10 Years, 10 Examples

Building for Sustainable Development in Gothenburg 2003-2013

THANK YOU!

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Annika Danielsson, Anna Gustafsson, and Liane Thuvander

Department of Architecture,
Chalmers University of Technology,
Gothenburg, 2016.

10 Years, 10 Examples

Building for Sustainable Development in Gothenburg

2003-2013

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Short about the examples

p. 12 **BIG/KORNET**
Living together is a way for many to get more for less

Kornet is a new development of cooperative rental units whose residents share their everyday lives. The lifestyle and sense of community offers the residents security, health, and wellbeing. It was the residents themselves who initiated the development, and they contributed to its design and budgeting and today they are responsible for managing the interior of the building themselves.

p. 14 **THE HARBOR HOUSE**
Building with no 'traditional heating system'

The Harbor House (Hamnhuset) is Sweden's first multifamily residential building built on passive house principles, which means that it is an energy-efficient building with no traditional heating system. During the design and construction process, the builder developed a model for life-cycle cost estimating to create a good basis for economic decisions. The lessons learned from the project have been disseminated to many other actors.

p. 16 **KATJAS GATA**
Mass-produced housing becomes low-energy housing

Katjas Gata (Katja's Street) was built during the 1960s and 70s, and has now dramatically reduced its energy consumption through a pilot project. The housing company sees this energy-saving renovation as an integral part of a larger effort to redevelop the whole area. The residents now experience greater comfort in their apartments, and energy is being saved by the addition of exterior façade insulation, mechanical ventilation with a heat exchanger, and replacement windows.

p. 18 **BROGÅRDEN**
Renovation with a holistic view and good collaboration

Brogården is a project that has taken a holistic approach to a comprehensive renovation project. The renovation led to a reduction in energy use through passive house techniques, additional places to meet, and reconfigured floor plans that make the apartments accessible for more people with diverse needs. The project also included the development of a wall system in three phases.

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Environmentally conscious living with a chance to garden

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p. 26 **17**
Sustainable living on seventeen well-designed square meters

In the housing development along Trekantsgatan (Triangle Street), nature is constantly present in the form of green roofs, an open stormwater treatment system, and gardens. The buildings were constructed with a natural ventilation system based on the stack effect. They have solar panels on the roof and drain-water heat capture for energy conservation. The project combines social benefit and cost-saving ideas that benefit both the management and the residents.

This industrial property was renovated to suit Magnusson & Freij (M&F), the company that owns and occupies it with their own offices, retail shop, and warehouse. M&F set lofty environmental goals for the project because they always want to do their best for the environment. The focus was on minimizing energy use, but they also worked with reclaimed materials and creating a good work environment. The building became Sweden's first BREEAM-certified renovation.

These three buildings are the first multi-family residential buildings with rental apartments in Sweden to be "Swan certified" with the Nordic Ecolabel. The project transformed a site with a worn-out and underutilized parking structure into a safer area with transit-oriented housing. The Nordic Swan certification offered a way for the developer, Familjebostäder, to organize the work of building environmentally sustainable housing with materials that are good in terms of both human health and the environment.

Apartment 17 is an experiment in which the resident sought radical solutions in terms of a dwelling's function and volume. A woodshed in a building that dates back to 1875 now holds a complex and beautiful apartment with high ceilings and a floor area of only seventeen square meters. Most of the interior is made of wood and reclaimed materials, and contributes to a resource-conserving lifestyle with low environmental impact while also taking good care of the one who lives there.

p. 28 **Utsikten Eco Village - House 7**
An owner-built low-cost home for a healthier and freer life

p. 30 ***Transistorgatan Preschool***
The zero-energy preschool as a long-term teaching method

House 7 is a single-family home in the Utsikten (Vista) eco village on the west-coast island of Orust. The house was designed based on ideas for living with healthy materials that would require very little energy to produce. The result is a pleasant and welcoming house with curving lines and well-wrought details made of wood, straw, and reclaimed construction materials. Nature is a constant presence in the village, and gardening has become a natural part of daily life, alongside the other local cycles of water and waste.

Transistorgatan Preschool is a new building with no net energy consumption. The owner, Lokalförvaltningen, wanted to learn from this construction project what other steps they could take toward more sustainable construction. Beyond the ambition to build a zero-energy building, they also wanted to use different kinds of visualizations to inspire the children to live and take action for the sustainable use of energy in society.

To Deal with the Systemic Crisis

What Is the Purpose of This Booklet?

We are now confronted with a great challenge. Our society as it looks today is going to have to change within the foreseeable future. The way that human activity impacts the environment on our planet cannot continue without serious consequences. Social injustice, insecurity, and the feeling of meaninglessness need to be countered. The global economic system built on growth is vulnerable both for individuals and for society as a whole. The challenge includes systematic problems that we have been propagating and must change. There are different ways to view this challenge—as a crisis or as an opportunity, or perhaps as both. It is a crisis that is going to make like difficult.

One opportunity is to create a better society. A systemic crisis is difficult, but if we seize the opportunity in the right way it could actually help us create a better society.

For many of you, it's not news that we stand before this great challenge. What we need to accomplish has been called by the World Commission on Environmental Development (1987) sustainable development, which it defines as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Our Intent

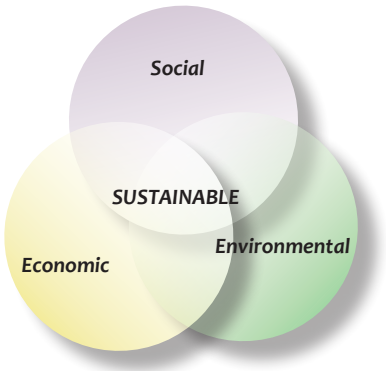
Architecture and urban planning is about the development of society through cities, buildings, places, and spaces. The point of departure for this booklet is to view the systemic crisis as a challenge, and it describes a variety of technological, design, and process strategies for buildings in Gothenburg that try to achieve a development toward the creation of a socially, economically, and environmentally sustainable society. The purpose of the booklet is to assemble and describe a number of good examples that could inspire others to build toward sustainable development going forward. The questions are: What good examples can be found in Gothenburg today? What has happened in the field of sustainable development in Gothenburg over the last ten years?

The booklet is directed toward a broad audience of diverse actors in the construction industry, including developers, property owners, consultants, general contractors and sub-contractors, and of course all the people who use buildings. All of us use buildings and the built environment in our daily lives, and so all of us need to be involved if we're going to create a sustainable society. That would require both knowledge and inspiration—two things we can hopefully find in the booklet Building for Sustainable Development in Gothenburg: 10 Years, 10 Examples.

We wish you all enjoyable and inspiring reading!

Annika Danielsson, Anna Gustafsson, and Liane Thuvander

Sustainable Building



Where Are We Headed?

Taking on the challenge of creating sustainable development is going to require that inspiring projects be executed on various levels and by a variety of actors. This booklet takes a closer look at the sustainable construction of buildings, and describes good examples of both renovation and new construction. To do that, we need a conceptual framework—the window through which we view our examples, and which defines what we mean by sustainable construction. We make the assumption that sustainable construction, like sustainable development in general, rests on three fundamental pillars: environmental, economic, and social factors. Because sustainable development is a political concept, it will always be informed by input from a variety of people.

The term "sustainability" is used in many different contexts today. That in itself is a good thing, but it can make it complicated for us to evaluate, for example, someone's assertion that a building is sustainable. For some people that may mean that the building promotes good contact among people. For others it may mean the building was inexpensive to construct. But for most of us it probably means that the building is sensitive to and good for the environment. For the purposes of this booklet, we mean that a building can only be sustainable if it unites all three aspects. We have therefore decided to allow the definition of sustainable development to be symbolized by three overlapping circles, with sustainability being the region in the center where all three come together. There is an ongoing discussion of "sustainability" in construction projects as to whether it should be a relative concept or an absolute concept. Can one call a building sustainable because it's better than the average, as so often happens today? Or do we need to think about sustainability in absolute terms? A third approach would be to talk about sustainability as a matter of specific performance metrics, characterizing various aspects of the building's performance in relation to the more general vision of sustainability. This is how sustainability aspects are described in the project examples included in this booklet.

