiendom KFs building management system by 2012.
- By 2012 all heating systems in buildings are converted to water-based heating system.
- When refurbishment is planned, energy use and environmental aspects will be focus areas and constitute a part of both the pilot study and basis for decision-making.
- The energy demand of all new buildings larger than 500 m<sup>2</sup> should be at least 20 % lower than what is required by the building regulations of 2007.

## Zoning constraints

The buildings are located in the Strømsø area in the city of Drammen, as shown in Figure 94.



Figure 94. Aerial photo of case buildings. Photo: (Drammen Eiendom KF).

The refurbishment of the residential buildings is planned to be done in conjunction with a city development project in Drammen in which the district of Strømsø will be fully refurbished. The main part of the refurbishment area is the town square in proximity to the train station. The project also includes the developed area close to the town square. The intention of the refurbishment project is mainly to lower the buildings' energy demand, and improve the district's impact on the environment by reducing the emission of greenhouse gases.

Another reason for the refurbishment project is to improve the reputation of the district of Strømsø and the city of Drammen. The city was earlier known as a place of traffic jams and a contaminated river. By 2010 the traffic situation has improved and a popular riverside promenade has been established by the river, which no longer is contaminated. The Municipality of Drammen wants to ensure growth in the business sector as well as becoming more attractive among existing and new inhabitants. The Municipality of Drammen aims at a future population growth of 1.5 % per year.

### Building type, present use and current users

Today, the five buildings serve as residential buildings containing four apartments each.

### Year of construction, representativeness

The five quite similar buildings are constructed in 1937 (see Figure 95). Brick walls and un-insulated roofs give a poor energy performance. The slabs against the cold attic are assumed filled with clay. The windows were replaced in 1985 (almost 25 years old) and some are punctured. The buildings are mainly naturally ventilated, which means there is no mechanical control of air volumes. In some of the apartments mechanical ventilation has been operating in the kitchen, but the functionality is poor. There is no mechanical ventilation from the bathroom. Heating is based on electricity and wood fuel.

Based on a condition survey and a strategic analysis, it is recommended that the building is upgraded to a concept that is close to the Norwegian passive house standard. The functionality of the building is poor, so an extension should be built to house toilets, bathrooms and elevator/stairs. It is not realistic to cover the building's electricity needs with energy produced at the building with current technology. This is because the site is not suitable for the use of wind turbines and a solar plant would not be economically viable. District heating is recommended as energy supply for Stibolts gate 13. Alternatively, electricity may be used if there is a need for a reduction of costs to complete the upgrade.





Figure 95. One of the five residential buildings in the case study. Photo: (Anders-Johan Almås).

### Funding models and solutions

The Municipality of Drammen is involved in different national programs, such as “Future built” and “Fremtidens byer”. The participation in these projects can benefit in allocations and funding if the residential buildings is included as a pilot project in these programs. More information about the programs will be presented later in the case report.

### Refurbishment topics and coverage

A condition survey has been conducted in order to reveal needs for maintenance and replacements (see Table 22). Overall, the state of the building is poor. There is a need for extensive refurbishment and improvement of energy efficiency. Structural building components such as outer and inner brick walls are in relatively good condition, while other components like windows and ventilation systems are in poor condition.

Table 22. Overview of condition survey.

Building component	Description
Outer walls	35 cm brick, exterior plaster. Plaster damages, need for exterior maintenance. Un-insulated walls, large heat loss.
Roof	Relatively new roof tiles, wooden structures are in good condition. Good ventilation in attic. Un-insulated roof, large heat loss.
Windows	From 1985. Leakages, poor thermal properties.
Slabs against attic	Slabs are filled with clay. Poor thermal properties.
Slabs against cellar	Concrete without visible damage. Poor thermal properties.
Ventilation	Natural ventilation, no mechanical ventilation from kitchens or bathrooms.
Electrical	Varies – mostly switch fuses. Automatic fuses in Stibolts gate 9.
Heating system	Electrical and wood.

The outer walls are brick walls in good condition, but the exterior façade is worn and is ready for upgrading. The insulating properties of brickwork are poor. The upgrade should be combined with outside insulation measures. Inside isolation is not recommended as this significantly increases the risk of mould growth, thermal bridges and frost damage. One should aim for passive house standard for the insulation of building components. The insulation can be simplified with plaster slabs or another desired cladding.

The buildings are naturally ventilated. A few kitchens have mechanical ventilation, but with varying function. The electrical system and piping systems are not currently considered in detail.

The measurement of energy consumption in 2007 and 2008 shows large variations in electricity use for the five different buildings. The reasons for this are not known, but the use pattern, number of persons in the household and "energy-saving attitudes" of the residents is of great importance to energy usage. On average, the energy consumption per building is around 60,000 kWh/year. This corresponds to approx. 300 kWh/m<sup>2</sup> heated gross floor area per year, which is very high. Today's regulatory requirement for residential buildings is 120 kWh/m<sup>2</sup> heated gross floor area per year, i.e. less than half of the measured consumption. Non-insulated building parts, old windows, draught and natural ventilation are the main causes of the high energy use. In addition, several of the apartments are equipped with a wooden stove.

Three different refurbishment concepts are analysed for Stibolts gate 13 as shown in Table 23. The first concept is refurbishing according to the Norwegian building code. Concept number two aims to satisfy the Norwegian passive house standard. The final concept examines the possibility of Stibolts gate 13 as a retrofit zero energy building. Simulation of energy demand, heat and moist conditions and calculations of thermal bridges are given for the concepts. In addition, building costs are calculated.

Table 23. Summary of analysis of different renovation concepts.

	Current state	Concept according to national building code	Passive house concept	"Zero energy building" concept
Net heating demand (kWh/m <sup>2</sup> /year)	287	51	15	15
Total supplied energy (kWh/year)	129,036	46,765	21,449	12,203
Supplied electricity (kWh/year)	107,505	13,825	21,449	0
Energy costs (NOK/year)	106,449	36,671	17,908	9,152
Investment costs, including tax (NOK)	-	4,466,000	4,578,000	6,539,000

According to the simulations, refurbishment to current building code level can relatively easily be carried through. To achieve a passive house standard, the challenges are somewhat larger. The annual space heating requirements for passive houses are equal to or less than 15 kWh/m<sup>2</sup>. The building's thermal bridges are a problem in achieving such a low energy demand. Results from the simulation show that it is possible to reach the passive house standard, but this requires scarifying of some functional qualities.

The energy supplies were also considered. A zero energy building must be self-sufficient when it comes to energy use. The main challenge for this concept is that the low wind speed in Drammen prevents the use of small scale wind turbines. The solar irradiance in Drammen is about 970 kWh/m<sup>2</sup>. Aiming for only use of solar panels for the electricity production is very expensive. It also demands a grid connected system. At present time there are no such systems in Norway due to restrictions for energy suppliers delivering to the grid. At present it is not realistic that Stibolts gate 13 could become a ze-

ro energy building. Recommendations for Stibolts gate 13 include reducing the energy demand considerable, and use district heating from a central heating-plant for heating and hot water. Solar cells could be included to deliver a small amount of the electricity needed. The recommended concept is a “near to” passive house level.

### Refurbishment strategy

Conclusions for Stibolts gate 13:

- Further investigations of the building's construction must be conducted, especially of foundations and the transition between wall and ceiling.
- The building should be upgraded to a concept that is close to the Norwegian passive house standard. The building's functionality should be improved.
- It is not realistic to cover the building's electricity needs with energy produced at the building site based on today's technology. This is because the site is not suitable for the use of wind turbines and a solar plant would not be economically viable.
- District heating is recommended as support for Stibolts gate 13. Alternatively, electricity may be used if there is a need for a reduction of costs to complete the upgrade.

### Intended future use and users

The intended future use is social housing as is today.

### Implementation of the strategy

The SURE project has investigated a random tender document of a typical refurbishment project of the school of Svensedammen (Drammen Eiendom KF, 2011). The SURE team has not been given access to other tender documents.

A new kindergarten is recently built as passive house standard, so the strategy is to some extent followed. But the procurement documents of the investigated tender documents are in lack of requirements regarding ambitious energy goals. Energy is barely mentioned. Therefore, the implementation of the strategy has a long way to go.

### Technological solutions

The tender documents aim for a standard fulfilling the national technical requirements (TEK10), which is the lowest energy performance possible. There is, though, focus on the use of heat pump as energy source. One of the statements in the procurement document is as follows: *“It is emphasised that the facilities will provide a good indoor climate as well as it should be based on energy-friendly and flexible solutions”* (Drammen Eiendom KF, 2011).

### Barriers (e.g. zoning, taxation, parking places)

The study of this specific case shows that the city planners have a positive and ambitious will to lift the buildings to a higher technical and energy standard. But at some level in the company, the breaks are on. Most likely, the financial situation is not clarified. The lack of focus on energy in the investigated tender document also reveals a distance between strategy and action.

### Incentives

Their incentives are to fulfil the goals stated in the energy strategy document. Also, public funding models for low energy refurbishment are available.

## Procurement protocol, project delivery system

This is not known, since the refurbishment project has not been initiated at present.

## Achievements: performance, costs, sustainability

This is not known, since the refurbishment project has not been initiated at present.

## End user engagement

The client has a well-established monitoring system for their buildings. To ensure that this also can be implemented in a refurbishment project, one of the statements found in the procurement documents is as follows:

*“To ensure that the delivery is of such a nature that the building has satisfactory solutions that give low operating costs, energy costs and environmentally friendly solutions, the client will thoroughly review the proposed solutions to ensure that all functions, interlocks, regulations and data communications are addressed.” (Drammen Eiendom KF, 2011).*

## Client as a change agent

While Drammen Eiendom KF is an agent on behalf of the municipality of Drammen, it is necessary to look at both Drammen Eiendom KF and the municipality as change agents in this context.

## At which fields will the client be active?

The Municipality of Drammen acknowledges the importance of an urban development, which makes Drammen attractive to both inhabitants and the business sector. They seek a sustainable development, which has low impact on the environment. The main focus areas are reduction of the buildings' energy demand and emission of greenhouse gases. To reach the goal concerning reduction of greenhouse gases both carbon footprints from materials, transport and energy use have to be in focus.

## How will the client get there?

The Municipality of Drammen participates in two different national programs in order to succeed with a sustainable city development, “Future Built” and “Fremtidens byer”. Both programs will contribute to better knowledge through transfer of experience between the program participants.

“Fremtidens byer” (“Cities of the future”) is a program started in 2008. In this project, 13 of the largest cities in Norway work together to reduce the emission of greenhouse gases (Miljøverndepartementet, 2009). The program is a co-operation between the government and the 13 cities. Through the program, the 13 cities will learn from each other and valuable experience will be exchanged. Actors in the building industry, both contractors and suppliers, also contribute to the program. This is another important success factor. The Municipality of Drammen has through the program completed two pilot projects, a school and a kindergarten, both of passive house standards.

The “Future Built” program is part of “Fremtidens byer”. The participants in “Future Built” are the municipality of Drammen and the municipality of Oslo, in addition to both governmental and private actors (FutureBuilt, 2010). The main intention of the program is to complete pilot projects, which in the short term reduce the emission of greenhouse gases with a minimum of 50 % from today's emissions. “Future Built” is established to be an arena for innovation and transfer of expertise between developers, architects, consultants,

contractors, municipalities and users. The refurbishment of Strømsø District is part of “Future Built”, and Strømsø School might be included in the program as a pilot project.

### **How will the client win?**

Drammen Eiendom KF participates in the two programs “Fremtidens Byer” and “Future Built” with the aim of being among the most environmental cities in Norway in the future. In turn, this will make Drammen an attractive location for new residents and companies.

### **At what speed will the client proceed?**

The programs they are a part of today have different time spans. The program “Fremtidens byer” will end in 2014, but “Future Built” will continue until 2018. During this period, new pilot projects will be established.

### **How will the client obtain returns?**

Pilot projects are partly supported by the state-owned enterprise Enova. Enova allocates funds on behalf of the government to projects, which aim at reaching high energy standards. Through the projects, the municipality will build up their competence of sustainable development, which will be useful in all future projects.

For the Municipality of Drammen, it is also important to enhance the reputation of the municipality. Population growth and growth in the business activity will contribute to the municipality’s economy.

### **To which extent can we see a coherent strategy action?**

The participation in different programs as well as development of pilot projects with high levels of ambitions gives the impression of a coherent strategy action. Drammen Eiendom KF has an established strategy for reduction of energy use as mentioned above. But the focus is mainly on new buildings, so the actor has a major challenge in refurbishing their buildings in a sustainable way. The client has been asked the following six questions, but has unfortunately not provided any answers:

- 1 How does your strategy fit with what's going on in the building sector?
- 2 How does your strategy exploit your key resources?
- 3 Will your envisioned differentiators be sustainable?
- 4 Are the elements of your strategy internally consistent?
- 5 Do you have enough resources to pursue this strategy?
- 6 Is your strategy implementable?

### **What kind of change management can we identify?**

There is no doubt that the focus on sustainable issues for new and refurbished buildings has increased. Stricter technical requirements, national programs for low energy buildings and contractors aiming for ambitious projects all contribute to force the actor to think sustainability. But the focus is mostly on new buildings. Lack of knowledge and economic barriers for refurbishment projects seems to slow down the progress of sustainable refurbishment of buildings. It seems like there is no clear overall strategy on sustainable refurbishment of buildings. The challenges are often larger for refurbishment of existing buildings than for building new buildings. With the new and strict requirements on energy, the need of knowledge in both technical, economic and social issues are of great importance. It seems like Drammen Eiendom KF is not able to implement their sustainable strategies into existing buildings at this stage. Guidelines and tools for sustainable refurbishment of buildings would probably be of great help.

## Guidelines

### **Which guidelines is the client using for green refurbishment of buildings?**

As mentioned earlier, a strategic analysis has been carried out in order to secure a sustainable refurbishment. The strategic analysis was carried out following the Norwegian guideline EMROB – Energy efficient, environmentally friendly and robust refurbishment of buildings. EMROB was developed by Multiconsult A/S in cooperation with Norwegian University of Science and Technology (NTNU) and SINTEF Building and Infrastructure (Almås, 2009). The guideline is developed as a tool and check list for decision makers, property managers, building owners, architects and consultants.

### **Is the client using qualitative or quantitative descriptions in the green procurement documents?**

As mentioned in the chapter “Procurement strategies” there is a lack of ambitious goals regarding energy performance or other green indicators.

### **Is the client using any kind of green classification system for refurbishing (LEED, BREEAM etc.)?**

Classification systems such as LEED and BREEAM have not yet been used for the actual case building. Other projects, which are a part of the Future Built program, have been evaluated with respect to reducing greenhouse gas emissions. To identify the emission of greenhouse gases from the buildings, the Norwegian tool Klimagassregnskap.no is used. The tool looks at emission from the building materials, energy use during operation of the building and transport related to the building (Klimagassregnskab.no, 2010).

No other projects by Drammen Eiendom KF are BREEAM or LEED certified. Currently, a Norwegian version of BREEAM (BREEAM-NOR) is being developed and will be completed during 2011. The classification system will after completion be an important guideline to sustainable refurbishment, which Drammen Eiendom KF can make use of.

Drammen Eiendom KF will make sure that all of their buildings, which need an energy certificate, will be certified. The Norwegian calculation methodology, which evaluates buildings' energy performance, was implemented 1 July 2010. All public buildings of a size larger than 1,000 m<sup>2</sup> should have an energy certificate. An energy certificate is also required when buildings are to be sold or rented out.

“Miljøfyrtårnsertifisering” is a Norwegian certification system, which certifies companies, organisations etc. that fulfils certain criteria. The criteria are all related to energy demand, emission of climate gases and other aspects related to the environment. According to the energy strategy document, Drammen Eiendom KF is going to assist all companies and organizations under the Municipality of Drammen with the certification process (Drammen Eiendom KF, 2009a).

### **Are the guidelines used by the client international (in English) or country specific?**

Klimagassregnskap.no is developed for evaluation of building projects situated in Norway. The certification systems “Miljøfyrtårnsertifisering” and BREEAM-NOR are systems developed for Norwegian conditions. The EMROB guideline is as well developed in Norway, but is not country specific.

## Which “green parameters” are usually described in the clients procurement documents for refurbishing?

The client, Drammen Eiendom KF, describes parameters related to energy use in buildings in their procurement documents. The parameters described are in accordance with the energy strategy document that Drammen Eiendom KF implemented in 2009.

## Conclusions

Drammen Eiendom KF has a great strategy for sustainable building management, but there is a lack of green procurements in real life. The tender documents are mostly focusing on safety, national requirements and standards. There are few, or none, ambitious goals, e.g. when it comes to energy performance. The client therefore need guidelines for how to implement the right sustainable measures in the refurbishment projects, and how for them to be measured.

The client has definitely changed the past 10 years, revealing the need for ambitious projects to be an attractive city to live in. Anyhow, the ambitious projects usually focus on new buildings and installations. There is a lack of strategic plans for refurbishing the existing buildings. There is also a need for a strategic tool for sustainable refurbishment so that the municipality can easily and on an early stage find out what to do with the buildings and which are the consequences. Focus on surveys and performance profiles of the buildings combined with a tool for deciding whether to refurbish or tear down the building is also missing.

The use of guidelines and certification systems varies between the different projects. There is a rapid development of new requirements, programs and certification systems regarding sustainable buildings. Therefore, the client needs a tool to make the right strategic choices in an early phase of the projects. There is also a need for a method or a tool to reveal the challenges in the building stock in order to aim at the right measures for refurbishing.

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# Appendix 10: Conversion of a school to homes for elderly people

By Anders-Johan Almås & Svein Bjørberg, *Multiconsult/NTNU*

## Introduction

The third Norwegian SURE case is on the conversion of an abandoned school in Bærum, some 20 km northwest of Oslo. The building owner is planning to change the building from a school building to an apartment building for elderly people (Figure 96).

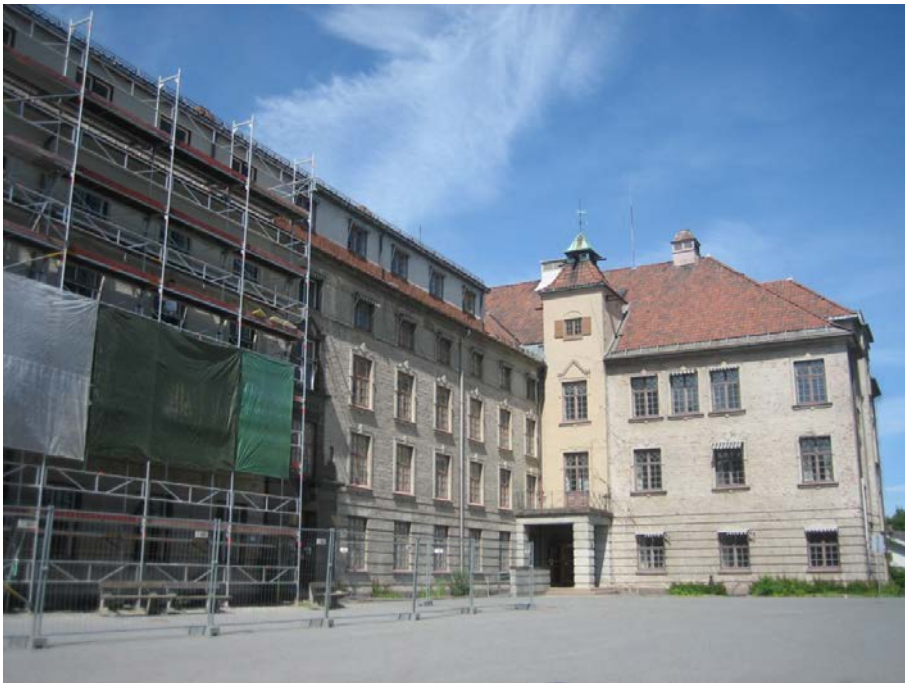


Figure 96. Part of Ringstabekkveien 105. The façade is protected and is now being maintained. Photo: (Anders-Johan Almås).

## Background

The Norwegian private building owner Optimo contacted the Norwegian team of researchers from the SURE project (Multiconsult A/S) to obtain guidance on building physics issues for an old brick building in the Municipality of Bærum, Norway.

## Purpose/scope

The scope of this case study is to develop a concept for sustainable refurbishment of an old, listed brick building situated in Norway. The results and experiences from this case study will be implemented in the SURE procurement guidelines for sustainable refurbishment together with the other Norwegian, Danish, Finnish and Icelandic case studies.

## Theory

The theory is mainly based on issues of sustainability, refurbishment, heat transfer, moisture transfer, air flows, energy and economics.

## Methodology

The methodology is based on a “strategic analysis”, which is an early stage evaluation of the whole building. First, a survey is conducted. Then, different concepts for refurbishing the buildings are evaluated based on the survey. Risks, energy demand, future use and a range of other aspects are taken into account trying to give the client alternatives for refurbishment and at the same time showing the consequences of the choices. A “best solution” is also presented to show e.g. how far it is possible to lower the energy demand without running too high risks and taking into account the costs.