We present here a number of examples to inspire the reader and spark discussion about certain aspects of sustainable development in Gothenburg, for which these projects represent the leading edge of practice in the field. Those aspects will be likened to building blocks that can be used to construct a sustainable development. They are divided into the categories of environment, economy, and society, as shown in the adjacent diagram. One could say we're providing here the ingredients with which to bake a cake, but not a specific recipe for how to combine those ingredients. We provide the stones with which to build a sustainable development, but not a definitive answer as to how they should be laid together.

Farsighted economic planning
long life time, life cycle cost calculations...

Affordable costs
profitability for developer, costs for operation, moderate rents...

Efficient management of resources
circular system for resources, only necesary consumption, cradle-to-cradle...

Collaborative format
working methods, collaborations, new ways of funding, business form, focus on process...

Lokal economy
car-sharing, shared spaces, closeness to smaller shops, local flows of goods and services and capital...

Social (cost) benefits
indirect economic impact on society included in calculations...

Diversity and integration
tenures, functions, size, peoples' background, equality, accesibility...

User benefit
usability, flexibility, identity, comfort...

Security and safety
perceived security, actual safety...

Communication
participation, empowerment of users, disessimination of experiences from projects, pedagogical aspects of sustainablity...

Beauty
architectural expresion, concept, materials, aesthetics...

Lifestyle, health and nature
healthy living, low envrionmental impact, cultivation, strong presence of nature...

Physical connections
access to service, access to job, easy to move betwenn areas/districts...

Sense of community
cooperation between people, meeting places...

Energy
constraction-, use- and demolition phase, embodied energy, type of energy, use adapted to needs, decreased energy needs...

Materials
resource efficient construction, reuse, environmentsal friendly, local materials, new materials...

Water
low usage, local systems, separate grey- and blackwater systems, individual metering...

Waste management
many fractions, small amount, eco-cylcle thinking...

Healthy indoor envrionment
harmless materials, low emissions, comfort, sound and noise, light, electricity...

Green structure
presence of green and blue, biodiversityd, symbiosis with building, ekosystem services...

Transportation
close to public transport, car-sharing, transporta of construction materials, bicylcle parking, walk-friendly area ...

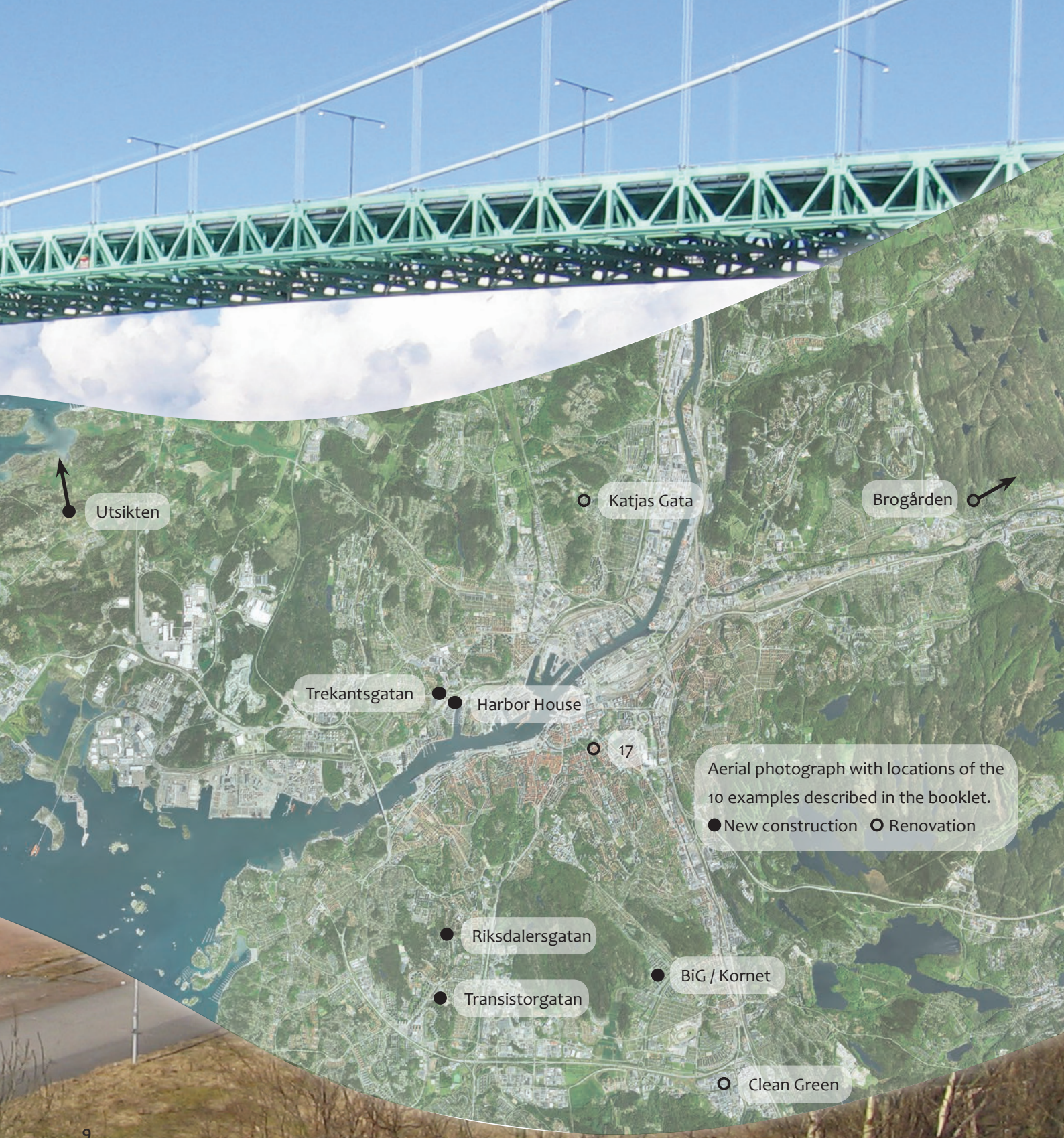
Land use
densification, extension existing buildings, construction on non-arable land, surrounding areas...

To Build Sustainable

The City of Gothenburg

There has been a great deal of interest in sustainable development in Gothenburg for a long time, with many contributors who have driven that development forward. In 2004 a booklet was published called Building for Sustainable Development in Gothenburg: 10 Examples. It is a collection of ten good examples of realized projects that were on the leading edge of environmentally friendly construction at the time, an easy-to-read and illustrative review from which readers could learn. The booklet explored how the experiences gleaned from these examples could be recycled and further developed in future projects. Among other things, it was a source of inspiration for a land-use planning competition for a housing development on Trekantsgatan in the Lundby Kyrkby neighborhood in 2005, and the buildings that grew out of that competition are described later in this booklet. The 2004 book also served as a source of knowledge for the production of the City of Gothenburg's 2009 program for environment-adapted construction, which established the framework for all housing built on city-owned property since then.

It is now more than a decade since the 2004 book came out, and a lot has happened in the intervening years. The examples described then are no longer representative of the leading edge of sustainable construction in Gothenburg today. This booklet updates the previous one with new examples from the forefront of the industry. It documents some of what has been done and discussed in the local sustainable development scene over the past ten years.



Aerial photograph with locations of the 10 examples described in the booklet.
● New construction ○ Renovation

Finding the Examples for Documentation and Inspiration

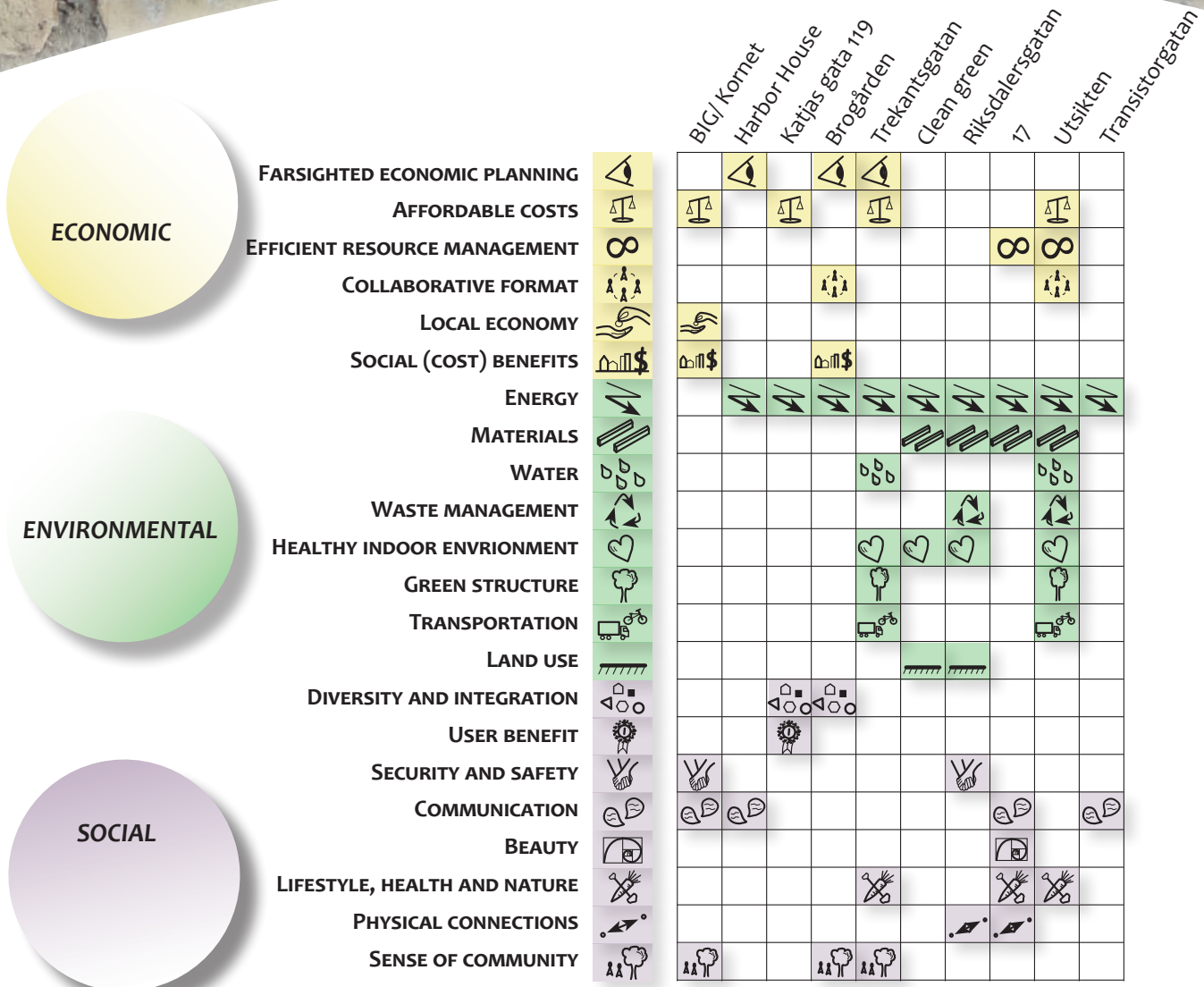
Method and Execution

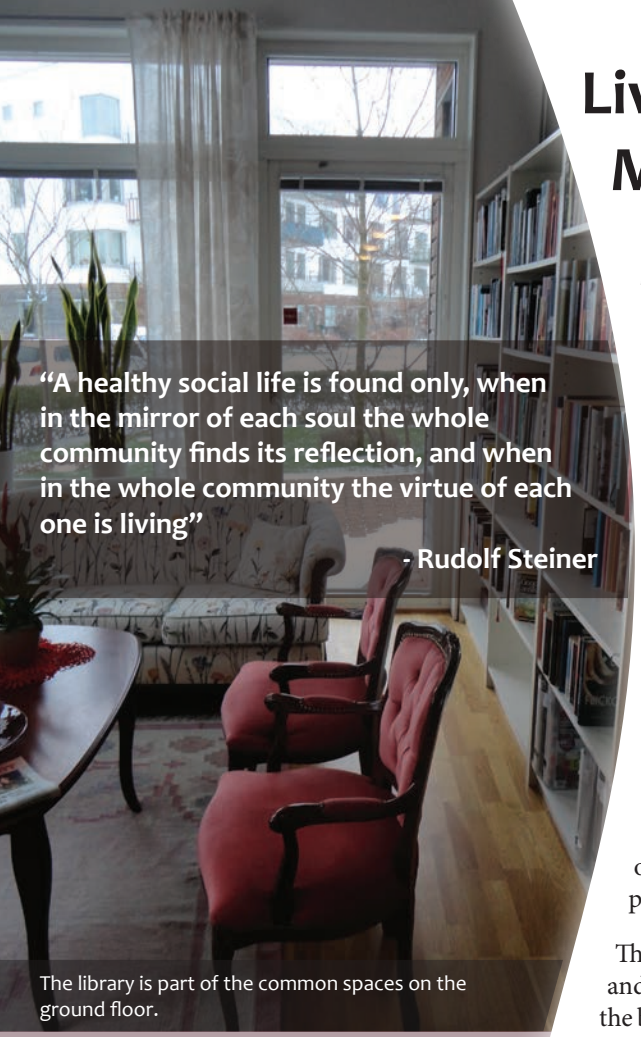
In looking for ten examples to describe and discuss, we began with a general search for projects with sustainable construction ambitions in Gothenburg and its environs that have been completed in the last decade. The search process was largely a matter of looking through architecture firms' websites and asking members of the city's construction industry to recommend projects. We consolidated the results into a list with brief information on about forty-five projects with the potential for inclusion in the booklet. From that list we selected ten examples to describe in greater detail. The criteria for inclusion in this list of ten were as follows:
a) include examples of both renovation and new construction; b) include both residential and commercial projects; c) include a variety of developers, architects, and owners; d) completed between 2003 and 2013; e) located primarily in Gothenburg; f) represent a broad array of different aspects at the leading edge of sustainable construction.

In parallel with this search we defined what we mean by sustainable construction (see page 6). The different aspects of the foundational pillars—environmental, economic, and social issues—were chosen to provide a framework for the discussion of the various aspects that go into building for sustainable development.

After that we did a more in-depth search for existing writing about the ten projects. In order to gather more information, we interviewed at least one key player on each project, based on the assumption that knowledge is produced in the conversation between interviewer and interviewee. We analyzed these interviews and the other material about the projects, and produced a presentation of each project in words and images, which we then submitted to the interviewees for verification of the facts.

It is important to note that this is a subjective selection of projects that is intended to capture a variety of examples around which to discuss different aspects of sustainable construction. In the table at right, the top row lists the projects and the column on the left shows the all the various aspects of environmental, economic, and social issues. The table indicates which of these aspects are discussed in each of the different projects, since not all of them are relevant or interesting in every one. The project descriptions thus provide documentation of ten built examples, and at the same time offer inspiration for future building.


BIG/ Kornet
Harbor House
Katjas gata 119
Brogården
Trekantsgatan
Clean green
Riksdalersgatan
17
Utsikten
Transistorgatan
ECONOMIC
FARSIGHTED ECONOMIC PLANNING
AFFORDABLE COSTS
EFFICIENT RESOURCE MANAGEMENT
COLLABORATIVE FORMAT
LOCAL ECONOMY
SOCIAL (COST) BENEFITS
ENVIRONMENTAL
ENERGY
MATERIALS
WATER
WASTE MANAGEMENT
HEALTHY INDOOR ENVRIONMENT
GREEN STRUCTURE
TRANSPORTATION
LAND USE
SOCIAL
DIVERSITY AND INTEGRATION
USER BENEFIT
SECURITY AND SAFETY
COMMUNICATION
BEAUTY
LIFESTYLE, HEALTH AND NATURE
PHYSICAL CONNECTIONS
SENSE OF COMMUNITY



The library is part of the common spaces on the ground floor.