## Contextual description of the case

### Owner and ownership

The owner of the building is Optimo, a private company mainly focusing on property investments and development in the following areas:

- Office buildings and residential buildings in the counties of Oslo and Akershus, Norway, for sale to end-users or investors.
- Project management and construction management.
- Maintenance and developing of properties.

Optimo was established in 1997 and has since sold projects for approx. NOK700 million (about €100 million). Their largest client has been Entra Properties, who until recently had a share of 51 % in Optimo. In 2010 Entra bought the last 49 % of the share, and therefore Optimo now is 100 % owned by Entra Properties.

### Overall strategy of the case owner<sup>3</sup>

Entra Properties was established in 2000 and is owned by the Norwegian Ministry of Trade and Industry. The company has a total of 1,150,000 square metres in their portfolio representing a value of NOK21 billion (approx. €2.5 billion).

Entra Properties will create values for the owner through development, management and leasing of buildings. Entra Properties is operating in full competition in the private property market. Their goal is to develop buildings, which lead to increased efficiency and rational solutions for customers in the private property market.

Entra Properties aims to be a company with special focus on ethics. The company will be developed based on honesty, responsibility and proactivity:

- Vision: “We improve our customers' efficiency and reputation”.
- Mission: “Entra will create values through developing, leasing and operating attractive and environmental-friendly facilities”.

Entra Properties will create values for shareholders and be a good host for customers and the environment. Although their main task is to create values, it is not indifferent to how money is earned. In the future the most robust companies will be those who manage to combine social and business aspects. As a large state-owned property, Entra's developments and social responsibility should be integrated into the company's business plan.

Entra Properties has the ability to influence customers and suppliers to help solve environmental challenges. With an ambition to become one of the leading actors in real estate regarding outer environment, the company wants to lift its own and the customer's expertise in this area.

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<sup>3</sup> This chapter is based on information retrieved from the website of Entra Properties (2011).

### *Environmental issues*

One of Entra's main goals is to reduce their properties' burden on the environment. Entra Properties has done – and still do – a large effort to reduce the amount of waste as well as the energy and water consumption in their buildings. They also have good systems for monitoring. To become a leading environmental actor, Entra Properties aims to take the lead in this field for property development. A new environmental strategy for the company is now under preparation.

In Entra's action plan for environment, the environmental objectives for different environmental topics are listed. For instance, the energy required in the existing rented buildings should be reduced by 10 %. Entra Properties is also in a partnership with Enova SF on energy reduction and is an active participant in the network Norwegian Green Building Council. Technical Director of Entra Properties, Nils Fredrik Skau, is chair of the Norwegian Green Building Council.

### *Cultural heritage*

Cultural heritage is tangible evidence of human life and work. The term also includes places associated with historical events, beliefs and traditions. Such a broad definition makes it necessary to clarify, which buildings that should be listed or protected. In Norway, the Directorate for Cultural Heritage has the main responsibility for national and major regional values. At the local level, the municipalities do independent evaluation. It is of Entra's opinion that the best building conservation is achieved through continuous use of the buildings. An effort must be a balance between cultural and social benefits.

### *Strategies and goals*

Entra Properties aims to focus on environmental aspects in:

- Operation and maintenance of properties.
- Planning of construction projects.

Entra will focus on this in areas such as urban and regional development, cultural heritage, architecture and aesthetics.

### *Social responsibility*

The establishment of the company is founded on social responsibility. In Proposition 84 (1998-99) on the establishment of Entra Properties under the heading "The state as developer and property manager in a social perspective", it is stated that the company should:

- Be a good example in areas relevant to urban and regional development, cultural, research and development tasks.
- Have a special responsibility for architecture and aesthetics.

The business of Entra influences the community through:

- Local community impact: The business of Entra affects those who are daily visitors to buildings owned by Entra, working on Entra projects and the local areas where Entra are present.
- Quality requirements of properties: Customers, but also society as a whole, expect and demand quality in buildings managed by Entra.
- Environmental impact of construction and operation of properties.

### *Portfolio*

Entra Properties' portfolio includes over 100 properties in many parts of Norway with the majority in the south-eastern parts of the country. The portfolio contains a number of buildings with the qualities and characteristics that make them cultural heritage objects. Buildings from many time periods with different applications have provided a wide range of size, style and signifi-

cance in Entra's portfolio. The reason for the protection often lies in the historic role the building played in architecture or construction methods.

### Zoning constraints

The case building is situated in the Ringstabekk area in the Municipality of Bærum, close to Oslo and is part of a group of several old buildings situated on the top of a small hill (see Figure 97). Ringstabekkveien 105 has a long history as a boarding school. It also hosted the occupying Germans during the Second World War. Due to the historical significance certain parts of the building are protected.



Figure 97. Ringstabekk area. The case building is the largest building in the middle of the figure. Source: (Entra Eiendom – Optimo).

### Building type, present use and current users

Ringstabekkveien 105 is a brick building with five floors above ground and two floors underground (see Figure 98).



Figure 98. The Ringstabekk case building. Photo: (Anders-Johan Almås).

Some modifications have been made on the upper floor for one part of the building by raising the roof to free more indoor space. The building has op-

erated as a boarding school for educating women in domestic issues like cooking, cleaning etc. The past years the building has not been in use. The building owner is planning to change the building from a school building to an apartment building for elderly people. The first floor will operate as a service centre for elderly people, managed by the Municipality of Bærum. The main goal of the concept is to give the potential buyers an opportunity to live in their apartment the rest of their lives.

### Year of construction/representativeness

The building was erected between 1921 and 1923. In the following a detailed description based on a survey conducted in 2010 will be presented (see Figure 99).

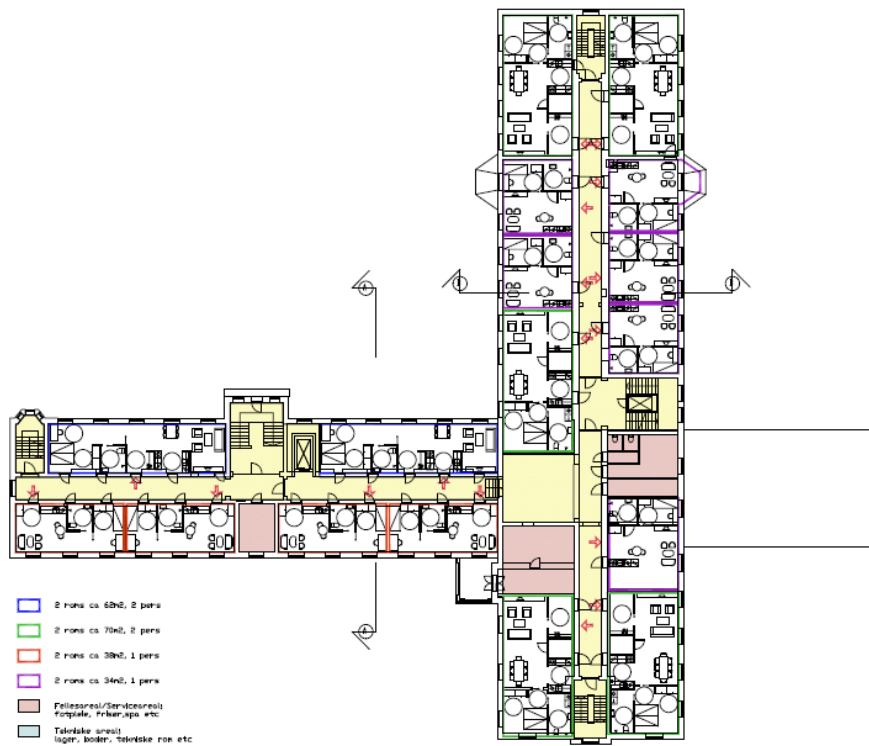


Figure 99. Second floor, as planned with apartments. Source: (Optimo – Entra Eiendom).

The façade is protected. The outer walls of the underground floors are made of stone (see Figure 100). Approximately 50 % of the stone walls are exposed to terrain. The other half is exposed to the outer climate. The outer walls from first floor to fifth floor are double brick wall constructions except the walls in the new top floor, which are made of light concrete. The U-value of the wall is estimated to 1.0 W/m<sup>2</sup>K for the double brick wall and 1.8 W/m<sup>2</sup>K for the stone wall and the single brick wall.





Figure 100. Outer wall façade. There is a clear distinction between the stone wall and the brick wall. Photo: (Anders-Johan Almås).

The roof is a hipped roof with trusses in wood-work and tiles as roofing. The attic is unheated. The floor (structural) beneath the attic has no insulation. The heat transfer (and flow) to the attic from the rooms below contributes to snow melting on the roof in winter time. The U-value for the roof is high, meaning around  $1.1 \text{ W/m}^2\text{K}$  (see Figure 101).



Figure 101. The roof seen from the cold attic. Photo: (Anders-Johan Almås).

The windows are mainly coupled windows (see Figure 102), except the windows in the stairwells (1-layer glass). The windows are protected and will be conserved. Some of the windows in the new part of the 5th floor are of recent date (2-layer glass). The U-value for the coupled windows is approximately  $2.8 \text{ W/m}^2\text{K}$ . For the one layer windows the U-value is estimated to  $4.8 \text{ W/m}^2\text{K}$ .



Figure 102. Coupled window. Photos: (Anders-Johan Almås).

#### *Air tightness*

Because of limited time for air tightness testing, only two floors of the building's southern wing were investigated, assumed to be representative for the building as a whole. Third and fifth floor in the northern part of the southern wing between the central stairway in the south wing and main wing were isolated from the other parts of the building (see Figure 103).



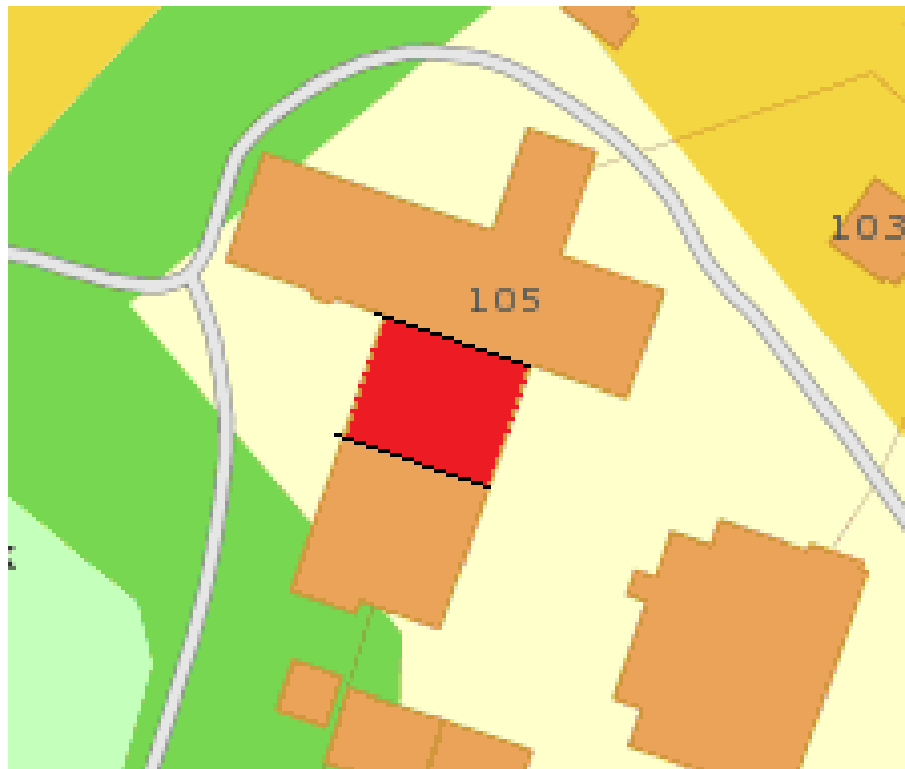


Figure 103. The air tightness was tested in the red area. Source: Adapted by Anders-Johan Almås.

Key values for the investigated zone are shown in Table 24 below. Both floors were tested at 50 Pa pressure according to Standard EN 13829.

Table 24: The results of the air tightness test in Ringstabekveien 105.

Test zone	Heated space	Volume	Infiltration number, $n_{50}$ (exch/h)
5 <sup>th</sup> floor	170 m <sup>2</sup>	375 m <sup>3</sup>	5.29
3 <sup>rd</sup> floor	193 m <sup>2</sup>	530 m <sup>3</sup>	4.65

The values for air tightness are high. Today's requirements for new buildings are 1.5 to 2.5. This means that the building has huge challenges regarding air tightness.

#### *Termography*

We noted a number of leaks in the building envelope while taking thermo-pictures at negative air pressure (see Case Appendix 1 for thermo-graphic pictures). In essence, the main problem areas are:

- Leaks around the windows.
- Leaks in wall vents at fifth floor (not possible to close).
- Leaks between wall/ceiling in fifth floor.
- Leaks in cracks between roof and wall.

#### *Energy system*

The building is heated by radiators supplied by district heating from excess heat from a nearby ice rink. The peak load is covered by electricity. An oil boiler is still functioning as a backup energy source. There have been some problems with the reliability of the district heating system. This will be taken into account when choosing energy system for the future.

#### *Technical equipment*

The building has a traditional luminaire lighting system, two elevators and a fire alarm system. The existing ventilation system has almost no heat recovery and no cooling. The whole ventilation system has to be renewed and the project has an aim to avoid cooling.

## Funding models and solutions

The building will most likely be sold after the renovation, but there is a possibility that the first floor will be rented by the Municipality of Bærum for social services for the elderly people living in the apartments.

## Renovation topics and coverage

These are the most likely renovation topics:

- No action on the outer walls due to restrictions and building physics.
- New windows.
- Insulation of the roof and cellar floor.
- New ventilation system with heat recovery.
- Upgrading of the heating system.
- A new energy power plant.

A new power plant, which also will be able to serve new buildings in the area, will be built according to plan. The heat system will also in the future be based on radiators. Depending on the security of supply for district heating, geothermal heat pump may be appropriate. Gas is considered as peak load. The decisions will be taken during 2011. A mechanical ventilation system with a high efficient heat exchanger will be installed. Use of solar collectors for heating of water will be evaluated (the building façade is listed). In the early phase, also other aspects of energy efficiency will be considered (lighting, operation, user training etc.).

Other relevant energy efficiency actions are:

- No action on the outer walls due to a protected façade.
- New windows inside of the existing ones.
- Insulation of the roof and cellar floor.

## Refurbishment strategy

Entra's Environmental Strategy 2010-2012 was adopted in 2009. It focuses on five main areas:

- 1 Improve the environmental standard of the property portfolio.
- 2 Building brand and strengthen its sales.
  - 2.1. Challenge the tenant to raise the building standard (depending on users).
  - 2.2. The tenant is responsible for internal energy costs.
- 3 Strengthening R&D and innovation projects.
  - 3.1. SURE – Nordic research project.
  - 3.2. LECO – Malmskriverveien 4, Sandvika (SINTEF).
  - 3.3. INTEND – EU project (Green Building Alliance/Can Energy).
  - 3.4. Upgrade – Application Research Council (SINTEF/Multiconsult) – upgrading of commercial buildings to the passive house standard.
  - 3.5. Glitne (Snøhetta/SINTEF) – tax for the construction of buildings, lower cost if better environmental profile.
  - 3.6. Future Built – Papirbredden 2.
  - 3.7. Norwegian Green Building Council.
- 4 Focus on new business (electric cars, power supply etc.).
- 5 Strengthen the organization and operation management (focusing on environmental indicators, goals and measurement).

## Intended future use and users

The building will be changed from a school to an apartment building likely to be combined with service facilities at ground floor.

## Procurement strategies

This chapter is based on a review of a random tender document of one of Entra's refurbishment projects: Middelthunsgate 29, Oslo.

### Implementation of the strategy

The tender document states in an early phase that the goals of the project should be:

- 1 The refurbishment should be a role model regarding environment and energy.
- 2 Weighted, delivered energy should not exceed 120 kWh/m<sup>2</sup>/year.
- 3 The building is listed. The refurbishment concept should therefore be discussed with the Directorate for Cultural Heritage.
- 4 The new office.
- 5 There should be no serious accidents during construction work.

The tender document also focuses on adaptability (flexibility, generality and elasticity), universal design, robust construction details, air tightness, LED lighting, indoor climate and monitoring systems.

Entra Properties has a clear focus on implementing their strategy into the tender documents. Anyhow, the goals are not very ambitious, aiming only at "a little better than national requirements standard".

Two of the project planners in Entra was interviewed by the SURE project team and gave the following supplying information:

- 1 Entra focus on selecting consultants in early phase for both energy and building physics.
- 2 Entra sets criteria beyond price. They want to choose the best expertise available.
- 3 Entra tries to ensure a multidisciplinary approach in early phase of the projects.
- 4 Environmental objectives are set in the tender documents.
- 5 As many goals as possible should be quantified (kWh/m<sup>2</sup>, waste management, lux level for lighting, etc.).

### Technological solutions

Entra Properties uses different tools to implement their strategy. A quality program prepared by Entra Properties and the tenant define the objectives and sets quality demands regarding architecture, adaptability and urban development. In this phase Entra Properties also engages the consultants.

### Barriers (e.g. zoning, taxation, parking places)

Entra Properties lists four main barriers for their work on sustainable refurbishment:

- 1 The client's willingness and understanding of environmental/sustainability.
- 2 "Training" of the users/tenants.
- 3 Competence of contractors and consultants/architects.
- 4 Double standard of the society is the biggest challenge.

### Incentives

Entra Properties lists four main incentives for sustainable refurbishment:

- 1 Market advantage – a sustainable approach will be a great advantage in the future.
- 2 Environmental considerations will become a larger part of the "value rating" of a building in the future.
- 3 Be in front of the market – long-term thinking.

- 4 Hard competition on labour. The younger generation is more environmentally conscious.

### **Procurement protocol, project delivery system**

Entra Properties has a specific contract strategy for each project. The award criteria vary between projects.

### **Achievements: performance, costs, sustainability**

Entra Properties focus on hiring the right person for the right job. The project manager of the contractor is very important.

### **End user engagement**

Entra Properties has the operational responsibility for common areas of the properties, facades and technical facilities. The tenant is responsible for energy, cleaning and interior maintenance for the leased premises.

## **Client as a change agent**

### **At which fields will the client be active?**

Entra Property aims to be the leading actor in property development regarding environmental issues in Norway.

### **How will he get there?**

By implementing their strategy into tender documents and trying to push the tenants to choose environmental-friendly concepts.

### **How will he win?**

To show the market that environmental-friendly solutions can be a market advantage.

### **At what speed will he proceed?**

Entra Properties has defined some Key Performance Indicators (KPI) within all levels of business. They have also developed a milestone plan for 2011, which will be revised every year.

### **How will he obtain returns?**

The returns will be obtained by rental income and "payback" as a market leader in environmental-friendly solutions for refurbishment.

### **To which extent can we see a coherent strategy action?**

The strategy has a strong foundation in the board of the company. Also, the managing director is personally involved in environmental issues regarding refurbishment of buildings. The client Entra Properties has been asked six questions with regard to the existence of a coherent strategy. The responses are:

- 1 How does your strategy fit with what's going on in the building sector?  
Entra believes its strategy fits with what is going on in the building sector. Entra has made the choice to be the environmentally leading property manager in Norway and believes that their environmental strategy is ahead of and is more ambitious than the rest of the industry.
- 2 How does your strategy exploit your key resources? Entra thinks that the strategy exploits its key resources. The key resources of Entra developed the strategy, but the whole organisation is involved in the implementation.
- 3 How will your envisioned differentiators be sustainable? Entra is convinced that its envisioned differentiators will be sustainable. Several of

- the indicators Entra uses are linked to the BREEAM methodology, which is to be adopted in Norway as the environmental certification scheme.
- 4 Are the elements of your strategy internally consistent? Entra considers the elements of its strategy to be internally consistent. The CEO is the driving force, and the entire organisation is engaged.
  - 5 Do you have enough resources to pursue this strategy? Entra believes it has enough resources to pursue the strategy.
  - 6 Is your strategy implementable? Entra views its strategy as ambitious, but achievable.

### **What kind of change management can we identify?**

Entra Properties' quality program is three years old. The program is a result of a change in the industry. Entra Properties has changed into a more environmental-friendly actor mostly driven by the increased focus on climate change and sustainable building latest years.

## **Guidelines**

### **Which guidelines is the client using for green refurbishment of buildings?**

Entra Properties has a quality program for all refurbishment projects. Further, BREEAM certification is being implemented. Energy and environmental consultants use their applications/tools in the projects directly. Entra Properties hope to certify all their buildings regarding energy within 2011.

### **Is the client using qualitative or quantitative descriptions in the green procurement documents?**

Most descriptions are qualitative, but some quantitative descriptions are given (e.g. delivered energy and lux levels).