Living Together Is a Way for Many to Get More for Less

BiG/Kornet

Kornet is a point block of cooperative rental units whose residents share their everyday lives as members of an economic association called Bo i Gemenskap (Living in Community), or BiG. The lifestyle and sense of community offers the residents security, health, and wellbeing. It was the residents themselves who initiated the development, and they contributed to its design and budgeting and today are responsible for managing the interior of the building themselves. However, the project could not have been realized if not for the good collaboration between the different stakeholders.

Sense of community: The fundamental idea for Kornet came from a group of people who wanted to live in community and share their everyday lives with one another. The point of departure was to create enthusiasm and mutual respect for one another, and that is central to the social aspects of achieving a sustainable whole. The basis for that sense of community was established through collaboration in the process of planning for the construction.

The sense of community is nourished through common activities, cooking and eating meals together, and sharing responsibility for the maintenance of the building. Today the residents are divided into six meal teams, each of which is responsible every sixth week for coming up with a menu, buying food, and cooking dinner in the building's restaurant kitchen. Another important factor in building a sense of community is the fact that the residents do so much together. They travel, go to the theater, work out, watch soccer, and host many house parties every year. Every weekday at 11 AM is coffee time for anyone who wants to join. There are many spaces in the building that are designed to support the sense of community. On the ground floor are the kitchen, dining room, workshop, cleaning room, office, bathrooms, living room, and library. On the eleventh floor are a roof terrace, two guest rooms, a sauna, hot tub, bathroom, gym, and another living room. The residents vary in age from 38 to 80 years old, with most between 55 and 67. One says it's like the building is a little village that includes every type of personality, where you have to learn to be sociable and to tolerate one another's differences.

Security and safety: The lifestyle built around community is important in creating a sense of security. The residents feel safe knowing that there are always other people close by. The residents look after one another to the extent that if one of them doesn't turn up as promised the others will go and find them. The grown children of the residents feel a sense of security knowing that their parents won't be alone as they get older. Locating Kornet in the Bifrost neighborhood of Mölndal, which elected officials wanted to purge of its reputation for disorder, was considered a stabilizing factor that contributes security to others besides those who live in the building.

Project: New construction of 44 cooperative rental apartments
Completed: 2006
Address: Utsädesgatan 7, Mölndal
Area: 2,330 m² habitable floor area, 3,433 m² gross floor area
Developer: Mölndalsbostäder AB
Tenant: BiG/Kornet cooperative association
Architect: Peter Sparrings, GF konsult
Contract form: Turnkey
Contractor: PEAB
Property manager: Mölndalsbostäder AB and association Bo i Gemenskap
Costs: €1,750/m² habitable floor area, including value-added tax, land, permitting, construction, consultants
References: p 34

Social benefits: The benefits of living in in a tight-knit community extend beyond the building and its environs. The City saw the project as an opportunity to save on healthcare costs in the long term because an active lifestyle is inherent in the idea of communal housing. One of the project's original initiators argues that the City will benefit economically because the residents will stay healthy and need less care and municipal services as they age.

Local economy: In order to create a society that is sustainable in the long term, we need to reduce our vulnerability to today's global economic systems. In Kornet there are several details that strive to do so. The shared spaces and exchange of goods and services within the association is a local way to organize some aspects of life with a degree of independence from the larger economic systems.

Communication: A key factor in getting the project actually built was the good collaboration among different stakeholders. The first step was for a group of people who wanted to live together in community to form an association. They contacted several elected officials and developers, and the Mölndal City Executive Board showed some interest and made the connection to Mölndalsbostäder, a city-owned public housing developer. As it was important to the association to keep the cost of living affordable, the developer established rather strict budgetary limits for the project. The general contractor worked from a construction cost budget based on a given monthly rent. The cooperative rental form of housing was determined to be the most suitable, which means that the BiG association leases all the units in the building as a block for ten years at a time from the municipal developer, Mölndalsbostäder, and the association in turn rents out the apartments one at a time to its members. Under the lease agreement, BiG is responsible for the maintenance of the interior common areas and the exterior landscaping. Each resident is responsible for his/her own apartment. By law the value of the cooperative rental unit may not increase in value, so everyone gives the association a deposit when they move in that is returned to them in full when they move out. It was important to the success of the project that all parties (the association, the developer, and the contractor) understood that the process would take longer, and important that all of them were committed to collaborating and worked actively to engage the residents in the process. BiG members divided up into working groups: the architect group; the economics group; and the management group; and thus were active throughout the entire process from the initiative to the building management. They were even involved on the construction site occasionally, and brought the workers snacks on their coffee break.

Affordable costs: One goal was to keep down the cost of construction and the resulting cost of living without undermining the quality. As BiG said, it should be possible for a common nurse's aide to live there. In 2004 the general contractor was given a budget of 1,000 euros per square meter of habitable floor area in order to ensure a reasonable rent for the residents. The total development cost ended up being about 1,750 euros per square meter of habitable floor area, including value-added tax, land, permitting, construction, design and engineering consultants, and profit and overhead. Each resident pays a rent based on the size of the apartment plus an additional 16% to cover the cost of the common areas.

The building is a tower block with 11 floors and 44 cooperative rental apartments.

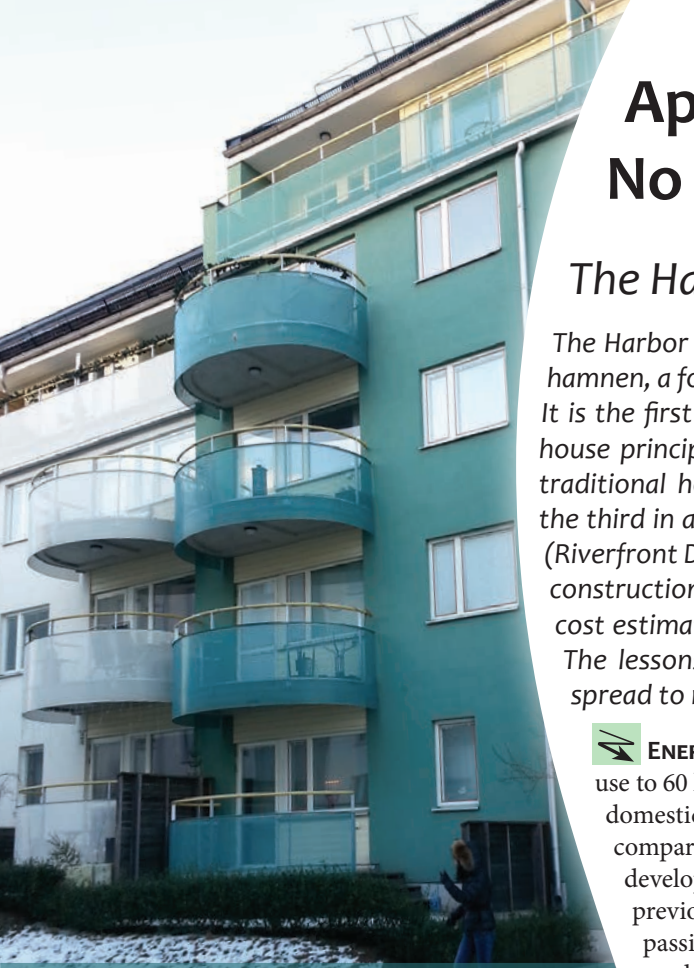
Outside this common living room on floor 11 is a large roof terrace.

The well-equipped restaurant kitchen is the heart of the building.
Photos, Annika Danielsson, 2014

Apartment Buildings With No Traditional Heating System

The Harbor House

The Harbor House is beautifully sited alongside the pool of Sannegårdshamnen, a former shipbuilding wharf, and includes 115 rental apartments. It is the first multi-family residential building in Sweden built on passive house principles, which means it's an energy-efficient structure with no traditional heating system. The Harbor House was completed in 2008, the third in a series of buildings by the developer Älvstranden Utveckling (Riverfront Devlopment) designed to advance the field of energy-efficient construction. In parallel the developer also created a model for life-cycle cost estimating to provide a good basis for making economic decisions. The lessons learned from the project had a broad impact, and were spread to many other actors in the industry.



"Never look down to test the ground before taking your next step; only he who keeps his eye fixed on the far horizon will find the right road."
- Dag Hammarskjöld

Great efforts were made to avoid heat losses, for example, from windows and balconies. Photo: Annika Danielsson, 2014

PROJECT: New construction of 115 rental apartments
COMPLETED: 2008
ADRESS: Ångaren Ediths Gata 4-10, Gothenburg
AREA: 7,868 m² habitable floor area, 15,021 m² gross floor area
DEVELOPER AND LANDOWNER: Älvstranden Utveckling AB
PROPERTY MANAGER: Familjebostäder in Gothenburg AB
ARCHITECT: White Architects AB
CONTRACT FORM: Turnkey
CONTRACTOR: NCC Construction AB
COSTS: €2,750/m² habitable floor area, including land, developer costs, and tax
REFERENCES: p 34

ENERGY: One goal for the Harbor House was to limit the annual energy use to 60 kWh/m² heated floor area—including energy for heating (12 kWh/m²), domestic hot water (13 kWh/m²), and building electricity (35 kWh/m²)—compared with the legal limit of 110 kWh/m². To achieve that objective, the developer adopted passive building principles used at a smaller scale in previous projects. These included designing the building to be heated with passive solar heat gain through windows, with the heat given off by people and household appliances, and with heat reclaimed from exhaust air by a heat exchanger instead of using a traditional heating system of radiators. To ensure that these sources would be sufficient, they focused on eliminating heat loss by making an airtight building shell with minimal heat bridges, adding extra insulation, and installing well-insulated windows. To minimize the amount of energy purchased for water heating, they included a 201 m² solar thermal collector installation on the roof and a 15 m³ accumulator tank in the basement. In order to complement to the solar collectors and to preheat the makeup air for the mechanical system, the building is also connected to the municipal district heating system. To create an incentive for the residents not to waste water or electricity, each apartment has smart meters that measure these and bill each unit individually.

The developer was the driving force behind the design of the building. Because of the many uncertainties surrounding the mechanical systems and other components, which had the potential to lead to high costs, a construction management at risk contract was chosen instead of dividing the risk between developer and general contractor. The builder, NCC, collaborated with the developer throughout the design process in order to simplify the building enough to ensure a reasonable cost. A collaborative development process was initiated in which the developer assumed

liability for the mechanical system performance because the consulting engineers didn't dare to try a non-traditional approach.

In the end the building did not quite achieve the goal of 60 kWh/m² per year. When Älvstranden Utveckling was managing the building the annual energy usage was between 57 and 75 kWh/m². In 2012 the building was sold to the municipal housing company Familjebostäder. The usage for 2012 was 85 kWh/m², of which heating accounted for 38 kWh/m², domestic hot water 18 kWh/m², and electricity 29 kWh/m². The solar collectors haven't been operational in 2012, which means the energy used for hot water could have been reduced. The amount of energy purchased for heating (38 kWh/m²) is notably high compared to the original goal of 12 kWh/m². Familjebostäder planned to improve the performance by optimizing the efficiency of the mechanical system, the air flow, the temperature of the makeup air and in the garage, the energy gained from the solar collectors, the use of water, and the heat loss from the hot water circulation system.

A 201 m² therma solar collector installation on the roof contributes to the domestic hot water supply. Poto: Annika Danielsson, 2014

FARSIGHTED ECONOMIC PLANNIG: During their work with the Harbor House project, the developer created a tool for lifecycle cost calculation (LCC) as a foundation for good economic decision making. The LCC model deals with many different parameters, including investments, interest rates, value-added taxes, ongoing operations and maintenance, periodic maintenance, and leasable space. The tool allowed them to demonstrate that a larger initial investment to create an energy-efficient building would result in a lower total cost over the life of the project, since the savings in operating costs was greater than the increase in annualized capital cost. The extra investment in energy-saving measures in the Harbor House ended up being 2.5% of the total project investment, and in comparison with a building constructed according to the industry standard in Sweden at that time the total annualized cost was lower for the Harbor House from the very first year. A comparisin over a thirty-year period also showed an economic advantage for the Harbor House over a standard building. From these calculations Älvstranden Utveckling, concluded that farsighted planning was economically beneficial. However, because the building's energy performance did not achieve the theoretical calculations, that conclusion deserves further consideration.

The Harbor house is sited alongside the pool of Sannegårdshamnen, a former wharf. Photo: Annika Danielsson, 2014

COMMUNICATION: The lessons learned from the Harbor House were shared openly throughout the entire process. It was a pilot project for Byggabo-dialogen (the Build-Live Dialogue), a collaboration around sustainable construction and building management among various actors in the construction industry. The LCC model worked like a battering ram in advocating for eco-friendly strategies and getting them approved. It is now available on the internet for others to use. The project came to be a valuable reference for energy-efficient construction, the creation of Swedish passive house standards, the Sweden Green Building Council certification system, and even the requirements that Älvstranden Utveckling established for new construction on their own properties.

With help of a vacuum based system, household waste is transported to a terminal building. Photo: Anna Gustafsson, 2016

Mass-Produced Housing Becomes Low-Energy Housing

Katjas Gata

Built in 1971, Katjas Gata 119 was a typical residential building from the era of mass-produced public housing. It was renovated as a pilot project, and reduced its annual energy use dramatically. The most energy-saving measures were the installation of heat-exchanging mechanical systems, additional exterior insulation, and new windows. The renovation was part of a comprehensive redevelopment of the neighborhood Backa Röd, in which the developer wanted to offer a variety of housing types with a variety of rental costs. Since the work was completed, the residents experience a greater level of comfort in their apartments. Lessons learned were incorporated into the renovation of other point-block buildings in the area.

"A pessimist sees the difficulty in every opportunity; an optimist sees the opportunity in every difficulty."
- Winston Churchill

The renovated building is a bright red gem with low energy use. Photo: Johan Twedberg, 2009

Project: Renovation of a tower block with 16 rental apartment (2-bedroom apartments, 80 m²)
Year of construction: 1971
Renovation Completed: 2009
Address: Katjas Gata 119, Gothenburg
Area: 1,244 m² habitable floor area
Developer and property manager: Bostads AB Poseidon
Architect: Pyramiden arkitekter
Contract: Performance contract with business partnering
Contractor: Skanska Sverige AB
Costs: €1.98 million exclusive excluding costs for the pilot project
References: p 34

Energy: The developer, Poseidon, wanted to use this project to study the opportunities and hurdles for energy-saving renovations of their entire housing stock from technical, economic, and social perspectives. In their work on Katjas Gata they saw the building as a system for achieving the goal of reducing its annual energy use from 178 kWh/m² to 60 kWh/m² heated floor area. The normalized annual energy use ended up being 52 kWh/m² in 2010, the first year after the renovation. Most of the energy savings on heating was achieved by installing a mechanical ventilation system with a heat exchanger, 200 mm of insulation on the façades, and new energy-efficient windows. During the winter months a radiator system connected to the municipal district heating system provides additional heat.