### **Is the client using any kind of green classification system for refurbishing (LEED, BREEAM etc.)?**

Entra Properties has approved the first BREEAM certifier in Norway and aims to be active in the BREEAM network in Norway. Selected buildings will be certified in the years to come.

### **Are the guidelines used by the client international (in English) or country specific?**

They are mostly country specific. A Norwegian version of BREEAM is now being developed.

### **Which "green parameters" are usually described in the clients procurement documents for refurbishing?**

Delivered energy, waste management, operation and maintenance, indoor climate, ventilation and lightening are usually described in the procurement documents.

## **Conclusions**

Entra Properties surely aims to be among the best in class regarding environmental-friendly refurbishment of buildings. The tender documents shows that Entra Properties is on a good path, but the defined goals in the tender documents could be more ambitious.

Entra Properties has clearly taken their responsibility seriously the latest years regarding environmental aspects in refurbishment projects. Quality

programs and tender documents now contain more sustainable indicators like energy, waste and use of materials. Anyhow, Entra Properties could be more ambitious in setting targets for sustainable refurbishment.

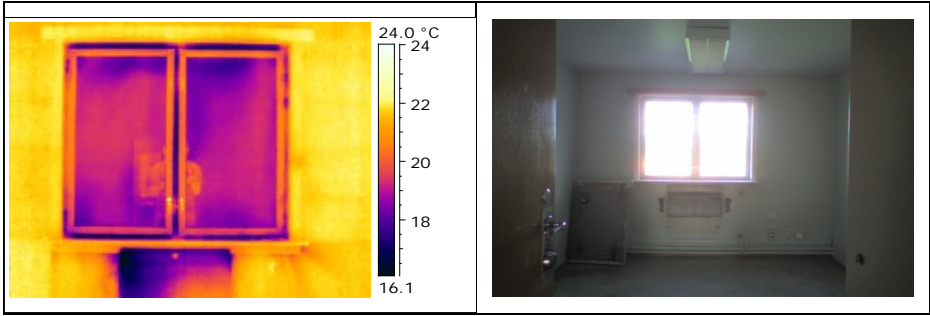
Entra Properties aims to be among the best actors in real estate when it comes to setting high targets for environmental-friendly refurbishment of buildings. BREEAM certification and energy labelling of buildings is on the agenda, and the focus on sustainability is absolutely present. Even so, the ambition level found in the tender documents should be even higher to reach the goal of their strategy.

## References

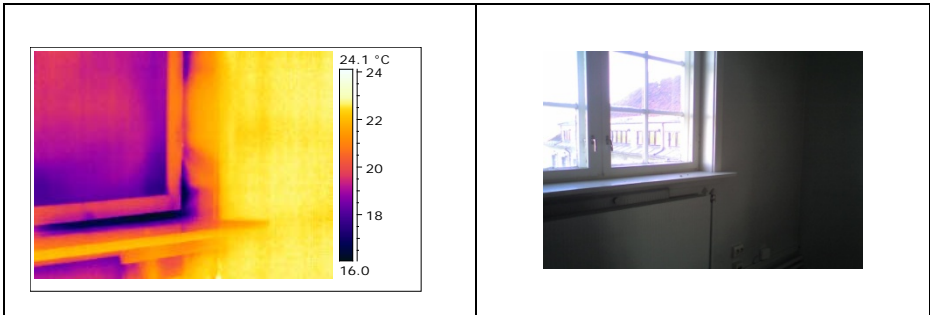
Entra Properties (2011). Website.  
Accessed October 2011 at:  
<http://entra.no>

# Case Appendix 1: Thermo-graphic pictures

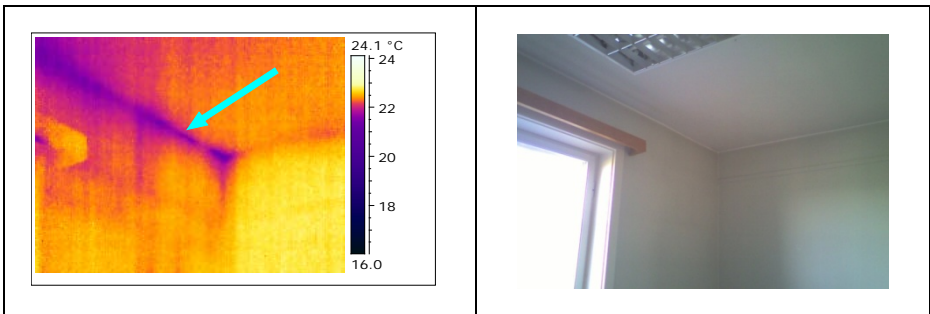
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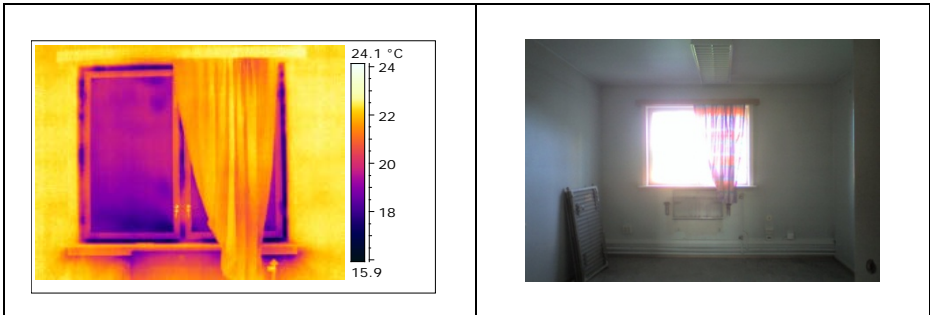
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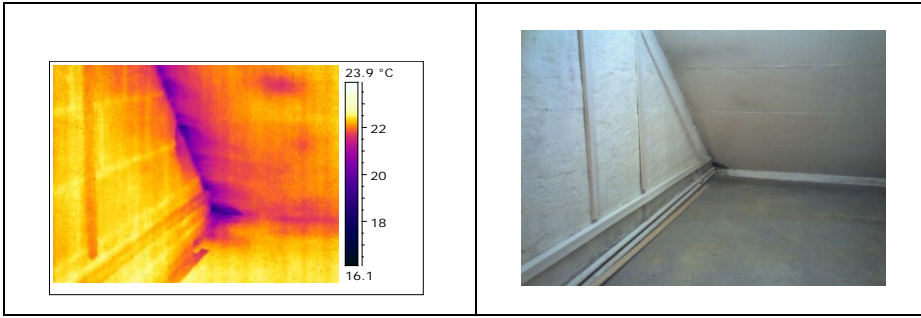
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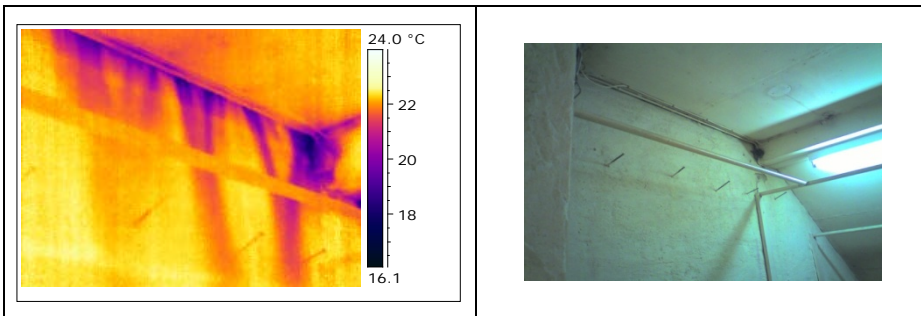
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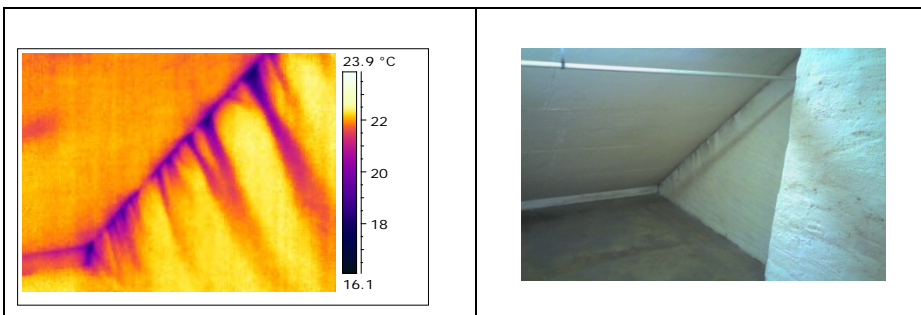
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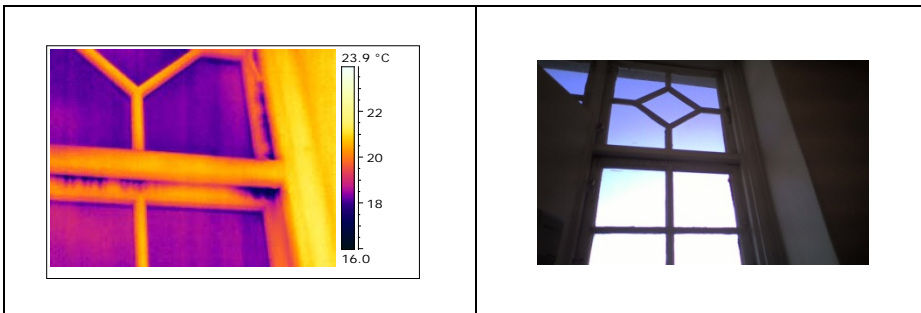
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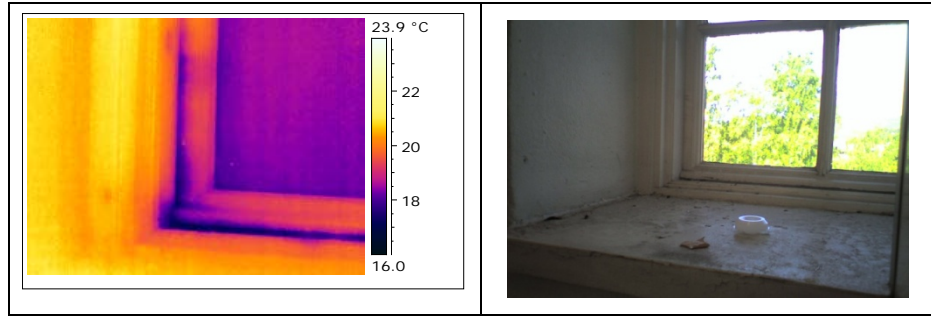


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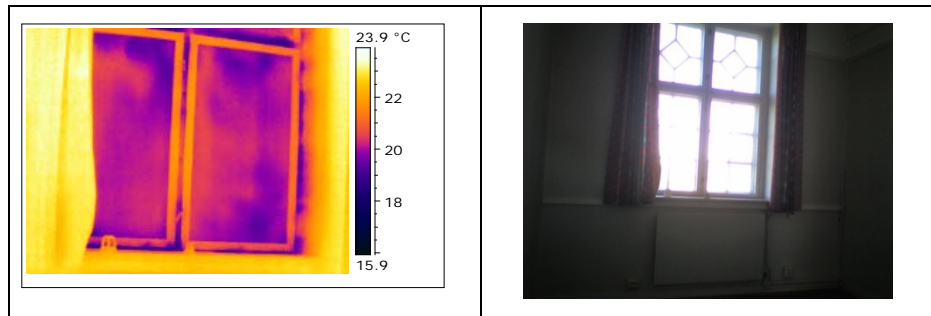




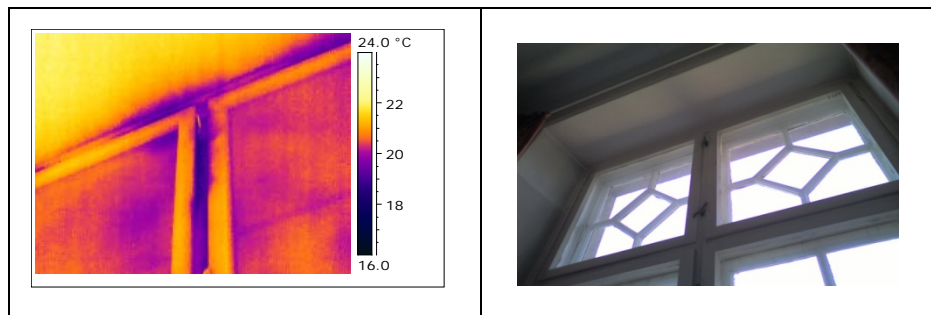
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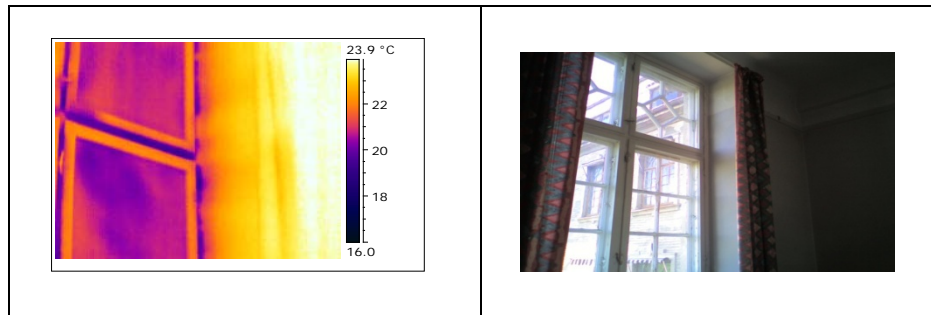
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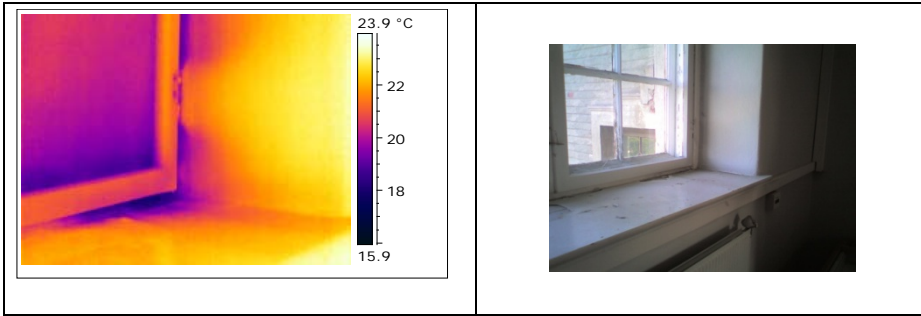
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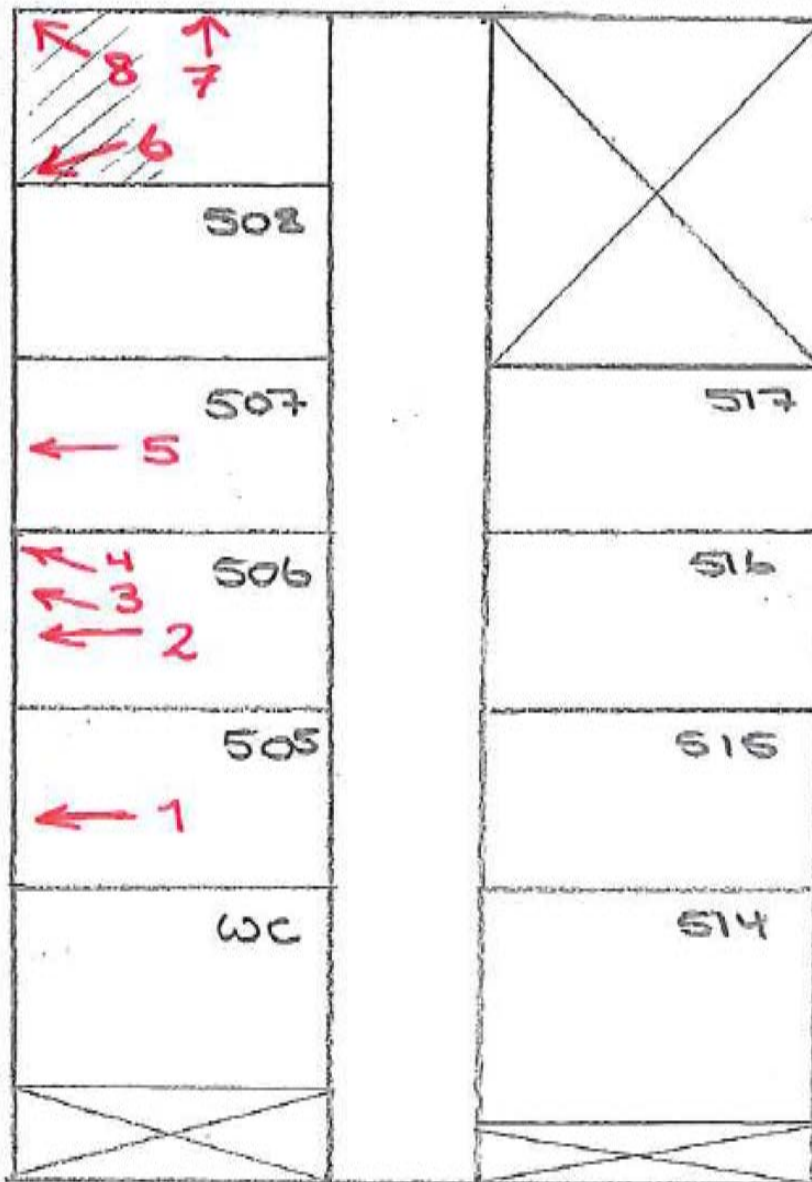
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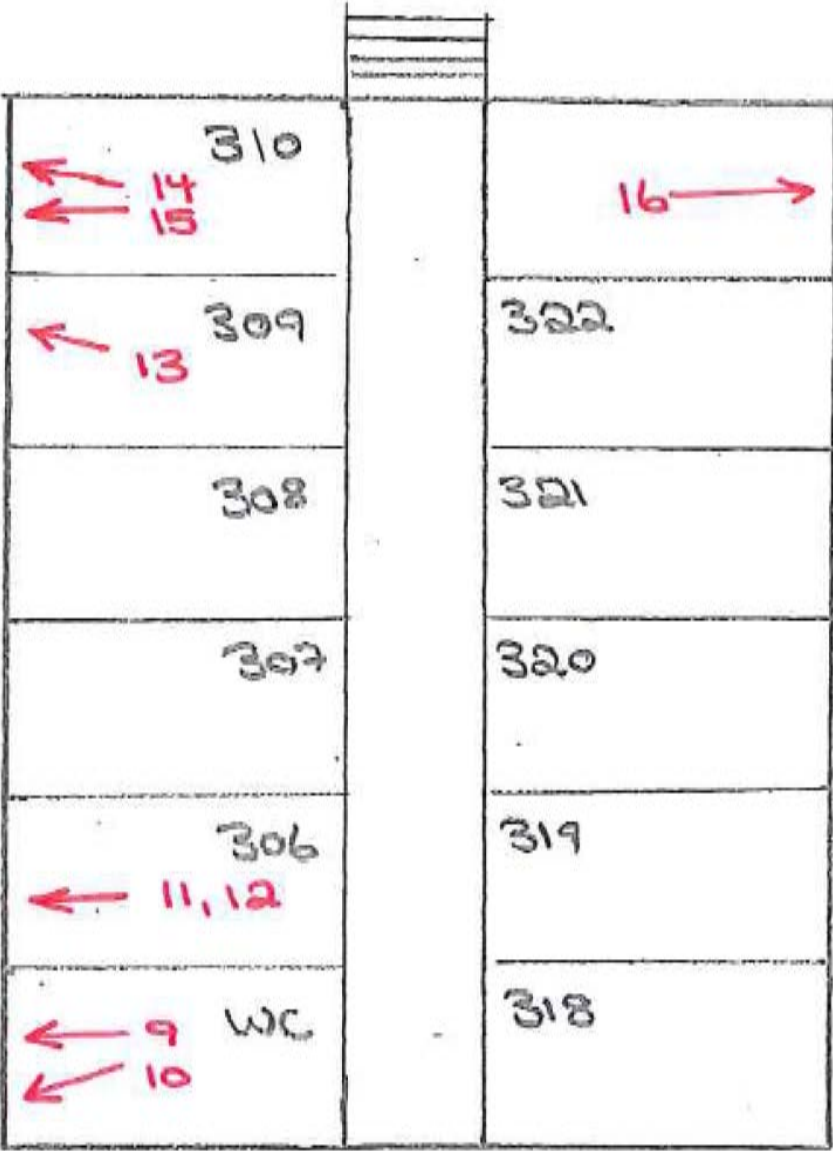
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Records 5<sup>th</sup> floor



Records 3<sup>rd</sup> floor



# Appendix 11: Low energy refurbishment of apartment blocks

*By Anders-Johan Almås & Svein Bjørberg, Multiconsult/NTNU*

## Introduction

The fourth Norwegian SURE case study is on low energy refurbishment of apartment blocks in the city of Kristiansand, located in the most southern part of Norway.