The renovation also reduced the building's energy usage for domestic hot water and electricity, as well as the heat loss from the district heating culvert. In order to incentivize the residents to reduce their use of water, individual metering and billing of hot water was introduced. Low-flow toilets and faucets were installed, along with a hot water circulator system for each apartment so residents wouldn't need to run the water so long to get hot water. However, as the energy used on domestic hot water depends on the user, Poseidon has estimated that the usage could rise from the 21.1 kWh/m² measured in 2010 to upwards of 26 kWh/m², depending on the number of people living in the apartments. In parallel with the preliminary study for Katjas Gata, Poseidon joined the Milparena research project, which dealt with the renovation of mass-produced housing with a focus on energy conservation. The developer could thereby conduct several extra studies, which helped them make well-informed decisions regarding the technical strategies.

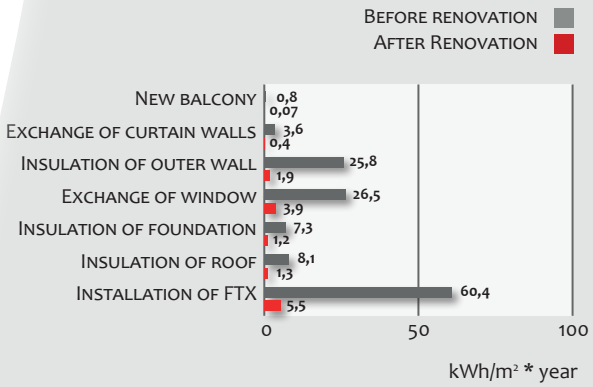
User benefit: One aspect of creating social sustainability is making housing with good indoor climate for those who live in it, which was achieved through this energy-saving renovation. Poseidon has compared resident surveys from Katjas Gata with surveys from an unrenovated building next door, and these show that indoor climate and thermal comfort were improved dramatically by the renovation. The apartments have become less drafty and there are fewer complaints about cold floors, low room temperatures, unpleasant smells, and noise. The choice of heating the rooms with radiators instead of heating the supply air, which is more common in buildings with mechanical ventilation, gives the residents more freedom to adjust the temperature of the rooms according to personal preferences. There have been somewhat more complaints of too-high temperatures during the summer, but on the whole the residents are very satisfied.

Affordable costs: Even though Poseidon didn't achieve profitability according to the calculation models prevalent at the time, the project did provide some valuable experiences. The developer's previous comprehensive renovations in the same neighborhood, which included new mechanical systems, façade renovation, and the replacement of balconies and the exterior walls at balconies, cost 1240 euros/m^2 of habitable floor area in 2009, including their own profit and overhead and the value-added tax. That calculation, however, is an extrapolation of what it would have cost in a typically sized renovation project of 100 units instead of 16. The work on Katjas Gata reduced the energy cost for each apartment by approximately 780 euros per year. In order to achieve profitability in energy-saving renovation work, Poseidon recommends: the building should be in need of an upgrade, one should strive to create new leasable space in connection with the work, and taller buildings are advantageous because more apartments share the same building envelop surface and the same mechanical system. For Katjas Gata a key precondition was that it was a point-block, which would allow all the units to be served by a single mechanical core. Poseidon benefited from these experiences in later renovations of five different point-block buildings in the same Backa Röd neighborhood.

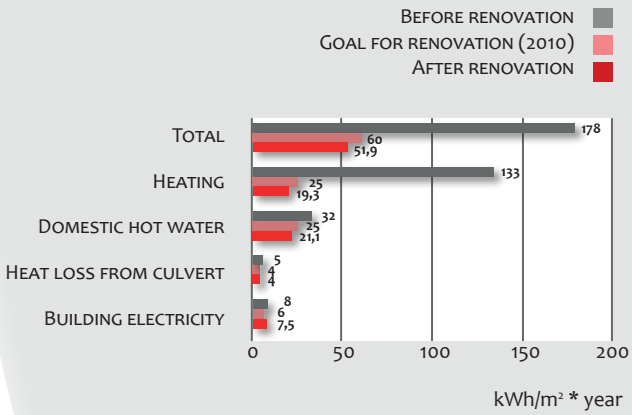
Diversity and integration: Poseidon owns 1500 of the 1600 apartments in the Backa Röd neighborhood, and has now completed a comprehensive renovation of the entire area. The development had previously been isolated from the surrounding areas by barriers and was poorly integrated with the city in spite of lying just four kilometers from downtown. The entire area was developed between 1969 and 1971, and people perceived it as monotonous. In the preparations for the renovation work, two objectives were to differentiate the neighborhood and to integrate it better with the city. Poseidon wanted it to offer a variety of housing types, different rent levels, and visual diversity in the appearance of the buildings. Katjas Gata and the five other point-blocks were part of that effort. They were to be given a housing standard equivalent to new construction, and be a somewhat more costly alternative in comparison with the surrounding neighborhood. The red stucco façades stand out among the surrounding gray buildings, making it easier for residents to orient themselves within the area as a whole.

Before renovation the tower block with its 16 apartments was an energy guzzler. Foto: Cathrine Gerle 2008

Energy savings for heating illustrated per measure.



Energy use before and after renovation.



Renovation with a Holistic View and Good Collaboration

Brogården

The Brogården neighborhood of Alingsås, originally developed in the 1970s, has been transformed by the renovation work that began in 2008. The property owner, Alingsåshem, began by examining the shortcomings and qualities of the area with a focus on the residents' experiences, and that gave the renovation effort a holistic approach. The project includes renovation using passive house techniques to minimize energy use and maintain a good indoor climate, as well as the creation of more meeting places and the redistribution of spaces in order to enhance diversity and integration. The effort was characterized by the owner's collaboration with the contractor and by the development of an exterior wall system.

One goal of the project was an increased variation of apartment types and enhanced accessibility. Photo: Annika Danielsson, 2014

Project: Renovation of mass-housing area from the 1970s with 16 lamellar houses and 264 rental apartments
Year of construction: 1971-1973
Renovation completed: 2009-2014
Address: Brogården, Alingsås
Area: 19,348 m² habitable floor area and floor area for facilities (after renovation)
Developer and property manager: AB Alingsåshem
Architect: EFEM Arkitektkontor AB and Creacon AB
Contract: Turnkey with business partnering
Contractor: Skanska AB
References: p 34

Energy: Because Brogården had such high annual energy use—as much as 216 kWh/m² including heating, domestic hot water, and building and unit electricity—for environmental reasons the work came to focus on improving energy efficiency. The objective was to reduce energy use to 92 kWh/m². To achieve that goal the renovation was undertaken using passive house techniques and a new kind of exterior wall developed for the project.

Each building was originally constructed with a cast-in-place rein-forced concrete frame, rather like a bookcase. That was essentially the only thing that was preserved in a gut renovation that aimed to extend the life of the buildings by at least fifty years. The exterior walls of the first building to be renovated were rebuilt with steel framing and a total of 480 mm insulation in three layers of different thick-nesses. The walls were assembled in place and took twelve weeks to complete for a single building. After the first building was complete, this wall system was reevaluated and replaced in the next series of buildings with 440 mm insulation in only two layers of equal thickness. The change reduced the number of screws that needed to be installed by about ten thousand per building, which simplified the construction process and reduced the time it took to build each building from twelve to four to five weeks. This second wall type was used for a total of thirteen buildings. The third step in the development of the wall system was to develop a prefabricated wall that took only one week on site to install on each building. The insulating wall covers the outer edge of the concrete frame, reducing heat loss through thermal bridging. For the first building renovated, a separate air handler was installed for each apartment, while the remaining buildings were equipped with central air. When the performance of the first building was evaluated, its normalized annual energy use was calculated at 48 kWh/m² not including household electricity.

Diversity and integration/Social benefits: A study conducted by the property owner, Alingsåshem, in preparation for the renovation of Brogården revealed a shortage of variety in the apartments on offer. The area comprised mostly one- and two-bedroom units, which meant there were few families with children living there. The buildings lacked elevators, and the apartments were not adapted for accessibility, which made it hard for elderly residents to stay on in the neighborhood as they grew older. Alingsåshem generally assumes that if you live well in your apartment and have a social meeting place in the vicinity, you're going to be able to meet many of your needs at home. From a more farsighted perspective, this benefits society in general because it costs so much less for the elderly to remain in their homes than to be accommodated in institutions. The goal was therefore to achieve integration and satisfy customers' diverse housing needs by providing a variety of housing types with plenty of accessibility and places to meet. The renovation work reduced the number of units from 299 to 265, of which 148 became fully accessible, with elevators installed within the original building footprint. The new apartment layouts were more varied as well. Most are still one- and two-bedroom units, but the number with three or four bedrooms has increased from three to twenty-eight.

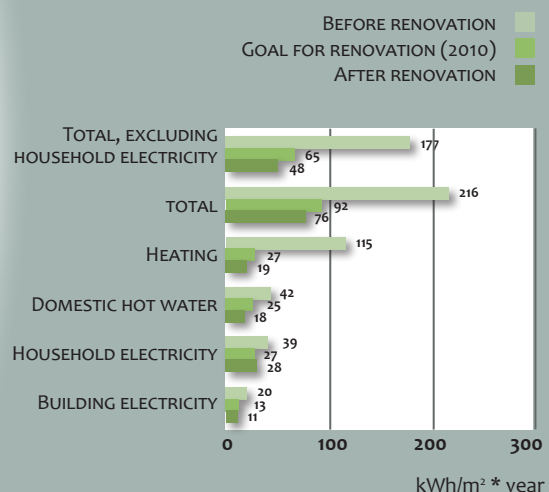
In order to address the shortage of meeting places, two apartments were converted into common social spaces for all residents. Photo: Pernilla Hagbert, 2014

Different wall systems were developed and evaluated. Photo: Annika Danielsson, 2014

Sense of community: In the past Brogården had suffered from a lack of meeting places. Part of the work with the area was developing a social safety net for the residents, and Alingsåshem determined that the shortage needed to be addressed. The renovations included converting two two-bedroom apartments into common social spaces for all residents to use at no cost. In this way Alingsåshem facilitates neighborhood social life, making it possible for social events to occur without taking responsibility for arranging them. Instead, it is the residents' association, various study circles, and groups of residents that organize the activities. The shared spaces have also been used for meetings about urban agriculture, which have attracted young and old alike and people from all kinds of backgrounds. There have been discussions of the possibility of the local healthcare clinic coming to one of the meeting places periodically to do check-ups as a convenience to residents.

Farsighted economic planning/Collaborative format: The property owner's choice to partner with a general contractor set the tone for the project and was important for the successful result. The joint venture between Alingsåshem and Skanska, with a shared budget and open book-keeping, made it easier to focus on developing strategies that worked for both sides while exploiting their complementary expertise as effectively as possible. The role of project manager was replaced by one of effectively facilitating collaboration among a diverse group of experts. Decisions were made with a holistic view. It wasn't always the cheapest product that was chosen. One illustrative example is the fluorescent tubes for the kitchen, where the team chose those that had the best energy performance and were easy for residents to replace themselves.

Energy use for the first building before and after renovation



Environmentally Conscious Living with a Chance to Garden

"In nature's economy the currency is not money, it is life."

- Vandana Shiva

The area encourages a lifestyle close to nature. Photo: Fredrik Augustsson, 2013

Trekantsgatan

In 2005, the developer Botrygg won a land-use competition with lofty environmental ambitions for adding density to a centrally located site near public transport services in the Lundby Krykby neighborhood of Gothenburg. The development comprises space-efficient apartments with affordable rents and opportunities for gardening. The buildings are equipped with a natural ventilation system that uses the stack effect and saves energy while providing a healthy indoor environment. They have solar collectors on the roofs and drain water heat recovery to save energy. Nature is present through roofs planted with sedum, gardening plots, and an open stormwater management system. It's an interesting combination of social benefit and cost-saving strategies for both owner and tenant.

Energy: The building's ventilation system uses the stack effect to draw in fresh air through an underground pipe located a couple of meters from the façade. The pipe brings the air into the basement, where it is preheated in winter in a large, uninsulated air chamber so that it can absorb heat from the earth beneath the building. Separate ducts deliver fresh air from this chamber to each apartment, where radiators heated through district heating provide additional warmth. In the summer the same system uses the relative coolness of the earth to chill the fresh air. Other energy-saving measures include humidity-activated fans in the bathrooms, low-flow hydronic radiators, 200 mm fiberglass insulation instead of the 150 mm that was common in 2005, and sedum vegetation that provides additional insulation on half the roof. The other half is outfitted with solar thermal collectors that warm the domestic hot water. Heat is recovered from the shower drain water and used to preheat incoming water. All the apartments have individual metering of heat and water, but rather than billing the residents for their consumption the system is used to inform those with the highest about how to conserve. Prior to construction the annual energy use was calculated to be 84 kWh/m^2. In 2013 it was verified at 89 kWh/m^2 for heating, domestic hot water, and building electricity.

Healthy Indoor Environment: The natural ventilation system was chosen in the interest of human health. The system has no air filters, which tend to crush harmful particles into smaller bits that can thereby become more carcinogenic. Instead the air chamber works as a sedimentation filter in which particles drop to the floor, where they can be cleaned up regularly.

Project: New construction of 105 rental apartments (studios, one - and two-bedrooms)
Completed: 2011
Address: Trekantsgatan 5-10, Gothenburg
Area: 5,646 m^2 habitable floor area
Developer & property manager: Botrygg AB
Architect: SHL arkitekter
Contract: Shared contract
Contractor: Botrygg Bygg AB
Costs: €2,600/m^2 gross floor area, including tax, contractor costs, and land
References: p 34

The air supply ducts that lead to the apartments start in the ceiling of the chamber so the particles don't get in.

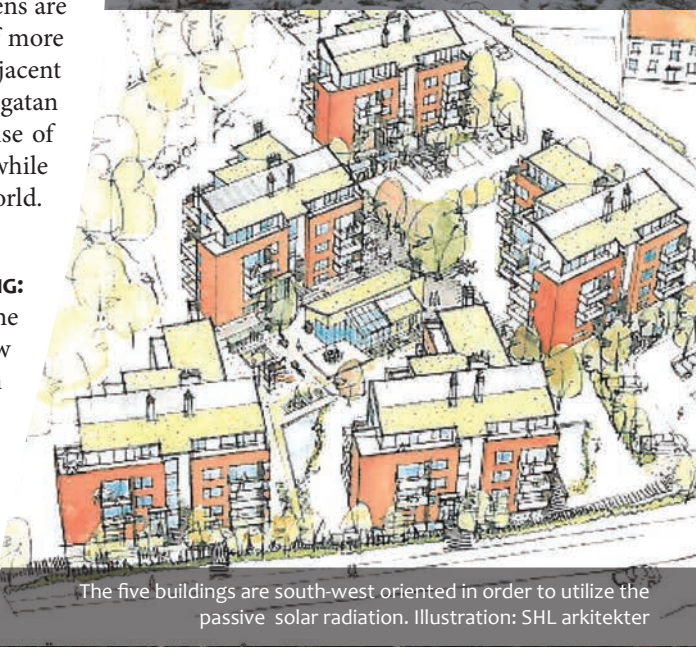
Water: All apartments have individual metering of water to encourage conservation. In 2011-12 the hot water usage was 0.7 m^3 of water per square meter of habitable space. The cold water usage was 1.1 m^3/m^2. The property also has a system for local treatment of stormwater. The sedum roof vegetation stores water when it rains, and a large gravel basin detains surface runoff on site before it filters down into the municipal stormwater system. On the ground floor the water treatment system is visible, with downspouts emptying into gutters set into the asphalt walkways that lead to the gravel basin. The design is intended to awaken residents' interest in issues of water management.

Lifestyle, Health and Nature/Sense of Community: The area provides opportunities for gardening with twenty plots on site, a small shared greenhouse, and a composter for garden clippings. The gardens are popular, and residents grow everything from potatoes to flowers. If more garden plots are needed there is land available on the site. The adjacent property is home to some chickens that occasionally visit the Trekantsgatan development. Gardening has become a natural way to foster a sense of community, a way for residents to form bonds with their neighbors, while encouraging a lifestyle enriched by close contact with the natural world. The property also includes a clubhouse for parties.