## Background

Kruse Smith is one of the largest building contractors in Norway. Refurbishment, rebuilding and rehabilitation of buildings are part of Kruse Smith's core business. Kruse Smith believes that sustainable refurbishment in general and energy efficiency in particular will progressively become more important in the future. In this context, Kruse Smith wants to use the experience from refurbishing a housing cooperative in Kristiansand, Øvre Kongsgård, to acquire expertise in this field. The Norwegian SURE team was contacted to do a review of the already planned project to find out how the project could get an even more sustainable profile.

## Purpose/scope

The scope of this case study is to evaluate a typical refurbishment project of a contractor in Norway and give further recommendations on an even more sustainable concept. The results and experiences from this case study are implemented in the SURE procurement guidelines for sustainable refurbishment.

## Theory

The theory is mainly based on issues of sustainability, refurbishment, heat transfer, air flows, energy and economic issues.

## Methodology

The methodology is based on an energy simulation of the building. Based on the calculated energy demand, alternatives for refurbishment in respect to energy efficiency are evaluated. A "best solution" is chosen by the building owner based on energy improvement, environmental issues and economics. The solution is then evaluated by the SURE group to establish what further improvements could be conducted that would make the project even more sustainable.

## Contextual description of the case

### Owner and ownership

Øvre Kongsgård 1 is owned by Øvre Kongsgård housing cooperative, which is the building owner of this refurbishment project (see Figure 104 and Figure 105).



Figure 104. Øvre Kongsgård, Kristiansand. West façade of the case building before refurbishment. Photo: (Kruse Smith).



Figure 105. West façade of the case building after refurbishment. Photo: (Kruse Smith).

Øvre Kongsgård housing cooperative has a close cooperation with Sørlandet Co-operative Building Society (SBBL – Sørlandet Boligbyggelag). SBBL is the cooperative building society of the southern part of Norway and is the result of the merger of the two co-operative societies “Kristiansand og Omegn Boligbyggelag” and “Agder Boligbyggelag”. SBBL has the function as consultant and representative of Øvre Kongsgård housing cooperative.

There are 15,000 members of SBBL and about 7,000 residencies are part of the co-operative building society. SBBL are part of the national federation of Norwegian co-operative building societies (NBBL). The housing cooperative has a general agreement with Enova, a state cooperation, which allocates public subsidies to projects with high ambitions regarding energy efficiency. During a period of five years, 10 % of SBBL member buildings will be refurbished.

## Overall strategy of the case owner

The overall strategy of SBBL is to offer technical and economical advice to the housing cooperatives. SBBL will request that the housing cooperatives undertake ambitious objectives regarding energy efficiency. The role of SBBL is to give advice and encourage energy efficiency. However, the final decision is made by the housing cooperatives themselves.

SBBL participates in a research project with the purpose of finding ways to communicate that energy efficiency is a necessary focus area in refurbishment projects and how to motivate buildings owners to invest in energy efficiency. Among others, NBBL and SINTEF are participating in this research project.

## Zoning constraints

Øvre Kongsgård 1 is located in a residential area close to the city centre of Kristiansand in the southern part of Norway. The street address of the case building is Olav Trygvarsons Vei 6A.

## Building type, present use and current users

The case building is a multi-dwelling apartment building with four floors above ground. The building also has two floors below ground, mostly parking areas, storage facilities and a boiler room. There are in total 54 apartments in the building. 31 of the apartments have a balcony on the west façade of the building. There will be no change of the use or users after the refurbishment of the building.

## Year of construction, representativeness

The building was constructed in 1965. When the building was designed, there was an architectural idea based on visual structural elements, called "Form Follows Function". "Form follows function" is a principle associated with modern architecture and industrial design in the 20th century. The principle is that the shape of a building or object should be primarily based upon its intended function or purpose (see Figure 106).

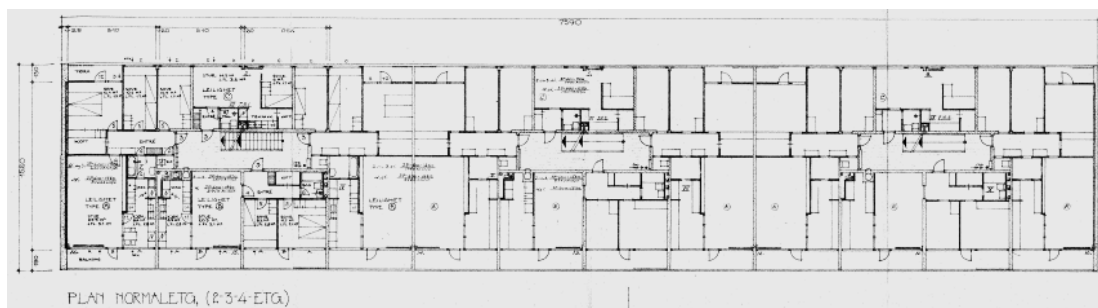


Figure 106. Layout of 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> floor. Source: (Kruse Smith).

This is the case for the structural partition walls of the case building. The consequences of the design of the partition walls are major thermal bridges. Thermographs have been taken of the building, which confirms the hypothesis. This leads to a heat loss and increased energy demand. There are restrictions to changes of the building façade decided by the municipality. No changes can be made to the expression of the façade and the window and door sizes have to be kept. Originally, there were restrictions to changes of the façades colour, but the colour choice is now optional.

## Funding models and solutions

The case project is completely financed by Husbanken with an interest rate, which is 1 % lower than the market rate. The monthly joint expenses of each apartment will increase by NOK100-150 (€12-18). If a defined low energy standard is reached, a subsidy from Enova will be around NOK4,000 (€500)



per apartment. The energy consumption of the building has to be followed up and reported to Enova the following five years after the refurbishment is completed.

Øvre Kongsgård housing cooperative will finance the refurbishment by loan in addition to the allocated funds they get from Enova.

### Refurbishment topics and coverage

The purpose of the project is to raise the technical standard of the windows by replacement and improve the energy standard by adding insulation, improving air tightness and reducing thermal bridges. The building's balconies will be changed into small winter gardens by adding glass façades. A mechanical (balanced) ventilation system will be installed in the apartments. The new energy standard of the building will be of a defined low-energy standard.

### Refurbishment strategy

The project aims at fulfilling the requirements to low-energy buildings in the Norwegian standard NS 3700, and the goal is to reach low-energy class 1 in this standard. The requirements to low energy class 1 in NS 3700 are shown in Table 25.

Table 25. Requirements to low energy class 1 in NS 3700.

Measure	Requirement
U-value, outer wall	$\leq 0,18 \text{ W/m}^2\text{K}$
U-value, roof	$\leq 0,13 \text{ W/m}^2\text{K}$
U-value, floor	$\leq 0,15 \text{ W/m}^2\text{K}$
U-value, window	$\leq 1,20 \text{ W/m}^2\text{K}$
U-value, door	$\leq 1,20 \text{ W/m}^2\text{K}$
Thermal bridges, $\Psi$	$\leq 0,04 \text{ W/m}^2\text{K}$
Air infiltration	$\leq 1,0 \text{ h}^{-1}$
Annual mean temperature efficiency of the heat recovery unit	$\geq 70 \%$
SFP-factor ventilation system	$\leq 2,0 \text{ kW}/(\text{m}^3/\text{s})$

### Intended future use and users

There will be no changes to the use or users of the building. The users of the buildings were generally positive to the refurbishment of the building. There are on the other hand some users who are critical to the installation of a mechanical ventilation system. There are no problems with the ventilation of the apartments today, and the users fear that a mechanically ventilated apartment will be more complicated and that the air quality will be reduced. A consequence of the new ventilation system will be a lower ceiling height.

### Suggested further improvements

The Norwegian SURE team has investigated the project and analysed both the technical solutions, the level of sustainability, the procurement documents and the communication between the building owner and the contractor. The analysis can be found in the following chapters. The SURE team has also suggested some improvements to the project, here summarized:

- 1 The tender documents should have been more ambitious and specific on energy level and sustainable parameters.
- 2 The energy source is an oil boiler. The insulation measures have reduced the energy demand, but the use of fossil fuels as main energy source is not sustainable. Therefore, we recommend installing a heat pump (geothermal) to be shared with other buildings in the area and electricity for peak loads. A solar heating system for hot water should also be evaluated.

- 3 The goals and strategic analysis should focus more on sustainable indicators. There is a great need of a tool for early planning regarding sustainable refurbishment.
- 4 The survey of the building should be more detailed to give the planners a good tool for making a performance profile of the building to take the right choices for refurbishing (see second bullet point).
- 5 The SURE team has not found any documents or programs for energy efficient use of the building. This should be easily available for occupants of the apartments.

## Procurement strategies

### Implementation of the strategy

In the procurement documents, SBBL set requirements to the energy standard of their projects. They also request use of products, which require minimal maintenance.

SBBL has a strategy not to set too many constraints to the contractors. The reason for this is to encourage the contractors to come up with the best solutions and to be innovative.

### Technological solutions

How the technological solutions are described in the procurement documents vary from project to project. In this case project, the technological solutions are to a limited extent described in detail. It is described that the buildings elements after the refurbishment has to achieve a defined minimum low-energy standard. There is no specification regarding the energy system. It is also pointed out that the energy system should be considered replaced based on environmental considerations.

### Barriers

As in most refurbishments projects for housing cooperatives, the attitude of the people living in the apartments is of crucial importance. Even if the start was a bit hard, the contractor has succeeded in involving the people in many processes during the refurbishment.

### Incentives

At first, the refurbishment of Øvre Kongsgård 1 only involved replacement of balconies and windows. Additional energy efficient measures were included in the design phase on the basis of economic support from Husbanken. Husbanken is an administrative body subordinated to the Ministry of Local Government and Regional Development in Norway. Low-energy standard projects or projects of higher ambitions may get economic support from Husbanken. This economic incentive was vital in the decision of additionally improved energy standard of the building.

### Procurement protocol, project delivery system

The contract is a design-build contract by contractor Kruse Smith.

### Achievements: performance, costs, sustainability

The contractor has been an active part in improving the energy qualities of the refurbishment project. Energy calculation of the building before refurbishing shows an energy demand of 269 kWh/m<sup>2</sup> per year. Of the total energy demand, about 192 kWh/m<sup>2</sup> is related to space heating. The calculated energy demand of the refurbished building related to heating will be about 30 kWh/m<sup>2</sup>. 30 kWh/m<sup>2</sup> is the maximum defined yearly heating demand of a residential building of low energy standard class 1 according to the standard



NS 3700. The indoor climate will be improved, and so will the comfort. Also, by glazing one of the balconies, the apartments increase their indoor floor area.

Table 26 shows key figures for a 74 m<sup>2</sup> apartment before and after refurbishment. As we can see, the market price has increased by 32 %. But none of the refurbished apartments are sold at this point, so the real increase in value is not known. If the apartment is sold for approx. €280,000, this will be quite remarkable. In that case, this case indicates that improving technical and esthetical qualities are of high importance economically for the owner of the apartments.

Table 26. Key figures for a 74 m<sup>2</sup> apartment in Øvre Kongsgården, Kristiansand. Conversion rate: €1 = NOK8.

	Before refurbishment	After refurbishment
Market price (EUR)	212,500 (+ loan)	281,250 (+ loan)
Joint loan (EUR)	5,598	83,811
Monthly rental costs (EUR)	257	586

The share of the joint loan is raised from €5,600 to €83,800, which more than doubles the monthly rental costs from €257 to €586. In other words, the costs of still living in the apartment are raised, but the comfort is much improved and the value has risen sharply.

### End user engagement

The apartment owners have been active in the process of the project decision making. Decisions are mostly taken within the board of Øvre Kongsgård housing cooperative, and the chairman of the board has been most active in the process. All the members of the housing cooperative have been informed through open meetings and have had the chance to influence the project.

### Client as a change agent

The SURE client is both the building owner (SBBL) and the contractor (Kruse Smith).

#### At which fields will the client be active?

SBBL will mainly focus on energy and environmental aspects. The question of cost versus benefit will always be important to SBBL and housing cooperatives, as they have limited economic resources. However, SBBL aims at motivating the housing cooperatives to be ambitious, and they want to stay ahead on a national scale.

Kruse Smith wants to increase their expertise on sustainable issues, energy use and environmental aspects in particular. Therefore, they need a tool for early communication with their clients.

#### How will he get there?

SBBL and Kruse Smith will follow their strategy. SBBL has an agreement with Enova, which will give SBBL economic advantages. The agreement is very important for achieving their goals.

#### At what speed will he proceed?

Ten per cent of the housing stock of SBBL will within the next five years be refurbished into buildings of a defined low energy standard.

### How will he obtain returns?

The individual refurbished building of a housing cooperative will increase its value. An estimated increase of value is about NOK150,000 (€18,000) of an apartment with a balcony. The fact that the apartments reach a higher energy standard is considered not to lead to an increased value of the apartment when sold due to a slow market on energy efficiency. The newly implemented building act on energy performance certificates might result in higher focus on the energy standard when buying a resident.

### To which extent can we see a coherent strategy action?

SBBL is slowly aiming for energy efficiency in their refurbishment projects. Kruse Smith has seen the advantage and need of having expertise on sustainable refurbishment. Participating in the SURE project shows that Kruse Smith really aims to secure a sustainable profile on their coming refurbishment projects. We have asked the client (Øvre Kongsgård housing cooperative) the following six questions. Here are the questions and answers:

- 1 The client considers its strategy to fit with what's going on in the building sector. Society in general and construction industry in particular has increasingly focused on reducing energy use in buildings. The building owner's purpose of the refurbishment was energy reduction coupled with the need for upgrading, better indoor comfort and to raise the technical standard of the building. Thus, the background of the project is consistent with the trends in the construction industry, but not a direct cause. There was no specific strategy in the project.
- 2 Does your strategy exploit your key resources? The client is a private housing cooperative and has not planned the project by using its own resources available within the housing cooperative. Instead, the necessary expertise is acquired through contractors or external procurement.
- 3 Will your envisioned differentiators be sustainable? The project was initiated with calculations indicating a project with short payback time. But the development of the project has led to a more strained economy.
- 4 Are the elements of your strategy internally consistent? The project is anchored to the client via a pilot project implemented. There was no specific strategy for the project.
- 5 Do you have enough resources to pursue this strategy? The client, a private housing cooperative, has not planned the project based on the resources available in the housing cooperative.
- 6 Is your strategy implementable? There was no specific strategy for the project.

### What kind of change management can we identify?

SBBL has through the later years improved their focus on energy efficiency. They have established workshops and courses for housing cooperatives, members and collaboration partners. The workshops and courses focus on the perspective of energy economics.

Another focus area of SBBL is universal design. In this case project, however, universal design is neglected.

As mentioned earlier, the economic issue is the leading aspect when decisions have to be made. For SBBL, the economic support and funding from Enova and Husbanken is an important motivating factor for energy efficient refurbishment.

## Guidelines

### **Which guidelines is the client using for green refurbishment of buildings?**

The clients are not using any specific green guidelines for sustainable refurbishment. To make sure that the building solutions are sustainable, energy consultants from SINTEF Byggforsk have been engaged, and the Norwegian SINTEF Building Research Design Guides are used.

### **Is the client using qualitative or quantitative descriptions in the green procurement documents?**

The Norwegian Standard for procurement processes is used. No specific guideline to green procurement is used, and the only green parameter found in the procurement document is that the building has to be of a defined low energy standard.

### **Is the client using any kind of green classification system for refurbishing (LEED, BREEAM etc.)?**

No green classification systems for refurbishment are used. The Norwegian Standard NS 3700 is followed in order to meet the requirements for a building of low energy standard.

### **Are the guidelines used by the client international or country specific?**

NS 3700 is a Norwegian standard based on the German concept of passive house standard and low energy standard. The standard is adapted to Norwegian condition based on the Norwegian climate, building traditions and design solutions.

### **Which "green parameters" are usually described in the clients procurement documents for refurbishing?**

The energy standard is usually described in the procurement documents for refurbishment projects. A calculation of the energy demand of the building is enclosed to the procurement document.

## Conclusions

The procurement documents are quite standard documents strictly focusing on barriers, limitations, law and the iron triangle: "time, cost and quality". First, the refurbishment project was supposed only to focus on improvements of balconies and windows. But the following process showed that public incentives of Enova and Husbanken together with an active contractor wanting to raise the energy standard of the building are crucial elements to achieve a successful refurbishment. The analysis also shows that the knowledge of sustainable indicators and energy efficiency measures are varying between the building owner, the contractor and the other actors of the refurbishment project. There is therefore a great need of a coordinator on sustainable refurbishment who has updated knowledge on the different indicators, like energy, indoor climate, economics etc.

There is a lack of use of guidelines and certification systems in the case project. As mentioned in the case reports of the city of Drammen, there is a rapid development of new requirements, programs and certification systems regarding sustainable buildings. Therefore, the client needs a tool to make the right strategic choices in an early phase of the projects. There is also a need for a method or a tool to reveal the challenges for the buildings in order to aim at the right measures for refurbishing. The tool or guideline has to aim for early phase planning. Communication of sustainable parameters, creat-

ing a performance profile of the building and a tool to check the sustainable parameters throughout the project are also needed.

A change in the market and requirements forces both the building owner and the contractor to focus on sustainable indicators, like energy efficiency and environmental-friendly materials. Both SBBL and Kruse Smith have taken effort to increase the knowledge of sustainability in their refurbishment projects. Anyhow, the level of knowledge varies between the different actors. Therefore, there is a great need of guidelines and tools to communicate sustainability for the clients to reach higher level of knowledge on sustainable refurbishment.



# Appendix 12: Refurbishment of residential building

*By Björn Marteinnsson, Innovation Center Iceland & University of Iceland*

## Introduction

The Icelandic SURE case is on the refurbishment of a residential block in the city of Reykjavik.

## Background

The building mass in Iceland is comparatively young or a little less than 30 years on average. In the 1950s and 1960s the housing market was in a great demand for new buildings and the period 1960-1980 was a lively building period. In this period houses were built in various places in and around Reykjavik, and the housing stock from this time is an important part of the environment – socially and culturally.

The energy situation in great parts of Iceland is somewhat special in that the energy is both cheap and sustainable. Energy for heating is geothermal hot water (about 80°C) from a distribution net, and electricity for household appliances and lighting electricity comes from hydro electrical power stations. The energy is therefore considered as environmentally friendly and from an environmental point of view not seen as necessary to reduce the use of. Energy production has a very low CO<sub>2</sub> footprint, but some contamination from H<sub>2</sub>S in the air from the geothermal stations. It is now considered how this contamination may be minimized.

The price for hot water in Reykjavik (2010) is 0.0095 €/kWh, and for electricity 0.0536 €/kWh, VAT included<sup>4</sup>. There is therefore a very little economic incentive for minimizing energy use. The energy requirements for new buildings stated in the building regulations are economically sound for new buildings, but it's not economically sound to refurbish older buildings to fulfil the regulations.

The yearly average outdoor temperature in Reykjavik (1997-2006) is 5.1 °C, and the average for the warmest month is 11.3°C. Thus, the heating season spans the whole year.

## Purpose/scope

The building stock from 1960-1980 is now in a growing need for maintenance. At the same time the functional needs are changing due to changing age distribution of the nation. There is a growing market for small flats that are appropriate for elderly or disabled persons. In maintenance of the building stock it is important to ensure that the buildings will be of interest for the near future, which in the case of Reykjavik means thinking and planning for future functional needs and health rather than minimizing energy needs.

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<sup>4</sup> The energy price of hot water based on efficient temperature difference in heating system of 45°C (52.3 kWh/m<sup>3</sup> water), exchange rate €1=ISK156.86.

The case presented here is the company Félagsbústaðir hf. which owns all social housing in Reykjavik municipality. The case study regards one of their multi-family dwellings, which are being renovated to increase the quality of living and ease of access to and inside the building.

The case is interesting as the building is typical for multi-family houses built in the period 1960-70, a very lively building period in Iceland, and shows what can be done to increase the standard of such buildings.

### Theory

The case studied is refurbishment with the main focus on quality increase, accessibility and quality. There is not a specific theoretical methodology at the base of either the project or the case study.

### Methodology

A case study on a multifamily house is presented. The study is based on discussions with contact persons on behalf of the house owner, the architects and staff of the construction company. Own studies during visits at the building site were made.

The persons contacted were:

- Client: Félagsbústaðir:
  - Sigurður Kr. Friðriksson, General Director.
  - Þórarinn Magnússon, Customer Service Director.
  - Stefán Jónasson, Inspection Supervisor.
- Architects: Páll Gunnlaugsson, ASK architects.
- Consultants: Hjalti Sigmundson, consulting firm.

## Contextual description of the case

### Owner and ownership

Félagsbústaðir hf. (Reykjavík Social Housing) is a public limited company, owned by the city of Reykjavík, who owns, runs and maintains rented social apartments for individuals and families under a specific income and property maximum.

The rent in social housing in Reykjavik is a fixed amount decided by the municipality. The rent is generally lower than that on the private market, and therefore it is actually subsidised by the municipality as has been customary for some decades. The right to rent a social housing dwelling depends on income wages and family size. Until 1997 the social housing formed a part of the general building stock of the municipality, and a maintenance and refurbishment fund for the buildings was therefore non-existing (the owner paying when needed).

In 1996 it was decided to establish a facility company (Félagsbústaðir hf.) for all the social housing in Reykjavik and from then on it is expected that the rent will pay all costs for the buildings.

When established in 1997 the housing company, Félagsbústaðir hf. took over 827 flats, and were required to increase their building stock by 100 flats per year, but this increase is now slower. In 2010 the building stock amounts to 2,200 flats, a total of little more than 160,000 m<sup>2</sup> (Félagsbústaðir hf., 2010). Half of the flats are in own buildings, the rest in buildings owned by many owners (the others usually private persons or companies)<sup>5</sup>. Most of

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<sup>5</sup> In Iceland each flat, or housing unit, is registered as an property and can be owned by an individual.

the building stock is located in buildings with a majority ownership of Félagsbústaðir hf. Only 10 % are single flats in buildings where all the other flats are owned by others.

The oldest flats in the building stock of the company are built in 1946, a large share is built in the period 1960-70 and then around 1980. At the outset of the housing company, a certain backlog in maintenance was at hand. Based on this the maintenance and refurbishment cost was initially estimated at 2.5 % per year of the total building cost of the stock, but has since been lowered in steps and is now down to 2 %. Part of the buildings needed huge outdoor maintenance due to e.g. damaged concrete, but this has now been carried out, and the basic maintenance level of all buildings is now considered satisfactory. Due to increasing age of the building stock major maintenance needs of sewage pipes, heating systems and electricity is nearing, and at the same time it is evident that major refurbishment will be needed to heighten the quality standard in the older part of the building stock.

The rent is based on a fixed index regulated sum per m<sup>2</sup> based on expected cost (including a fixed percentage for maintenance and refurbishment) and then subsidised by 33 %. The rent does not change with the general price fluctuations on the private market.

### Overall strategy of the case owner

The objectives and purpose of Félagsbústaðir hf. are (Félagsbústaðir hf., 2010):

- To own and maintain social housing in Reykjavik.
- To be a service company in the housing market.
- With the founding of a public limited company (plc.) to own and maintain social apartment buildings, where the operation is separated from the Municipality of Reykjavik and the cost, performance and responsibility is more visible than before.
- The municipality's role changes from being a directly involved actor to monitoring the quality of the service and giving necessary restrictions to the operations and financial situation of the operator.
- To change the operations of social housing in the city so it resembles comparable operations in Western Europe.
- To employ professional methods with the purpose of keeping rental price at a minimum and improving tenant service.
- To increase supply of social housing to meet the housing demands of those who cannot redeem debt service payments on loans for purchasing apartments and are unable to find rental housing at affordable prices.
- Félagsbústaðir hf. shall operate for the benefit of public interest.

The operation of Félagsbústaðir hf. shall be fully sustainable and non-profitable.

The client owns all social housing in Reykjavik and aims to be a front runner in the field of good accessibility and living standard in dwellings. To be successful, and at the same time fulfil economic requirements the housing company states that it is important to:

- Keep the flats in use, and preferably with as few replacements of users as possible.
- Keep a good building standard to make the flats desirable for users with different needs.
- Give the tenants a good service and listen to their wishes regarding what can be done better.
- Keep maintenance costs low.



## Zoning constraints

The building is located in an area with many other buildings of similar form and volume, all from the same building period. The planning authorities have a great wish to maintain the overall architectural expression of the district as intact as possible, but neither the building nor the district plan is specifically listed as architecturally interesting.

## Building type, present use and current users

Meistaravellir 19-23 was built in 1964 as a multi-family social housing, and has been used for this purpose since and will continue to be so (Félagsbústaðir hf., 2010a). The building has three stairwells and four floors with two apartments on each floor. The apartments are rather small or about 55 m<sup>2</sup>. In the basement there are storing rooms for each apartment. The building does not have an elevator as this was not required at the time of construction.

The building is made of in-situ poured concrete (outer walls, floor slabs and inner walls between apartments). The outer walls are insulated on the inside with 50 mm cork insulation and cement rendering. The roof construction is timber roof on a concrete slab. The use of concrete insulated on the inside results in many thermal bridges. The windows are a two pane insulation glass with U-value of 2.9 W/m<sup>2</sup>K and massive wooden frames.



Figure 107. Meistaravellir 19-23. South view (during refurbishment). Photo: (Björn Marteinnsson).

Almost the entire part of the south facing façade and a part of the north façade are insulated panels to the height of 85 cm, a window band and then again 35 cm of panels above windows, the panels insulated with 50 mm polystyrene (Figure 107). Other windows on the north façade are relatively small as seen from the drawings and no windows at all on the two end walls of each building (Figure 108).



Figure 108. North view. New window openings have been cut out on the gable wall (during refurbishment). Photo: (Björn Marteinsson).

Air tightness of concrete buildings in Reykjavík is usually rather good ( $n_{50} < 1$  air change per hour) if tightness of windows is good. The air change rate for the buildings in question, or single flats, has not been measured.

### Year of construction, representativeness

The building, built in 1964, is typical for multi-family dwellings from the building period 1960-79 in Reykjavík. The plan of one level after elevator has been built is shown in Figure 109.

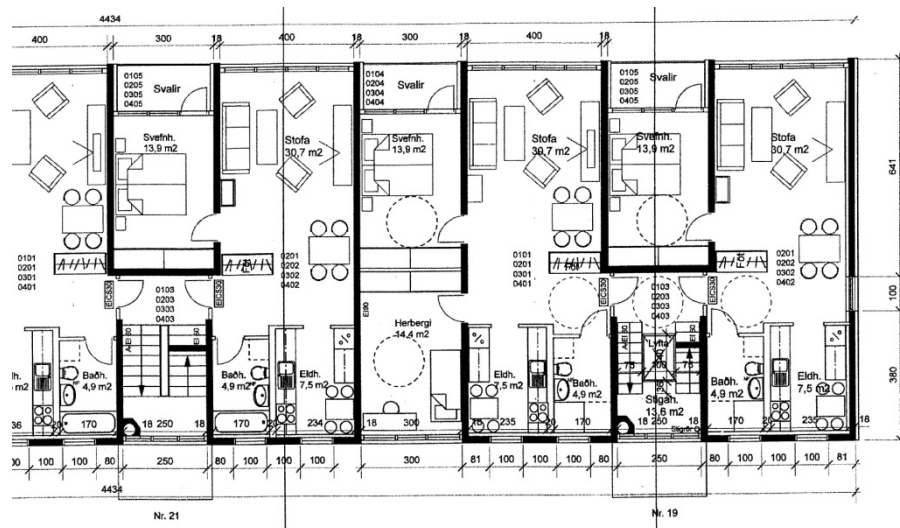


Figure 109. Second floor plan after refurbishment. Source: Architects of refurbishment (ASK architects).

## Funding models and solutions

The renting cost in social housing in Reykjavík is a fixed amount based on size of apartment. Therefore it is not possible to heighten it due to maintenance or refurbishment costs. For regular maintenance this is not a problem, but decisions regarding major refurbishment actions need to be considered carefully as the cost must be paid off by regular income. In this situation the facility company needs to have access to loans at favourable terms and the maintenance and refurbishment must result in lower costs in the long term.

The Housing Financing Fund in Iceland normally gives loans for refurbishment of buildings when owned by individuals, but did not do so for social housing. In 2008 the facility owner Félagsbústaðir hf. took up successful negotiations with the fund to change this so that the social housing corporation would have access to these loans that have better terms than general loans on the market, usually 4.5 % rent and a payback time of 50 years.

The refurbishment discussed is funded by loans from the Housing Financing Fund to 90 %.

## Renovation topics and coverage

For some years there had been increasing problems with the sewage pipes, which were more and more often clogged, and clearly these needed to be changed due to age. As this is a major work disturbing the core function of the house (the tenants) it was considered appropriate to use this event to make more extensive refurbishments at the same time:

- Insulate gable walls better as tenants complained about cold surfaces.
- Replace windows and fill-ins below windows on south façade and part of north façade to get increased insulation and better material quality.
- Re-model part of the house so as to make it usable as a dwelling for life (accessible for handicapped and elderly).

## Refurbishment strategy

The facility owner has a house with 30 apartments that the company had planned on selling before the bank crisis in Iceland (autumn 2008). The tenants had moved out, but due to the crisis a buyer could not be found. The tenants of the building to be refurbished moved to this building, which is located about 12 km away and where they do not have to pay rent during the months to come. The refurbishment will be done during the summer months; partly as the climate is suitable and partly so as not to disturb the school days of the children. The rent in the refurbished house will not change from what it was before as this has always been the policy of the owner. For these two reasons, the tenants therefore do not have a strong will to oppose the refurbishments and have moved (temporarily) in good spirit.

## Intended future use and users

The building will continue to be social housing for Reykjavik municipality.

## Procurement strategies

### Implementation of the strategy

Implementation of the strategy is carried out by strict on-site control, decision making and coordination by the highly experienced personnel of the owner.

### Technological solutions

Some years ago the windows on the north facing walls were refurbished by taking out the window panes and, as the wooden part was shown to be in a good shape, new window frames with windows to open were fitted into the

old frames. This reduces the daylight opening of windows somewhat as the windows were from the start rather small, or about 10 %. This does not affect the bathrooms too much, but it clearly affects daylight possibilities in the kitchens at the north façade.

The concrete in the building is in good shape, even the balconies are fine. It is therefore not considered necessary to make changes to structural parts or put on a weather protection on the house as a whole. Consequently, the effect of most of the thermal bridges in the house will not be affected by the refurbishment. Energy calculation for the house was not done prior to refurbishment or in connection with planning of refurbishment actions as increased energy efficiency was not seen as important. The windows (clear glazed double panes) and wall panels (with 25 mm insulation) on south and north side are taken out and new ones put in. The new window panes are double glazed with an e-low film, and insulation in new panels is 75 mm insulation and the outer panel of double glazed panes.

New window openings were made on each of the end walls, and these walls were insulated on the outside with 50 mm insulation and cladded as the tenants in these apartments had complained about the low surface temperature. Small wall areas between living room and balconies are also insulated and cladded.

The sewage pipe system is totally replaced. Also the electrical wiring and fuse box have been replaced, so now each apartment has its own electricity meter, but the heating system for all apartments in each stairwell is supplied with one joint energy meter. The wall between bathroom and kitchen in each apartment is made up of a double wall of lightweight concrete blocks, thus forming a properly sound insulated pipe duct between the two walls.

Where possible, domestic materials are used e.g. wall elements of light weight concrete blocks instead of the now more frequent gypsum boards and thin walled steel profiles.

Actions to give better access for disabled (even persons in wheel chairs in some instances) were made after discussion with the national association for disabled persons.

In this area in Reykjavík, built in the late 1960s and early 1970s many multi-family dwellings are four storeys high and without an elevator. This clearly affects the value of the top floors of the buildings, and an elevator is therefore of a general interest. Elevator is put into one of the stairwells. This is the first action of this kind in Iceland and had to be discussed thoroughly with building authorities and requiring a test with a mock up first (see the details later). The outer dimension of the elevator will be 100 x 160 cm and the inner dimension of the cabin 80 x 140 cm. The net width of the stairs will be 75 cm after the change. To ensure that the daylight will not decrease too much (and to give a more open feeling in the now narrow stairwell) the elevator shaft and the walls of the cabin are made of glass (Figure 110).

The access to the building from outside is re-modelled to make it possible for persons in a wheel chair to enter the building and move to the elevator.



Figure 110. Existing staircase with an elevator built in. Photo: (Björn Marteinsson).

Door openings in apartments are made wider to give better access inside the apartments and also out to the balconies.

The kitchen is totally rebuilt and is now a little smaller than before, but the kitchen area now has a better layout and can be used by a disabled person.

The bathroom will be a little larger than before and totally remade. The bathtub will be removed and a shower will be installed. Thus, the bathroom can be used by disabled persons.

A waste sorting facility is built outdoors to make sorting of waste possible.

### **Barriers**

From the start of the project there was a strong will to ensure that the refurbished building, or at least a part of it (one stairway), would be accessible for disabled persons. As the building is 4 storeys high, and the first floor is placed 1.4 m above the plot surface, this makes an elevator necessary. In an early stage of design it was considered to apply for a building permit for an extra floor on top of the building to pay for the cost of installing an elevator, but it soon became clear that this would not be permitted.

The only reasonable way to install an elevator in the building is making room for it in the existing stairway. This result would be stairs with a width of 0.75 m wide instead of the initial 1.05 m, and the fire authority was not willing to give the necessary permit for this. A mock-up was built to show how much free space would be available in the stairway and this was then tested by ambulance personnel (the Fire Brigade), who concluded that this would not hamper them in their work in carrying sick people in or out of the building. In the end a permit for the elevator was given by the building authority, but the decision is still debated.

### **Incentives**

The refurbishment with an elevator installed makes the building accessible for a broader profile of clients (disabled and elderly) and will be easier to rent out.

The refurbishment actions taken are expected to lower the energy use of the building to some degree:

- The insulation standard is only heightened to a small extent by better insulation of an end wall of the building and parts of the south wall.
- Better control devices on heating system and more efficient heating. In a similar refurbishment action at Skúlagata this has been shown to lower the energy use somewhat, but this gain is lost again later as time goes by.
- Better information to tenants on efficient energy measures.

The owner (Félagsbústaðir hf.) claims that the main incentive is that better standard of the building in general will lower unforeseen maintenance needs dramatically as the tenants will value the building and environment higher and thus show more respect for it. This claim is based on experience from similar actions during a period of 13 years as of now (since 1997).

### **Procurement protocol, project delivery system**

The project in this case study is a case study for the client too, especially regarding wishes of better accessibility to and inside the building and it was known from the start that some decisions needed to be taken or reformed during late stages. The client therefore wished to have a very good control of the project:

- Planning and design is done in cooperation between the client and consulting firms especially chosen for the work by the client.
- In the construction phase the client, together with hand-picked consultants, takes care of all quality control and considerable part of both planning and supervision too.
- The construction firms are some, rather small, specialized actors in the field of refurbishment, chosen by the client.

Félagsbústaðir hf. usually has 60-100 persons working for them in maintenance and refurbishment of buildings.

### **Achievements: performance, costs, sustainability**

The refurbishment of one third of the building is finished (one stairwell with 6 apartments):

- The changes in plan of stairwell (with elevator) functions well and accessibility of flats is good for disabled persons, which can easily get into the building and to each of the flats and the storerooms on the ground floor.
- Inner surfaces of flats and stairwell are light in colour and daylight in flats and stairwell appealing.



- Flooring material where small ramps have been made to give wheelchair access to bathrooms and balconies is well solved and not uncomfortable for a walking person.
- Flooring materials (linoleum) are put on an underlying felt, which will improve step-sound insulation between flats considerably.
- New doorframes and doors, and inventory in kitchen are solid and seem durable.

The refurbishment of window panes, extra insulation of gable wall and wall parts of the south facing walls will increase the surface temperature of these building parts (Table 27). The change in surface temperature is typically 0.6-0.9 °C and for locations close to the surfaces the needed air temperature for a given thermal comfort may be lowered by this amount, but in general the effect may be estimated as half the change. The effect is further increased by higher surface temperature of window panes, especially those in the living rooms. Thus, the increased surface temperature may in general result in that the necessary air temperature, inside the apartments at the gable walls, may be lowered by as much as 0.3-0.5 °C without changes in operative temperature. The refurbishment actions will certainly result in better thermal comfort generally (more even operational temperature in the different rooms of each flat) but also give somewhat lower energy losses (as much as 2-3 %).

Table 27. Inner surface temperature of gable wall before and after refurbishment (indoor temperature = 20°C).

	U-value (W/m <sup>2</sup> K)	Outside air temperature (°C)			
		-10	-5	0	5
		Before refurbishment	0.66	17.4	17.9
After refurbishment	0.38	18.5	18.8	19.0	19.3

The real effects of increased insulation on gable walls and south wall on thermal comfort and economy have not been evaluated so far, but calculated energy losses before and after refurbishment are shown in Table 28.

Table 28. Calculated energy losses before and after refurbishment.

	Size (m <sup>2</sup> or m <sup>3</sup> )	Before (W/K)	After (W/K)	Ratio	Delta: Lowered energy loss ratio
Transmission loss (total)		1177.1	947.1	0.74	0.20
Roof	146.2	77.1	77.1		0.00
Walls (netto)	323.8	220.8	149.5		0.32
Windows and doors	202.7	627.4	501.4		0.20
Floor	146.2	78.9	78.9		0.00
Thermal bridges		172.9	140.1		0.19
Ventilation loss*	1822.9	328.1	328.1	0.26	0.00
Total thermal loss		1505.2	1275.2	1.00	0.15

Note: Air changes n=0.5 1/h.

Transmission losses are about 75 % of total losses in this multi-family dwelling. Even after refurbishment losses through windows account for about 53 % of total transmission losses and thermal bridges account for 15 %. To minimize net energy losses through ventilation, it would be necessary to put in a thermal exchanger, a very expensive solution as the building is ventilated by natural ventilation through windows only.

The refurbishment cost for the building alone (cost for moving tenants temporarily to other dwellings not included) is about 134,000 ISK/m<sup>2</sup> (about 885 €/m<sup>2</sup>), which is a little more than half the market price for a dwelling of this type and location.

### **End user engagement**

The refurbishment is a huge intervention in the flats as kitchens and bathrooms are totally re-made, the main pipes for sewage and part of the heating system is replaced, and in addition all door openings in the flats in one of the stairways are made wider. This made it very much preferable to move the tenants out of the flats during the construction time – which needed a great good will and cooperation from the tenants.

A representative for “The Association of disabled persons” was consulted regarding all decisions and solutions affecting better accessibility of the building.

Decisions on increased insulation, mainly on the two gable walls of the building, and new window openings on same walls are done based on discussions with the tenants.

## **Client as a change agent**

### **At which fields will the client be active?**

The client owns all social housing in Reykjavik and aims for being a front runner in the field of good accessibility and living standard in dwellings. About half of the client's building stock has been refurbished since 1997, although with somewhat lower standard than presented in this case study as the wish for good accessibility is new in the client's strategy. The rest of his building stock will be refurbished during the next decade or so with similar standard as used in the case study presented.

### **How will he get there?**

As the portfolio of buildings owned by the client are dealt with as a whole, the refurbishment costs and maintenance of single buildings is taken from a central fund, but without undue increase in the rent (the maximum rent is regulated in social housing in Reykjavik). This results in that all measures must be cost effective in the long run and the owner must get high ratio of the cost funded by loans as it will usually take considerable time for repayment.

### **How will he win?**

The client has already proven for himself that a good building standard and goodwill from the tenants pay off in less cost due to unplanned maintenance. Better standard of the buildings resulting in good accessibility and lower operational cost increases the groups of interested tenants to be and makes for a better competitiveness on the market as the tenant can always choose to accept the subvention and then rent on the open market.

### **At what speed will he proceed?**

The client aims for having at least one major refurbishment work going on at all times. How fast this will get the complete building stock to a good standard has not been discussed so far.

### **How will he obtain returns?**

Félagsbústaðir hf. is a non-profit social housing company that is actually in competition with the free market. It is important to keep the tenant group



steady and thus better to be able to get goodwill and good behaviour. This will in the long run lower maintenance costs and ensure better cash balance.

### **To which extent can we see a coherent strategy action?**

The client has since 1997 constantly upgraded his building stock by refurbishment and in some isolated cases by selling off existing stock and building new. The target for quality standard has been increasing all the time.

### **What kind of change management can we identify?**

Until recently the client's main focus was on traditional maintenance, now refurbishment aiming for higher standard, better quality and accessibility is the main theme. The client has built up a very effective telephone service that is open every day, where tenants can call in to inform about damages and maintenance needs and generally inform on the situation in their buildings. This is said to have increased the interest of tenants for their environment and results in better conduct.

## **Guidelines**

### **Which guidelines is the client using for green refurbishment of buildings?**

The client has a "Green bookkeeping" document, but not a specific guideline for refurbishment. There is though a growing consensus in the firm of what they expect of refurbishment based on own projects and what they see is done abroad, a strategy that will probably be put down in a guideline in near future.

The client has a very clear idea about quality of interiors and flooring materials, which he claims are very important to keep down unforeseen maintenance (e.g. door posts, kitchen interior and floorings in stairways).

It must be mentioned that some aspects that are often mentioned or included as "green" parameters in e.g. LEED and BREEAM are almost generally used in Iceland. This applies for example to:

- Water-saving toilets.
- Water-saving showers in public spaces.
- Thermostatic valves on heating elements.

### **Is the client using qualitative or quantitative descriptions in the green procurement documents?**

The descriptions are so far mostly qualitative, but some materials are preferred above others.

### **Is the client using any kind of green classification system for refurbishing (LEED, BREEAM etc.)?**

The client is not using any kind of green classification schemes. At the time being it is not clear if the success of the work will be evaluated according to any kind of a scheme – they contact the tenants regularly to get input from them.

### **Are the guidelines used by the client international (in English) or country specific?**

The guidelines used are in Icelandic only, and they are specific for the client.

## Which “green parameters” are usually described in the clients procurement documents for refurbishing?

The following parameters are usually included in the client’s procurement for refurbishment:

- Use local materials as far as possible.
- Use materials that are easy to clean.
- Use durable materials.
- Planning so that sorting of waste is possible.

## Conclusion

With regard to procurement, in maintenance and refurbishment work the facility owner very often hand-picks consultants and construction companies and relies on own expertise to ensure quality and coordination. There is therefore often no specific procurement documents used in the projects, only a general aim of the owner is documented. This lack of documentation may give problems in case key persons in the firm are unable to attend on site or in the worst scenario even quit working.

With regard to innovation, the conscious emphasis of the client on better standard of buildings is resulting in better conduct of tenants that are now more interested in their environment. The generally more attractive environment increases the goodwill of tenants and gives a more stable and better economy in operation of facilities. The status of social housing in Reykjavik is higher than before and the methodology is a worthy model for others to follow.

With regard to guidelines, there is clearly a lack of documentation for maintenance and especially refurbishment as these could be of great value to stake out aims for the future. A clearly documented methodology and list of possible actions would help when tackling new projects: documented case studies are a worthy addition to information on the market.

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# Appendix 13: Energy-efficient refurbishment of VAV Sahatie 2, Vantaa

*By Pekka Huovila & Jyri Nieminen, VTT Technical Research Centre of Finland*

## Introduction

The two first Finnish case studies are provided by ARA (The Housing Finance and Development Centre of Finland), which is a governmental agency of Finland operating under the supervision of the Ministry of the Environment implement social housing policy. ARA's main task is to finance state-subsidised rental housing production. The centre has other obligations such as making grants for housing repairs available and to supervise the granting of state guarantees on loans for owner-occupied housing. The centre's target is to promote well-planned quality housing at reasonable housing cost, to promote housing development and to produce information concerning the housing market. Properties to be constructed must be located at comfortable and safe areas in municipalities with housing demand. ARA has a staff of 70.

The overall strategy of ARA's case studies is to improve the asset value, improve both the performance and cityscape, and rationalize the use of old state subsidized housing stock. The state subsidized housing for rent does not allow for adding the renovation costs to rent, rather the refurbishment will be funded by long-term loans, specific subsidies, and other government sources of funding for energy-efficiency improvements. ARA also supports infill construction and demolition of old buildings to be replaced by new energy-efficient buildings in suburban areas to serve as source for refurbishment funding.

ARA brought in two clients VAV and DAS who provided their case studies for SURE. They represent rented apartment houses constructed around the 1970s. Typically three to four floors without elevator, poor thermal insulation, problems with indoor climate, need for repairs in roofing and façades. The development objectives are: improved energy efficiency (Nordic passive house level as an objective), industrial renovation technologies for roofing, façades, windows, balconies and sewage, elevators, supplementary construction and substitute housing. The refurbishment should be carried out without major increase in rental rate. Supplementary construction is seen as means for financing, especially when possible without changes in zoning and being able to provide needed additional parking places.

## Background

VAV's case study is an apartment building from the 1970s where they had originally planned mainly to paint the façades, repair balconies and to check the condition of the roof in Sahatie 2 when the opportunity opened up to collaborate in the Nordic SURE project. In discussions first with ARA and later also with VTT the client's interest grew towards energy efficient refurbishment with a wider scope and more ambitious objectives. Below, Figure 111, Figure 112 and Figure 113 show how the buildings looked like before the refurbishment took place.



Figure 111. Sahatie 2 Vantaa in February 2009 before the refurbishment started. Photo: (Pekka Huovila).



Figure 112. Sahatie 2: four staircases, 42 flats and 3,622 brm<sup>2</sup> in three or four floors. Photo: (Pekka Huovila).



Figure 113. Sahatie 2: balconies in poor condition. Photo: (Pekka Huovila).

### Purpose/scope

The main objective for the client was to realize energy-efficient refurbishment in a representative apartment building of the 1970s with improved indoor performance and without considerable raise in rental costs. The development aspects related to the use of industrial replicable solutions that could be further applied in other similar cases.

### Methodology

Preliminary planning by consultants contained studies, surveys and measures in energy efficiency, addition of lifts, air permeability, construction of an additional floor, investigation of harmful substances and condition assessment of sewer, roof, facades and balconies. The outcomes were discussed together with the refurbishment project partners ARA and VTT in SURE meetings where new ideas and alternative solutions were proposed.

Air permeability measurements were carried out in two apartments. The measurement results showed that air-resistance levels corresponded well to that of modern new construction levels. Future corrective measures couldn't significantly improve the building's air tightness.

An asbestos survey was performed at the site. Visible plumbing insulation was examined as well as floor coverings, wall and ceiling panels, paint on each of the front face of the balcony, the end wall and the façade, acoustic panels and fastening material, ceramic tile adhesive material. Of the reviewed materials, asbestos was found in original pipe insulation, stairwell vinyl asbestos plates and acoustic panels in the heat distribution rooms. The investigation led to the contract documents containing a provision for the demolition of aforementioned materials according to the regulations and guidelines for asbestos demolition work.

At Sahatie 2, drainage surveys were performed in ten apartments and ground sewers at the site. On the basis of the surveys, the apartments' drainage was found not to be in need of repair. The depressions caused by the effluent sewer under the base of the building were considered to be of such a size that the entire sewer and the storm sewer adjacent to it should be replaced.

In roof inspection, it was found that the roof wells and pitch were insufficient and so were the raises of the insulation. Upon inspection, it was noted that

the outer roof needs to be renovated within 5-8 years. It was decided that to improve the energy efficiency of the roof, the inner roof would be replaced. This decision was supported by the estimated remaining service life of the outer roof.

## Contextual description of the case

VAV (public housing association of the City of Vantaa) was founded in 1986 to manage subsidised housing in Vantaa. Today VAV owns 10,000 dwellings and more is constructed every year to meet growing housing needs in Vantaa. VAV's mission is to produce affordable housing services of good quality to meet the needs of citizens and commerce in Vantaa and to maintain the value of the existing building stock.

### Owner and ownership

Sahatie 2 is owned by VAV Asunnot Oy. It represents typical construction of apartment houses built in 1960-1980 with the highest energy consumption in terms of space heating and hot water heating of all the housing in Finland, and the number of flats in these buildings is high, thus, the potential for energy savings is very high. Also, the case represents refurbishment of houses funded by a public body, ARA.

### Overall strategy of the case owner

Long customer relations and lower rental level than the competitors ensure cost of living to remain reasonable. One third of VAV's costs originate from energy and waste. VAV has its own environmental programme aiming at housing that saves energy and environment. The environmental programme did not directly influence the building process even though the objectives set in the SURE case study were in line with the energy efficiency objectives.

In accordance with a LVW-pipeline condition inspection, the remaining lifespan was estimated for cold water network of galvanized steel pipes longer than 15 years, for cold water network of copper pipes 15 to 20 years, for hot water copper pipes 10 to 15 years, for heating water pipe network at least 20 to 30 years and for plastic pipes 10 to 15 years. On the basis of performed condition survey, it was decided that the water pipes will be renovated, water heating network will be maintained, vertical drains and horizontal flush mounting drains will be renovated.

The construction plan of Sahatie 2 was started after the design-build contract was signed. The planning objectives defined in the contract agreements were contained in the construction method report. During the planning phase it was agreed that the following design-build contract would not include the following changes:

- Rehabilitation of the apartment's separate WC surfaces.
- Remotely read apartment specific hot and cold water metering.
- Renovation of Laundromat surface drainage structures.
- Heating pipes replacement of the first floor apartments.
- Renovation of clubroom and storage doors.
- Additional lighting point for the living room.
- Additional antenna sockets in the bedrooms.

The interior work was completed in two phases:

- In the first phase, the A and B level residents lived in temporary housing for four months.
- In the second phase when the A and B levels' interior work was completed, these residents would move back to Sahatie 2.

The C and D level residents' interior renovations began when the A and B level residents move back has been performed and the C and D level residents moved into the temporary housing for four months. At the same time as the interior work, work at the site included outer roof renovation, renovating the façade with an insulated coating, window replacement, and general construction work.

### Zoning constraints

Current plan doesn't allow construction of an additional floor. Obtaining a building permission for that is estimated to take two to three years after the likely complaints of the neighbours in the hearing process. In addition, the number of parking places for the property wasn't sufficient even for the number of residents at present.

### Building type, present use and current users

Sahatie 2 rental apartment house is three floor high at the entrance side and four floors high at the other with no elevators. It has 42 living units and the housing surface equals 2,586 m<sup>2</sup>.

### Year of construction, representativeness

Sahatie was constructed in 1972. It represents typical social housing of the 1970s. The building was designed with the following construction and structural solutions (see Figure 114 and Figure 115):

- Foundations, spread footing.
- Façades, prefabricated components.
- Base, spread footing, cast in place.
- Intermediate and inner roof, cast in place.
- Outer roof, shingled with bitumen sealant.
- Balconies, prefabricated.
- Heating system, water circulating radiator (district heating).
- Air conditioning system, mechanical extraction system.



Figure 114. Sahatie 2 during renovation in June 2010. Photo: (Pekka Huovila).





Figure 115. Sahatie 2 during renovation in August 2010. Photo: (Pekka Huovila).

### Funding models and solutions

Sahatie 2 renovation is financed by ARA loan for long term interest assistance. Funding covers the basic renovations of the entire contract value, except for the costs of removals to temporary housing and expenses arising from vacancies. Removals and vacancy costs are borne by VAV. The funding models may change according to national policy. In addition, energy efficiency support was obtained from the government and also project assistance from ARA.

### Renovation topics and coverage

Roof façades and windows were renovated. Ventilation, electricity and telecommunications, and water pipes were renewed. Carpets and kitchen fixture were replaced, walls and ceilings painted, balconies glazed and as a surprise, also quite recently modernized bathrooms because of the need of sewer renovation that was discovered in the condition assessment. The investigated development topics included also elevators, additional floor and temporary housing.

#### *Environmental sustainability*

Energy efficiency was one of the major aspects in sustainable refurbishment of Sahatie 2 (Table 29)

Table 29. Energy consumption in the case building.

Properties	Calculated energy certificate with present solutions	Chosen solution
U value, W/m <sup>2</sup> K		
Slab on ground	0.29	0.25
Slab with crawl space	0.36	0.36
Upper slab	0.39	0.15
External wall	0.45	0.27
Wall on ground	0.30	0.30
Windows	1.80	1.26
Outer doors	1.80	1.80
Air tightness, n50 (l/h)	1.5	1.0
Specific Fan Power (kw/m <sup>3</sup> /s)	1.2	2.5
Heat recovery, annual efficiency (%)	-	64
ET value (kWh/brm <sup>2</sup> /a)	191	108
ET class	E	B
Space heating need (kWh/brm <sup>2</sup> /a)	134	52

Additional thermal insulation in the envelope together with new ventilation system with heat recovery is calculated to half the energy consumption. That will be verified after the first full heating year by the end of 2012.

#### *Accessibility*

Several options were studied with respect to the addition of lifts including lifts into the existing stairwell and a new stairwell outside of the building frame and lifts inside of the building frame inside existing apartments. Studies of different alternatives showed that the implementation of either option was not possible. Placement into the staircase didn't work because a new stairwell would encroach on existing emergency routes contrary to regulations and the widening or re-location of emergency routes was not possible because of the narrow space. The placement of lifts inside the building into current apartments would weaken the functionality of apartment layout.

#### *Financing*

According to a completed assessment, the construction of an additional floor would require significant strengthening of the foundation. In addition, the change would require applying for planning permission as the maximum floor area allowed by current zoning laws would be exceeded. The resulting cost of strengthening the foundations and the long waiting period for obtaining the planning permission caused the abandonment of the additional floor construction.

#### *Economic efficiency*

VAV Asunnot Oy searched for transitional apartments to be located as closely as possible to the Sahatie 2 property. VAV Asunnot Oy offered the residents three different housing options during the renovation period:

- 1 Living in temporary housing.
- 2 Moving permanently to temporary housing.
- 3 Terminating the lease.

### **Refurbishment strategy**

VAV Asunnot, NCC Rakennus Oy and Optiplan signed a two-phase development project cooperation agreement. In the first phase, the scope and qualitative targets of the project were defined and a project program prepared. In addition, the parties agreed upon duties, responsibilities and costs. Also as a result of the project plan's first phase, NCC Rakennus Oy gave a design-build offer to VAV Asunnot Oy regarding the project.

The second phase of the cooperation agreement consisted of the design and construction of the building by NCC Rakennus based on the design-build offer. VAV Asunnot Oy had the right to reject the design-build offer after the first phase.

The energy efficiency target was set such that the refurbishment work would reduce the heating energy needs by half. A four-step energy survey was to be performed concerning the target, which included the following steps: a draft phase energy study, building certificate energy assessment, energy certificate and license update and calendar year energy review.

#### *Resident engagement and interaction*

Sahatie 2 residents were placed in VAV Asunnot Oy temporary housing during the construction work period. Temporary housing was realized in two stages. In the first phase, the A and B level residents lived in the temporary housing for four months and in the second phase when the A and B levels' interior work was completed, the C and D level residents stayed in the same temporary housing. The idea of setting up temporary module hous-

ing units for the residents for the duration of the renovation work proved economically unfeasible.

Three information meetings were held for the Sahatie 2 residents before the start of the renovation. VAV has established a well working procedure with resident interaction. The information sessions dealt with the following issues, among others: content of the renovation, schedule and costs, temporary housing, moving plans and housing during the renovation period. The main purpose of these meetings was to keep the residents informed about the consequences of the refurbishment process to their everyday life.

The dissemination of information regarding restrictions on water, electricity and other amenities was delegated to the contractor and carried out using fliers delivered directly to residences, as well as fliers posted on notice boards in the stairwells. A representative of VAV Asunnot Oy was responsible for general announcements at the site. Figure 116 shows Vahatie 2 after the refurbishment.



Figure 116. Sahatie 2 after refurbishment in January 2011. Photo: (Pekka Huovila).

### **Intended future use and users**

No changes in future use or users are foreseen.

## **Procurement strategies and analysis of the results**

### **Implementation of the strategy**

VAV's sustainable refurbishment strategy was implemented in the Sahatie 2 case study in collaboration with NCC and their design firm Optiplan. Avoiding raise in rental costs was a significant boundary condition in the development.

### **Technological solutions**

Industrialized, replicable solutions were searched for e.g. for lifts, additional floor and replacement housing. The applied solutions represent good state-of-the-art and can be applied in future refurbishment projects.

### **Barriers**

Maintaining the rent level at a desired state creates challenges since heavy refurbishment often leads into the needs of modernization and providing inhabitants tangible improvements in addition to better indoor climate.

The zoning constraints are rigid. The hearing process when applying a change in the local plan commonly leads to complaints and delays, thus weakening the interest of the developer for obtaining funding through additional construction and increasing the density of the block. Old neighbour-

hoods are often already short of parking places and organizing supplementary parking underground leads to additional costs, which may be considerable.

Rental loss during refurbishment was important in this case study.

### Incentives

Subsidies in energy efficient refurbishment increase motivation towards considering that aspect of sustainability.

### Procurement protocol, project delivery system

The chosen project delivery system was a design build contract in two phases. Below, Figure 117 shows a refurbished apartment block.



Figure 117. Sahatie 2 after refurbishment in January 2011. Photo: (Pekka Huovila).

### Decision making based on life-cycle costing

Future rental costs were the dominant factor in the refurbishment process. The energy costs are included in the rents. Water consumption is charged separately according to the number of dwellers in the flat. Decreased energy consumption in the building stock in a long term will reduce the risks of uncertainty related with possible increase in energy prices. Table 30 shows the rent level, cost and finances of the refurbishment project.

Table 30. Refurbishment accounts and estimated costs.

Rent, cost and finance	
Rent before refurbishment	8.97 €/m <sup>2</sup>
Rent after refurbishment	9.95 €/m <sup>2</sup> + water 15 €/person/month
Cost of substitute housing	159,329 €
Costs	
Acquisition value of refurbishment	3,761,227 €
Long term loan interest assistance	3,287,947 €
Without loan interest support	473,280 €
Finance	
Own funds	929,598 €
30 year interest support	2,630,358 €
Energy support	179,328 €
Project support from ARA	21,944 €

### Client as a change agent

#### At which fields will the client be active?

VAV is willing to exploit experiences from Sahatie 2 as a model for their other blocks of flats constructed during the same period, especially if the aim is

energy-efficient refurbishment. Whether the objective in future refurbishment projects will be set e.g. for halving the heating energy consumption is not sure.

### **How will he get there?**

Continuing sustainable refurbishment based on lessons learned from Sahatie 2 will increase the knowledge and competence at the demand side, influencing also to that in the supply side. Hopefully in future projects, even more ambitious targets can be set and sufficient space for innovation can be kept in order to encourage development of novel and sustainable industrialized solutions that can lead into even better results.

### **How will he win?**

Sustainable refurbishment should reduce the risk level and in the long run at least also reduce running costs in VAV's housing stock. Improved indoor conditions should result in better occupant satisfaction and higher occupancy rates. Steps forward to progressing in implementing their recently updated environmental strategy, VAV improves their corporate responsibility, thus improving their image, which is positive in front of taxpayers and municipal council.

### **At what speed will he proceed?**

In today's business environment incremental improvement is more likely rather than disruptive innovation, even though considerably faster progress than the regulatory level can be achieved.

### **How will he obtain returns?**

The returns should be achieved through higher rate of occupancy and better risk management in predictive maintenance and systematic repairs meaning lower operating cost and higher value of their housing portfolio.

### **To which extent can we see a coherent strategy action?**

There were changes in key personnel during the case study that may influence development and implementation of the future strategy. Sahatie 2 showed what can be done in energy efficient refurbishment projects in the future. The expertise from the supply side was exploited in the development.

## **Guidelines**

### **Which guidelines is the client using for green refurbishment of buildings?**

The objectives and alternative solutions have been discussed with the main project partners VTT and ARA. The solutions have been chosen by VAV after discussing them with NCC and Optiplan. During the SURE process several meetings have been held together.

### **Is the client using qualitative or quantitative descriptions in the green procurement documents?**

Performance values have been quantified during the design process. The approach has been "what can be achieved within given budget".

### **Is the client using any kind of green classification system for refurbishing (LEED, BREEAM etc.)?**

No kind of green classification system for refurbishing has been applied. The shift in energy class (E → B) was used as a benchmark. It is based on simulation, not by actual measurement of consumption, which will be done afterwards as a follow up.

Are the guidelines used by the client international (in English) or country specific?

In the specific case, the guidelines were case specific.

Which “green parameters” are usually described in the clients procurement documents for refurbishing?

The main social sustainability issues relate with indoor conditions, environmental sustainability on energy class and economic sustainability on rents.

## Conclusions

With regard to procurement, the applied concept can be used for similar cases in future refurbishment projects. Condition assessment of sewerage led into refurbishing the bathrooms, which were refurbished only a couple of years ago. A systematic maintenance plan could have avoided that additional work, cost and disturbance. Loss in rental income during renovation became important. Keeping the rent close to the existing level is quite challenging in an individual refurbishment project. It becomes easier if one can balance it within a larger building stock. The client knows well the affordable rental level for their tenants in that district. Some modernization aspects should be included in the refurbishment process so that the tenants can observe some additional change after the disturbance than the lower energy consumption they may not even have to pay themselves due to various social support schemes. Communication with tenants and their engagement is crucial. This process is well managed at VAV, and it didn't cause any problems in this case at least.

With regard to innovation, Sahatie 2 pilot is a step forward. Energy efficiency of the case study will be monitored. Findings from the process have been disseminated e.g. in SB10 Finland Conference and different ARA seminars. There's always a risk that Sahatie 2 remains an isolated pilot for VAV. Hopefully other ambitious pilots follow and sustainable refurbishment becomes mainstream renovation practice.

The main contractor found the Sahatie 2 case study useful for them. Such ambitious energy efficiency targets in refurbishment projects are not common, and new knowledge was obtained through the SURE pilot project.

With regard to guidelines, sustainable refurbishment guidelines are still needed to set the performance target levels and to measure the conformity throughout the process. Thinking about the indicator weights, plot opportunities and condition assessment related with systematic maintenance seem to be important. Setting concrete target levels and exploring different opportunities early in the process should guide the design and decision process in systematic way.

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# Appendix 14: Renewal of student's hostel DAS III, Rovaniemi

*By Jyri Nieminen, VTT Technical Research Centre of Finland*

## Introduction

The Domus Arctica Foundation (DAS) is a non-profit housing provider in Rovaniemi, Finland. DAS manages, rents and develops student's hostels on prime costs. The present number of apartments is about 1,000 for about 1,700 students.

DASIII is a student's hostel built in 1975 (see Figure 118). The building requires renewal primarily due to insufficient apartment floor plans and size distributions, and overall improvement of the interior. There are no technical problems with the building, but the technical systems and lifts require upgrading.



Figure 118. Student's hostel DAS III in Rovaniemi, Finland. Photo: (Jyri Nieminen).

The performance of the building was analysed using dynamic simulation on energy performance and measurement of the airtightness of the building envelope. Life-cycle cost analysis was carried out to study the costs and benefits of the refurbishment. The analysis shows that extensive improvement of energy performance is not economically viable. The façades of the building are in good technical condition, and a window renovation was carried out in 1995. Ventilation system refurbishment is considered as a feasible action to improve the energy efficiency of the building and indoor air quality.

## Background

The aim of the co-operation between the SURE project and the Domus Arctica Foundation was to assess the possibilities to renew the building. The



basic aim of DAS was to improve the architecture, usability and indoor environment by new facade coating, new balconies and lifts and by interior renovation. These actions are in line with the renewal of neighbouring buildings (see Figure 119).



Figure 119. The neighbouring building DAS II after refurbishment. Photo: (Jyri Nieminen).

### **Purpose/scope**

The scope was to assess the possibilities of improving the energy performance of the DAS III building with industrial prefabricated components. The benefits of refurbishment were analysed by simulations and costs analysis. The results served as basis for the decision-making at DAS.

### **Methodology**

The assessment is based on the building's design documentation and interview with the facility management and maintenance staff at DAS. Energy simulations were carried out using VTT's WinEtana tool. WinEtana tool is a monthly based energy analysis tool.

Thermal quality of the building envelope was assessed with blower door tests for airtightness and thermo-graphic analysis.

Life cycle costing (LCC) was used as a technique for estimating the costs of whole refurbishment and alternatives. The technique can assist decision-making in investment processes. LCC is used to evaluate the cost performance of a development throughout its lifecycle, including acquisition, development, operation, management, repair, disposal and decommissioning.

### **Contextual description of the case**

The case DAS III is one of the hostel buildings in the same address. Two other building has already been refurbished for better usability, appearance and additional room spaces above the top floor.

### **Owner and ownership**

The building owner is Domus Arctica Foundation DAS. DAS is an owner and builder organisation that rents student homes in the city of Rovaniemi at the polar circle.

## Overall strategy of the case owner

DAS is a non-profit foundation established in 1969. The founding members are the City of Rovaniemi and two associations. The foundation has its own maintenance organisation.

The DAS foundation's strategy is to upgrade its buildings according to changing needs of the tenants. There is a continuous feedback collection from the inhabitants. Also, the inhabitants can give their feedback and views directly to the maintenance staff visiting the buildings regularly. The process is based on close contacts with the tenants. As a non-profit organisation, DAS requires external financing for any refurbishment or upgrading. Typically the financing is provided by ARA, The Housing Finance and Development Centre of Finland.

The overall goal for DAS is to have a high rate of occupancy in its hostels. Therefore, main focus is in the tenants' acceptance and overall performance as a student home, and level of rent suitable for students. The student's hostels DAS I - III are located conveniently right in front of the Rovaniemi railway station and in walking distance from the university (Figure 120).

## Zoning constraints

The building's gross floor area is 2,443 m<sup>2</sup> of the total building rights of 2,450 m<sup>2</sup>. Local building authorities can increase the rights by 10 %. Higher volumes require change in the master plan, e.g. in case of a full height additional floor or extension.

The site includes parking spaces for the occupants. The number of parking spaces is a master plan requirement, although the site performance could be improved by reducing the number of parking spaces and e.g. new storages for cycles and sports gears instead. A reduced number of parking spaces would also make it possible to build extensions in the buildings.

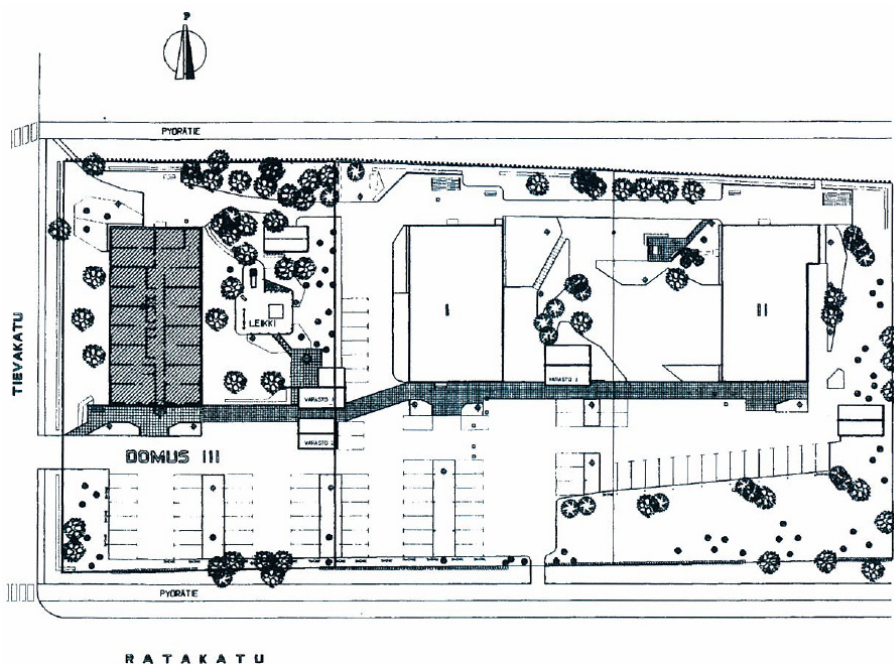


Figure 120. DAS III site plan. The building's gross floor area is 2,443 m<sup>2</sup> with 46 apartments and total net floor area 1,923 m<sup>2</sup>. Source: (DAS, 2009: 5).

## Building type, present use and current users

DAS III is a five-floor apartment building with 46 apartments for 84 residents. Total net floor area is 1,923 m<sup>2</sup>.

### Year of construction, representativeness

The year of construction is 1975. The building has a load bearing concrete structure. The main façades are light weight wooden structures and gable walls concrete structures (Figure 121). All walls have masonry façades. The building system is not very typical for the era.



Figure 121. DAS III has a ventilated masonry facade. Photo: (Jyri Nieminen).

The DAS Foundation has already refurbished the building in 1995 (Figure 122 and Figure 123). The building has a mechanical exhaust ventilation system with fresh air supply through window integrated faucets. The heating system is radiator heating with district heat. The technical condition of the façades is good. There are no known moisture damages in the building.



Figure 122. The windows were upgraded in 1995. Photo: (Jyri Nieminen).





Figure 123. Entrance. Photo: (Jyri Nieminen).

The refurbishment concentrated on apartments and room order and fixtures in the apartments and bathrooms. The courtyard with parking spaces was refurbished in 1993 with new surface structures and sockets for car heaters as well as garden structures and user leisure time areas. New waste collection systems and bicycle storages were also built.

### Funding models and solutions

A new refurbishment especially for improvement of the energy efficiency of the building was under consideration. Domus Arctica Foundation applied for a loan from Housing Finance and Development Centre of Finland with interest subsidy. Also, the aim was that the foundation applies for specific development funding through The Finnish Innovation Fund. This financing scheme would cover the basic renovation costs, the concept development for energy-efficiency, design and monitoring. The aim was to start the renovation project in 2011-12. However, the outcome of the process was that the benefits of a large energy refurbishment are too low compared to the costs. The major refurbishment will be carried out e.g. in connection to the refurbishment of building service systems.

### Renovation topics and coverage

The considered refurbishment included energy-efficiency improvement, new facades, additional spaces for user activities and measures to improve the performance e.g. new balconies. Also, additional floor may become a target depending on the possibility of master plan change.

A condition survey carried out that there are no major problems in the building. However, the present selection of apartments is not attractive enough for the student. Renewal of the ventilation system was found difficult as there is not enough space for routing of centralised systems.

There are three buildings on the site, DAS I - III. DAS I and II were refurbished in 1996 and 1998 with façade renewal, new sloped roof replacing the old flat roof, a clubroom of 245 m<sup>2</sup> underneath the new roof (by building authority permission, 10 % exceeding the building permission), and balconies (Figure 124).



Figure 124. The neighbouring building DAS II after refurbishment. Photo: (Jyri Nieminen).

Energy and water consumption in DAS III is shown in Table 31. The average energy consumption for space heating and hot water is 52 kWh/m<sup>3</sup> corresponding to 162 kWh/m<sup>2</sup> gross floor area.

Table 31. Resource consumption in the case building.

Year	2005	2006	2007	2008	2009
Energy consumption					
Electricity (MWh)	245	231	218	204	197
Electricity (kWh/ m <sup>2</sup> )	100	95	90	84	80
Heating (MWh)	338	372	351	355	333
Heating (kWh/ m <sup>2</sup> )	139	152	147	146	137
Heating, normalised (MWh)	400	457	383	372	354
Heating, normalised (kWh/m <sup>2</sup> )	164	187	157	153	145
Water consumption					
Total cold water (m <sup>3</sup> )	3,139	3,419	3,291	3,052	2,899

The results of airtightness tests carried out showed that the building envelope is sufficiently airtight with  $n_{50} < 1$  l/h. The infrared surveys did not show any major problems in the building envelope. Some minor air leakages were found (Figure 125).

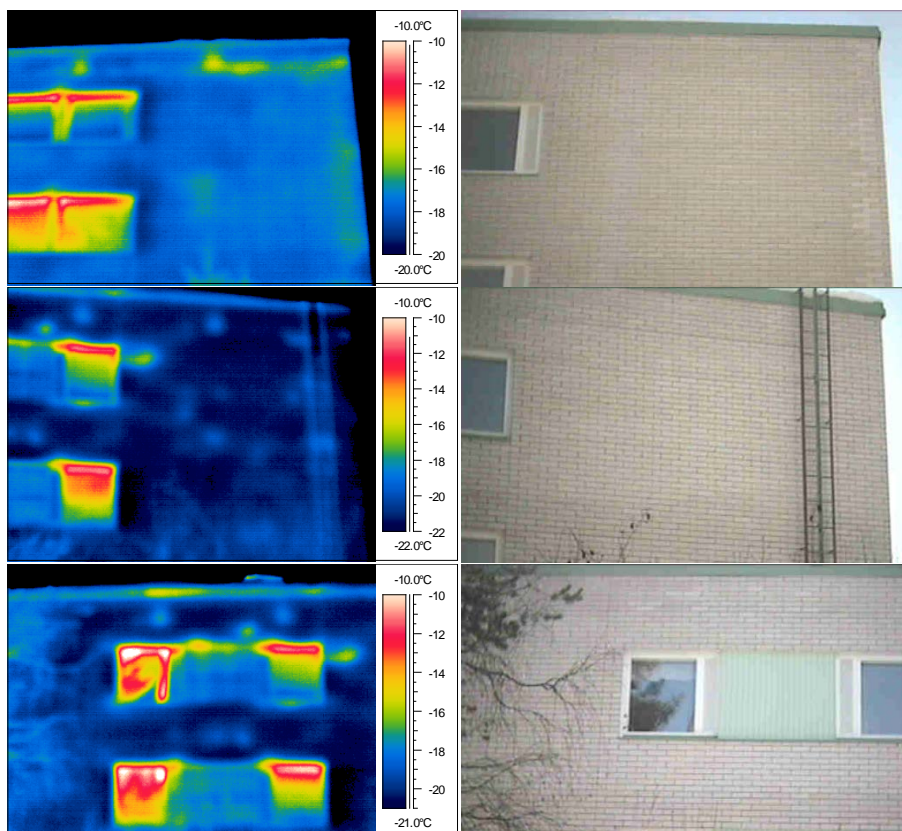


Figure 125. Selected results from thermo-graphic analysis. In general, the survey did not show any major problems with the building. Photos: (Jyri Nieminen).

Table 32 shows the possible energy-efficiency refurbishment measures. No specific energy target was set for the selection of measures, rather the measures selected are technically feasible and there are adequate experiences in implementation of the measures in earlier projects.

Table 32. Suggested energy saving measures in DAS III.

Building component	Energy saving measures
Ventilation	Replacement of existing exhaust ventilation with mechanical supply and exhaust ventilation with heat recovery efficiency of 75 %.
Roof	Rebuilding the existing flat roof. New sloped roof with usable heated space underneath the new roofs. Roof U-value $U = 0.35 \Rightarrow 0.09 \text{ W/m}^2\text{K}$ .
Facades	Dismantling the existing facade, additional insulation with exterior thermal insulation composite system. Wall U-value $U = 0.40 \Rightarrow 0.17 \text{ W/m}^2\text{K}$ .
Windows	New windows, U-value $U = 1.8 \Rightarrow 0.8 \text{ W/m}^2\text{K}$ .
Doors	Existing doors.
Water system	Apartment based water metering, pressure reducing valves, water saving fixtures.

Figure 126 shows the possibilities of various energy saving measures. According to energy simulations, the most profitable measures in terms of energy-efficiency improvements are refurbishment of ventilation system, new windows and apartment based water metering and/or water saving fixtures.

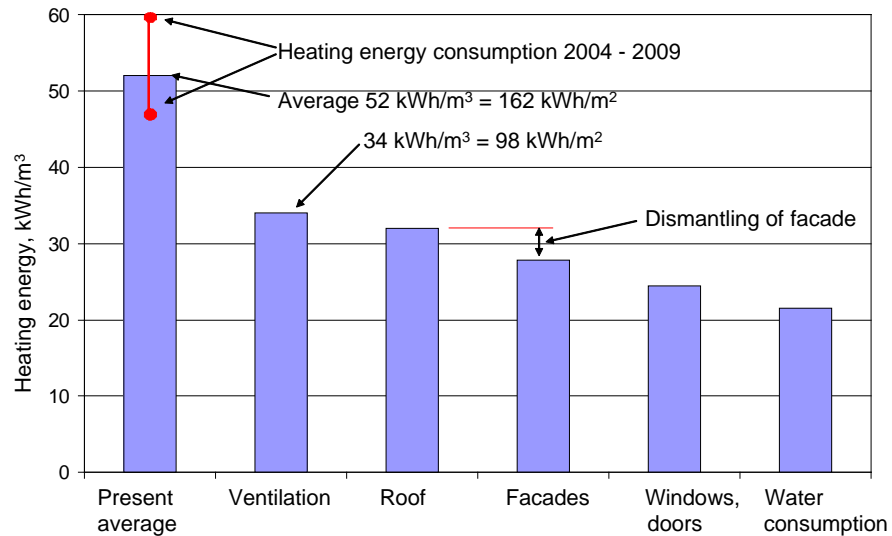


Figure 126. Impacts of energy saving measures in DAS III. Source: (Jyri Nieminen).

### Refurbishment strategy

The refurbishment financing was suggested to be based on two sources: a loan from the Housing Finance and Development Centre of Finland (ARA) and a grant from Sitra, the Finnish Innovation Fund. The probable refurbishment process will need to be based on a bidding process following the guidelines by ARA. The ARA guidelines include strict limits on the costs per m<sup>2</sup>. The possible Sitra funding enables the use of energy experts in the evaluation of possibilities and a design clinic procedure. The design clinic refers to a process where building professionals, building authorities and city master planners can analyse the project and suggest solutions for refurbishment. The wide co-operation between different stakeholders also helps for actual refurbishment design.

### Intended future use and users

The building will remain as a student home.

## Procurement strategies and analysis of the results

### Implementation of the strategy

A technical feasibility study was carried out for decision making. The aim was to conclude the possibilities of renewal in terms of investment costs and life cycle costs as well as impacts on maintenance.

The DAS Foundation does not have detailed long term maintenance and repair plan. This is a clear shortcoming in the process. Also the foundation lacks an environmental strategy that serves as a guide for decision-making.

### Technological solutions

The feasibility of various energy-saving measures led to following technological solutions:

- Apartment based mechanical ventilation with heat recovery: Fresh air inlets and exhaust air outlets through terminal units in exterior walls.
- New windows: New energy-efficient wooden windows for cold climates with a total U-value 0.65-0.75 W/m<sup>2</sup>K compared to existing windows in the building with U-value of 1.8 W/m<sup>2</sup>K.
- Water saving fixtures: new faucets giving hot water (> 37 °C) only on demand, and pressure reducing valves in the main water pipe.

The building's electricity consumption is high. This would suggest renewal of fixed lighting and circulation pumps, timer-driven car heating sockets, and

lift. A common sauna and laundry use a lot of electricity – a sauna as much as 10,000-15,000 kWh per year. Building integrated solar electricity is a possibility to reduce auxiliary electricity for building services systems.

The basic energy-efficiency solution is widely used in refurbishment and, thus, there is lot of experience on the procedures, difficulties and benefits. This information does not reach the institutional building owners. The main reason for poor procedures in energy refurbishment is the lack of or insufficient environmental strategy. This situation does not support energy efficient refurbishment.

### Barriers

The present master plan restricts the possibility for an additional floor. In this case, more dense urban structure is beneficial also for the students living in the building. The DAS III locates just in front of the railway station and close to the university premises. Improvement of the performance and appearance of the building would help getting new residents.

Barriers to the suggested refurbishment are:

- Master plan renewal is a slow process. The processing of the possible complaints on the new plan may take years even though the city is ready to increase the building rights.
- Apartment based ventilation systems increase maintenance. The filters in the system need to be changed twice per year. However, routing of a centralized ventilation system is very difficult in the building.
- Windows: the technical quality of the existing windows is good.
- Financial planning: refurbishment costs will be high, and suggested financing sources may not be enough. Increasing the rent, however, may not be possible.

### Incentives

DAS has a possibility to apply for interest subsidy loan and direct subsidy provided by ARA, and a grant for development of the concept provided by Sitra.

### Procurement protocol, project delivery system

The intended refurbishment process was a turn-key contract where the main contractor carries the responsibility of the design and construction.

### Decision making based on life-cycle costing

Table 33 shows the anticipated costs of different actions. The analysis is on a general level, as no preliminary cost calculations based on real design were carried out. The key challenge is that the present building is technically in a rather good condition. Façade renewal is thus considered unnecessary due to low impact on energy performance. The DAS considered the total investment cost level too high and economic benefits too low to start an extensive refurbishment for better energy performance. Specific barriers for positive decision were:

- Low foreseen energy cost benefit.
- Increase in energy costs were considered moderate in the foreseen future.
- Dismantling of the well-performing façades.
- Increased maintenance costs due to apartment based ventilation units.



Table 33. Refurbishment concepts and estimated costs.

	Concept 1	Concept 2	Concept 3
Description	New windows, doors and ventilation systems	New windows, doors and ventilation systems, additional insulation for exterior walls and roof	New windows, doors and ventilation systems, renewal of exterior walls and additional insulation for roof
Heating demand	-25 %	-50 %	-75 %
Measures/cost	€/net floor m <sup>2</sup>	€/net floor m <sup>2</sup>	€/net floor m <sup>2</sup>
Façade coating	70	-	-
Façade dismantling	-	-	45
Façade groundwork	-	-	70
Additional insulation	-	15	45
Windows, balcony doors	-	110	110
ETICS <sup>1)</sup>	60	60	70
Ventilation systems	200	200	240
<b>Total costs</b>	<b>330</b>	<b>385</b>	<b>580</b>

Note 1) Exterior thermal insulation coating system with rendering.

The life cycle cost calculation gave a payback time of 20-40 years for the different refurbishment concepts. It was considered that apartment based ventilation system would increase maintenance work by at least one week in a year for change of filters in each of the machines twice a year including procurement of the filters and recycling the existing ones. The price of district heat in Rovaniemi was relatively low (60 €/MWh, including taxes) at the time of decision-making, although environmental taxing will increase the price considerably. However, the DAS Foundation's decision was to postpone the energy refurbishment.

## Client as a change agent

### At which fields will the client be active?

DAS Foundation provides housing for students. Their aim is by high quality accommodation to have a high usage rate of apartments. The recent investments include also improvement of exterior comfort at the building sites, recycling possibilities and improved storages for bicycles etc. Environmental considerations are not very strong in the daily business.

The problem with DAS is the lacking environmental strategy. There is no program to tackle the energy, emission or other environmental issues with the exception of recycling. Also, the long-term maintenance and repair plan seems not to be adequate.

### How will the client get there?

To be able to create a strong and credible environmental strategy, the foundation needs consultancy. The decision-making, however, depends on the attitudes of the board members of the foundation.

### How will the client win?

The foundation is deeply absorbed in running the daily processes. To accelerate an environmental change process, external actors like the Housing Finance and Development Centre ARA as the main funding source should push forward the energy-efficiency issues and communicate the importance to the board. The tenants' role may also become important along the increasing environmental attitudes.

### **At what speed will the client proceed?**

The speed depends completely on board decisions.

### **How will the client obtain returns?**

By investing in creation of the strategy and long term plan to achieve the goals set in the strategy.

### **To which extent can we see a coherent strategy action?**

The foundation does not have an environmental strategy. As the organisation is rather thin, there are not enough resources for actions. So far a coherent strategy is not present.

## **Guidelines**

### **Which guidelines is the client using for green refurbishment of buildings?**

In the specific case, the client only followed the suggestions by VTT until the negative decision on refurbishment targets.

Forerunners in the segment e.g. Kuopion opiskelija-asunnot Oy (builder of the Finland's first net zero energy apartment building) should be given a lot of publicity. Their projects would give valuable information on the processes, challenges and benefits of green procurement.

Guidelines should be specifically directed towards certain segments of building owners. This refers to solutions for e.g. façade refurbishment and ventilation system renewal. Towards the end of 2011 such guidelines with examples are being published on the Internet e.g.:

- <http://www.teeparannus.fi/kimu/>
- The Ministry of Environment's website: <http://www.korjaustieto.fi/>

### **Is the client using qualitative or quantitative descriptions in the green procurement documents?**

Not applicable.

There is not enough common information in an understandable format for institutions who struggle with daily businesses. Obviously, such an institution like DAS expects the guidance and corresponding requirements to come from the government along with relevant subsidy policies.

There are no guidelines on how to make a communication plan to motivate the decision-makers. Such guidelines are available e.g. through Husbanken in Norway, but they are not directly applicable in Finland.

### **Is the client using any kind of green classification system for refurbishing (LEED, BREEAM etc.)?**

No.

### **Are the guidelines used by the client international (in English) or country specific?**

The guidelines were case specific and based on ARA's recommendations.

The suggested technical solutions and procedures to ensure funding for refurbishment are applicable to any refurbishment project in the specific market segment. There has to be some ambition in the goals, though.

## Which “green parameters” are usually described in the clients procurement documents for refurbishing?

Requirements on technical properties for building envelope, heat recovery etc. are typical. Very seldom an overall energy target is set.

## Conclusions

With regard to procurement, three major lessons were learned from the case study:

- Institutional building owners do typically not have a clear environmental strategy. They are not able to assess the willingness of the tenants on higher rent for better environmental performance. Especially in the case of a student's hostel, the tenants' environmental attitudes may be favourable for energy refurbishments within the limits set by impacts on their living standards.
- There is lack of services for building services systems maintenance. In the case of apartment based ventilation, the change of filters could be outsourced to service providers thus limiting the impacts on daily maintenance work.
- Missing targets do not motivate the builder. Well defined goals make it easier to strive towards high quality refurbishment. A key to target setting is a long term plan for maintenance, repairs and cost efficient energy efficiency improvements.

With regard to innovation, there were no change management to be identified at the time of consideration of possible refurbishment. The coming energy efficiency requirements for existing buildings do have an impact on building owner's strategies in the near future. Decisions by the board were taken along the funding possibilities by ARA and Sitra. The main driver is the main funding source's environmental strategy.

With regard to guidelines, the following main lessons can be observed:

- Building owner should have a long-term maintenance and repair plan with an anticipated time frame for different repair actions.
- User perspectives should have a high priority in development of the refurbishment project. Right on time information on benefits, improved indoor comfort, disturbance caused by the refurbishment, improved exterior environment and comfort would help in the process.
- LCC analysis should include two parts: basic financial calculation and scenarios including future changes in energy prices, incentives, interest rates etc.
- Institutional building owners do not necessarily have staff with experience on energy efficiency. The daily work is to run the business, and thus specialised consultants are needed.
- An environmental strategy is required.
- Environmental classification tools are not of interest for an institutional builder and building owners, if the real estate development is not among the scope of ownership.

# Appendix 15: Helsinki Parish Union – Töölö Church, Helsinki

*By Pekka Huovila and Jyri Nieminen, VTT Technical Research Centre of Finland*

## Introduction

The Parish Union of Helsinki (EVL) is a community of members whose focal point is celebrating mass and divine services. The parishes in Helsinki each have their own activities with a local perspective. They cooperate with each other and also regionally and within the city as a whole. There are 18 Finnish and 3 Swedish parishes in Helsinki. They are responsible for statutory economic functions and activities concerning real estate.

The overall strategy of EVL is to manage their assets by life-cycle principles. The aim is to estimate the refurbishment demand of the whole building stock governed by EVL and set the refurbishment schedule according to maintenance cost evaluation by 2 – 3 years cycle. The internal rent principle allows for creation of refurbishment funds for individual buildings. There are 30 experts working in real estate development in the Parish Union of Helsinki.

The congregation aims to act exemplary towards the environment. Sustainable development in their activities covers ecological, social and economic sustainability in harmony with legislation and ethical values. The cornerstones are ethicality, interaction and continuous improvement. The Parish Union of Helsinki has a church environmental diploma. It has been last renewed in 2010 until 2014.

## Background

The Parish Union of Helsinki selected Töölö church as its SURE pilot (see Figure 127 and Figure 128 for an overview).



Figure 127. Töölö church. Picture: (Arkkitehtuuritoimisto Käpy ja Simo Paavilainen Oy).

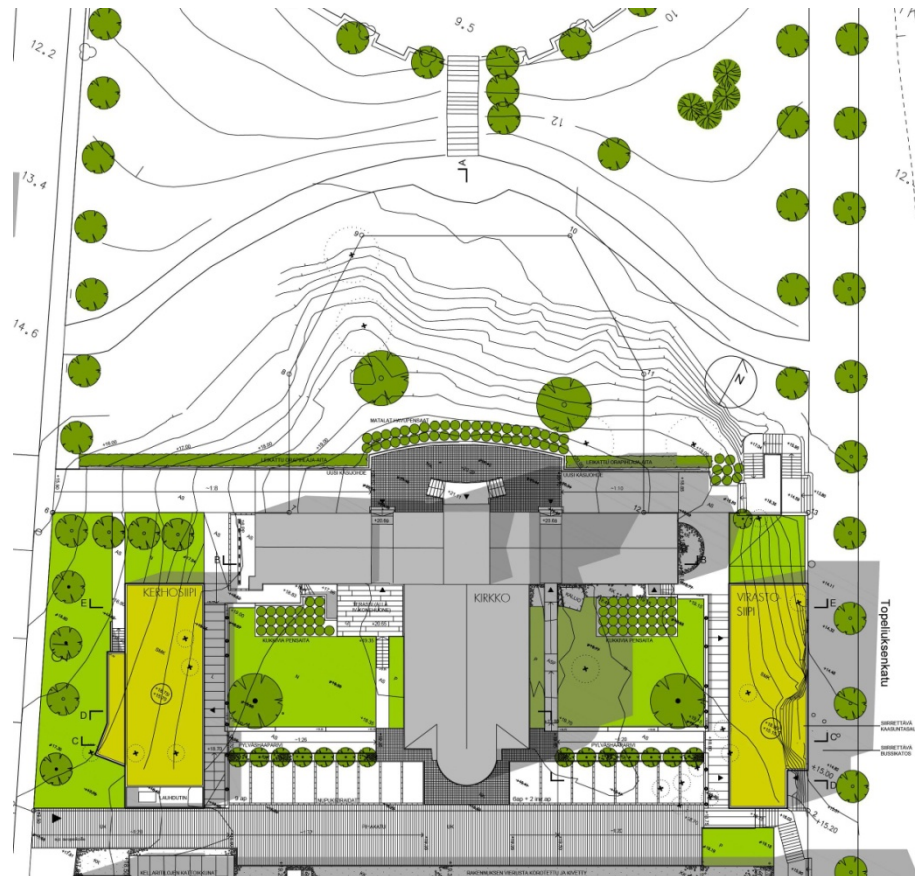


Figure 128. Töölö church with new extensions at both sides. Picture: (Arkkitehtuuritoimisto Käpy ja Simo Paavilainen Oy).

The church, constructed in 1930 and slightly renovated in 1970, started to be technically at the end of its service life. The refurbishment aims at improved energy efficiency and ameliorated indoor conditions with better serviceability. Supplementary construction is planned for the parson and for the congregation. Merging two parishes in Töölö leads to reorganization of activities in the congregation. Need for better accessibility and development in City of Helsinki, including public transport, sets challenges for Töölö church to improve its visibility and function amongst local parishioners. The objective is at the same time, not only to refurbish the church, but also to develop a systematic sustainable renovation process for EVL and tools to support it.

### Purpose/scope

The main objective for the client was to create internal guidance for sustainable refurbishment and sustainable procurement process. Since the church itself is protected, the means for considerable improvement of its energy efficiency were quite limited and renewal of the whole plot including two new buildings and their new services was chosen as a scope for the case study.

### Methodology

The Parish Union of Helsinki re-organized their activities in the neighbourhood when merging two congregations in Töölö. The decision was to build two new buildings on the same plot with the Töölö church in parallel with its refurbishment process, and to release five offices occupied outside their two church facilities in the district.

VTT studied the indoor comfort of the church, proposed sustainability targets for both refurbishment and for supplementary construction as well as a procedure for carbon footprint monitoring, gave design guidance and performed energy simulations. These led into setting objectives by the client for sustainable refurbishment and renewal of the activities in the plot.

The design team, led by Architectural office Käpy ja Simo Paavilainen Oy, comprising also engineering offices Vahanen Oy, Äyräväinen Oy, Veikko Vahvaselkä Oy and Nurmi Oy, documented together the guidelines during their design process.

## Contextual description of the case

### Owner and ownership

The Parish Union of Helsinki owns around 1,000 rental apartments that are offered primarily as dwellings for its own staff provided by the employer. They own also office premises, 40 churches, 26 parish buildings and 6 cemeteries.

### Overall strategy of the case owner

The Parish Union of Helsinki wants to act as a responsible building owner, thus maintaining its building stock following the principles of sustainable development.

### Zoning constraints

Töölö church is protected by the National Board of Antiquities. It is located in a neighbourhood with nationally important cultural built environment. Therefore development of two new buildings next to the church on the plot between a school and a park has been followed closely also by the authorities (Figure 129).



Figure 129. Töölö church as seen through the park. Photo: (Pekka Huovila).

### Building type, present use and current users

Töölö church is used at present primarily for church services for members of the congregation. In addition, the facility houses a nursery and space for different gatherings of various groups. It also contains a kitchen that serves meals for the users.

### Year of construction, representativeness

Töölö church was designed by architect Hilding Ekelund and represents classicism of the 1920s, a phase preliminary to functionalism. The white asceticism of the basilica with its belfry is said to suit well the Töölö atmosphere. The church was inaugurated 13 April 1930, and it is now protected by its cultural and architectural values (Figure 130).





Figure 130. Töölö church, Helsinki. Photo: (Paju, Finland) (CC BY-SA/2.5).

### Funding models and solutions

The Parish Union of Helsinki collects internal rent for the use of their facilities through which they may collect refurbishment funds. They also act as a building owner and developer in the real estate market and manage their assets by developing, selling and buying properties in addition to maintaining, refurbishing or demolishing them.

### Renovation topics and coverage

The main objectives in renovation of the old church were to improve the indoor conditions and to increase its energy efficiency and through additional thermal insulation and efficient HVAC systems.

In new construction, the target was set to meet the energy efficiency level of the passive house in Southern Finland 20 kWh/gross m<sup>2</sup> for the two annexes together. VTT's calculations about how that can be achieved are shown in the tables below. Based on these calculations, solutions with corresponding U values were discussed and recommended for the office building (see Table 34) and the Club House building (see Table 35).

Table 34. Energy targets of the office building: 21 kWh/gross m<sup>2</sup>.

Case	Office 2010	Passive
Heating system	15,400	4,500
Cooling of spaces	420	2,100
HVAC heating	13,300	3,100
HVAC cooling	1,300	0.0
Fans	3,300	2,000
Pumps	13	2.1
Domestic hot water	2,000	2,000
Heating and cooling of spaces (kWh/brm <sup>2</sup> )	66	21

Table 35. Energy target of the Club house: 19 kWh/gross m<sup>2</sup>.

Case	Club House 2010	Passive
Heating system	12,800	3,600
Cooling of spaces	800	60
HVAC heating	9,500	3,300
HVAC cooling	1,000	1,400
Fans	2,300	2,000
Pumps	9.8	6.4
Domestic hot water	3,600	3,600
Heating and cooling of spaces (kWh/bm <sup>2</sup> )	54	19

### Refurbishment strategy

The strategy was to consider renewal of the services in the plot as a whole: energy efficient refurbishment of a listed church and construction of two new buildings at a passive house level as defined by VTT for the Nordic climate.

Before merging the two Töölö parishes, the Taivallahti congregation occupied three facilities outside TempPELLinaukio church, and the Töölö congregation occupied two facilities outside the Töölö church. In the unified Töölö congregation the functions from five external locations can be moved to the two new buildings next to Töölö church (see map in Figure 131).

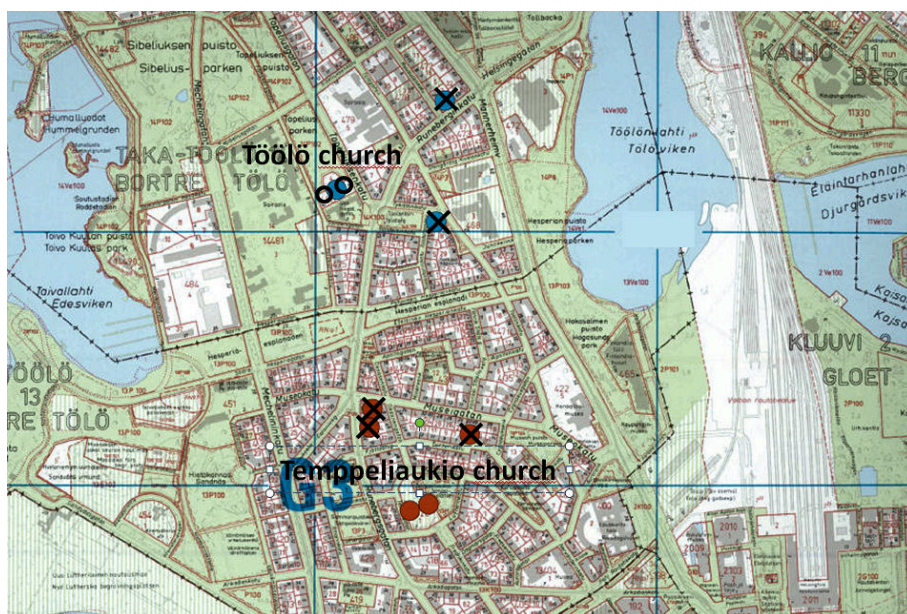


Figure 131. Two annexes next to Töölö church (blue) and five released facilities after the completed renewal process of the merged congregation. TempPELLinaukio church (orange) as one of the most popular tourist attractions in the city may focus more on concerts and similar activities in the future.

### Intended future use and users

The new office building with a gross floor area of 460 m<sup>2</sup> (384 m<sup>2</sup> net) has 114 m<sup>2</sup> at ground floor and 270 m<sup>2</sup> at first floor. The new club-house with a gross floor area of 450 m<sup>2</sup> (378 m<sup>2</sup> net) is split into 189 m<sup>2</sup> both upstairs and downstairs. When these buildings are in use, EVL has as a result 290 m<sup>2</sup> less space, but more suitable for their needs.

### Procurement strategies

#### Implementation of the strategy

The main emphasis was to reorganize and to renew services in the plot with the refurbished listed church and two new facilities that could together meet



the Nordic Passive House level. This target increases considerably energy efficiency of the site, especially when compared against the changed functional unit (re-organized services of the merged parish). In addition to energy efficiency of the buildings, it also influences in local travel work by centralizing the church activities around Töölö church and at the same time releasing activities from five offices around the neighbourhood.

### Technological solutions

The energy efficiency of the refurbished church is improved by additional insulation in floor, roof and windows together with energy efficient HVAC system without compromising the architectural quality and cultural values. New mechanical ventilation and cooling improve the indoor conditions, but increase overall energy consumption despite of all energy saving and heat recovery measures with building automation.

The renovation made in 1970, 40 years after its completion, concerned mainly surfaces and spatial arrangements. Technical systems were not renewed then, and that is done now. The use of some parts of the building at present is prohibited because of indoor climate problems there. During this refurbishment the damaged and deteriorated parts must be repaired immediately and their systematic maintenance must be assured. Remaining service life estimates were given for the main building systems, parts and components.

In new construction, focus is on thermal insulation of the envelope, air tightness, lighting and electrical appliances. The use of renewable energy supply in the city centre turned out not to be feasible after investigation.

The structures with the following U values [kW/m<sup>2</sup>K] were compared with the building code of 2010:

- Walls: 0.107 and 0.08 (0.17).
- Roof: 0.06 (0.09).
- Floor: 0.08 (0.1).

### Barriers

Refurbishment of a listed building sets constraints for ambitious increase of energy efficiency.

Getting the zoning change approved delayed the process.

### Incentives

Helsinki Parish Union is committed to be ethically responsible and to care about the environment.

### Procurement protocol, project delivery system

A traditional design-bid-build procurement mode was applied.

### Decision making based on life-cycle costing

Life cycle costing is the practice already adopted by the Parish Union of Helsinki.

### Client as a change agent

#### At which fields will the client be active?

The client has a possibility to act as a frontrunner and set ambitious objectives also for environmental sustainability, in addition to life cycle costing, indoor conditions, serviceability and cityscape.

### **How will he get there?**

Internal guidance, more experiences from the coming projects and integration with existing tools would be helpful. Benchmarks from other projects can be useful even though they may be quite different of their nature.

The real estate unit of the Parish Union of Helsinki is in a key position for change. Success relies strongly on individual motivation and skills.

### **How will he win?**

Sustainable procurement means quantifying the target and guiding the design.

Ethical values and commitment to corporate responsibility are important in addition to risk management and life cycle economy.

Caring about the environment and improving energy efficiency motivate sustainable refurbishment. Commitment to the church environmental diploma demand action. Interaction with the neighbouring Parish Unions of Espoo and Vantaa may provide a platform for exchange of experiences in similar kind of environment.

### **At what speed will he proceed?**

The type of change witnessed is incremental improvement and learning by doing.

All decisions must be approved by the Parish Council or the Church Council. The approval process in individual projects takes some time and budget constraints are tight.

### **How will he obtain returns?**

Increased user satisfaction and improved services together with smaller carbon footprint are appreciated without forgetting life cycle economy.

### **To which extent can we see a coherent strategy action?**

The direction is clear. The progress depends on success in individual projects.

## **Guidelines**

### **Which guidelines is the client using for green refurbishment of buildings?**

In this case, the client followed the suggestions by VTT and discussed those and their cost consequences with the design team.

### **Is the client using qualitative or quantitative descriptions in the green procurement documents?**

EVL has their church environmental diploma, but it does not address specifically construction projects.

### **Is the client using any kind of green classification system for refurbishing (LEED, BREEAM etc.)?**

The client is not using any kind of green classification schemes. The Parish Union of Helsinki is a member of Green Building Council Finland (fiGBC) and follows e.g. the development of various rating schemes also through that platform. fiGBC intends to disseminate information about relevant core sustainability metrics and assessments but does not promote and commercialise certification systems.

### Are the guidelines used by the client international (in English) or country specific?

These specific design guidelines hopefully develop into wider practice that can be applied in future projects and even be shared with other congregations in the domestic market.

### Which “green parameters” are usually described in the clients procurement documents for refurbishing?

The starting point may be architectural quality, functionality and cityscape together with good indoor conditions. If the energy class is unsatisfactory, corrective measures are taken.

## Conclusions

With regard to procurement, many churches are listed, and their sustainable refurbishment strategy may contain combining re-organisation of new services with renovation as it occurred in the Töölö church case.

With regard to innovation, front-running clients have opportunities to influence the course of change. However, individual case studies always have their constraints and specific features. Development should be continuous to achieve major improvement.

In refurbishment, achieving improved performance of buildings as energy efficiently as possible depends on constraints of the case. Combining renovation with new construction, Nordic Passive House targets can be taken as a starting point for all new built. The impacts are considerably increased energy efficiency compared with business as usual.

With regard to guidelines, the guideline documented by the design team based on Töölö church case study serves as a reference for coming projects and are intended to be applied in future refurbishment and other procurement projects by EVL.

Quantified target levels and benchmarks are useful to guide the design process. New development should be integrated with tools already used. Unfortunately, the SURE Guideline and Indicator Tool was not available at the time it could have been tried.

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This report describes the lessons learned and conclusions of 11 Nordic case studies. The studies were undertaken as part of the Nordic project SURE: Sustainable Refurbishment – lifecycle procurement and management by public clients.

The analysis of the case studies is addressing three interrelated themes: sustainable procurement, innovation and guidelines for construction clients.

This study has identified three different strategies towards sustainable refurbishment and developed a guideline and indicator tool.

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