Affordable Costs/Farsighted Economic Planning: Botrygg, the developer and property manager, estimate that the buildings will last at least 100-150 years, so they're taking a long view on their investment. The project aims to combine social benefit in the form of more eco-friendly choices with cost savings for owner and tenants alike. Botrygg wanted to empower their tenants as consumers by allowing them to stay longer in the same apartments. In 2013 residents paid an average of €157/m^2 of habitable space. As a way of supporting the residents' household economies, Botrygg purchases electricity, television, broadband internet, and VoIP services collectively before selling them on to the residents, buying in bulk at a low enough rate to save each household hundreds of euros a year.

Transportation: The buildings were designed to prioritize locally produced materials in order to minimize the use of energy for transporting them to the site. For example, the concrete comes from plants nearby and is cast in place, which requires less transportation energy than prefabricated elements shipped from distant factories. However, granite from China was selected because it was less expensive than granite from local quarries in Bohuslän County. Botrygg has also contributed a car to the area's car-share pool for residents, and it is used 40% of the time. There are only thirty-three parking spaces on the property, with 0.31 spaces per unit compared to the 0.65 typically provided in similar developments.

The area provides plots for gardening, a greenhouse, and a clubhouse; and sometimes visiting chickens from the neigborhood. Photo: Annika Danielsson, 2014



The five buildings are south-west oriented in order to utilize the passive solar radiation. Illustration: SHL arkitekter

On the plots grow both food and flowers. Photo: Fredrik Augustsson, 2013

Visionary Renovation with BREEAM Environmental Certification

"Visa mig hur du bygger och jag ska säga dig vem du är."

- Christian Morgenstern

The existing staircase was repainted and connects today the shop on the ground floor with the office on the first floor.
Photo: Annika Danielsson, 2014

PROJECT: Renovation and conversion of an industrial building into an office, retail space, and warehouse
YEAR OF CONSTRUCTION: 1971
RENOVATION COMPLETEDD: 2011
ADDRESS: Argongatan 12, Mölndal
AREA: Floor area 3,750 m²
DEVELOPER, PROPERTY MANAGER, AND USER: Magnusson & Freij AB
ARCHITECT: Kjellgren Kaminsky Architecture AB
CONTRACT: Turnkey
CONTRACTOR: Högströms Energiteknik AB
COSTS: Aquisition of property 1.98 millon euro, renovation €2 million (whereof €1.07 million for new installations)
REFERENCES: p 34

Clean Green

The renovation of this industrial property was designed to accommodate the offices, retail space, and warehouse of the owner and developer, Magnusson & Freij (M&F). The company's desire to always do their best for the environment is reflected in the environmental goals it set for the project. They decided early on to try for environmental certification of the building through BREEAM. The project focuses especially on energy conservation, but it also includes reclaimed materials, reuse of portions of the old building, and creating a good working environment. Clean Green became Sweden's first BREEAM-certified renovation project and achieved M&F's goal of a 'Very Good' distinction.

ENERGY: Energy performance was the primary environmental aspect of the work on the entire project. All of the energy used to operate and heat the property comes from renewable sources and is environmentally certified. The objective was to use little energy to operate the building compared to other properties with similar size and use. It was estimated that the industry that previously occupied the building had consumed 1.2 million kWh annually, all but 400,000 kWh of which was used in energy-intensive manufacturing. M&F aimed to cut that non-manufacturing number in half to 200,000 kWh per year including heating, hot water, and electricity. That corresponds to 59.2 kWh/m² of space annually. Early in the planning process they studied the profitability and feasibility of various power generation systems, including photovoltaic solar panels, solar thermal collectors, wind power, geothermal, and district heating. M&F wanted to be as energy-independent as possible. Advanced planning for a small wind power plant on the roof was ended by zoning regulations. In the end they connected the building to the municipal district heating network.

One of the largest investments in the project, which also reduces the energy required for heating, is the new mechanical system with a heat exchanger that recovers heat from exhaust air and uses it to preheat supply air. The system gets additional heat from a water-filled heat storage tank connected to the local district heating system. The mechanical system is controlled by a timer, and uses the day-night temperature difference to reduce the need for heating and cooling during business hours. Insulation was added to the façades and roof of the office portion, but the roof of the warehouse could not accommodate the additional structural

load. Instead the focus was on ensuring an airtight envelop. In order to minimize the need for cooling, all of the office windows were fitted with a sun-screening and light-reducing film, and a fixed grid to screen the sun was installed over the windows on the south façade. All new lighting armatures utilize high-frequency ballasts for low energy use. The lighting in the offices and staff areas as well as some of the lighting in the warehouse is controlled by occupancy sensors and adjusts to compensate for daylight conditions.

Energy use depends on how a building is used. BREEAM therefore gives points if the owners provide a user's manual for the building, which they did in this case. People who work there can read how the building works and how user-related choices impact its energy use. For example, they are encouraged to keep the windows and doors closed and to think twice before adjusting the room temperature because of the large effect these have on the energy needed. The manual is good, though it is used primarily by M&F's building manager, but if anything changes in the building's systems all of the employees are notified.

Material/Land Use: Making use of an existing building in a construction project is good for the environment. First of all, it utilizes land that has already been developed rather than exploiting a new greenfield site. Secondly, reusing parts of the old building reduces the amount of new material needed. In this project, nearly the entire existing building shell was reused, including the structural frame and much of the façade. The motivation was economic as well as environmental. In addition, some portions of the interior were preserved, including a number of walls, an elevator, and two staircases. M&F didn't want to replace things that still worked, in keeping with the general idea of not being wasteful with materials. Three major additions were required in order to adapt the buildings to their new use: a new office area, a new mechanical room, and a new entrance. There was some site work done behind the building, but the existing soil could be reused without the need to bring in any fill.

Healthy Indoor Environment: An important aspect was to create a good working environment. It was a challenge modifying the old industrial building to accommodate M&F's need for offices, warehouse, and retail space. The new uses require completely different conditions in terms of creating a good working environment and high level of thermal comfort. That challenge ran throughout the design work in parallel with the energy conservation goals, and the solutions address both objectives. These include adding insulation to the exterior walls, sealing air leaks to eliminate drafts, screening the sun to minimize solar heat gain, and a new mechanical system divided into two zones based on the different activities inside. Taken together these measures satisfy the conditions for good comfort. The results of these strategies have been good for the most part. Unfortunately the indoor climate has not been entirely satisfactory either in summer or in winter, probably indicating the need to adjust the mechanical system and for building occupants not to leave doors open in summer.

In order to minimize the need for cooling, the office windows on the south facade have a fixed grid to screen the sun. Photo: Annika Danielsson, 2014


Retail space where Magnusson & Freij sells consumables. Photo: Annika Danielsson, 2014


Large parts of the climate shell were kept in the renovation project. Photo: Krister Pettersson, 2010

Swan-Certified Building with Materials Good for Health and Environment

Riksdalersgatan

Familjebostäder's three buildings on Riksdalersgatan in Högsbo are the first multi-family residential buildings with rental apartments in Sweden to be 'Swan certified' with the Nordic Ecolabel. The project began with the developer's desire to do something new with the site, which had an underutilized parking structure that was an unsafe place in the neighborhood. The Nordic Swan certification offered a way for Familjebostäder to organize the work of building an environmentally sustainable housing development. The certification process demands the use of materials that are good in terms of both human health and the environment.

The buildings have a concrete framework with fiber cement boards in different colors as facade material. Photo: Krister Engström, 2012

Project: New construction of three buildings with 100 rental apartments
Completed: 2012
Address: Riksdalersgatan 47-53, Gotheburg
Area: 6,565 m² habitable floor area, 9,280 m² gross floor area
Developer and property manager: Familjebostäder i Göteborg AB
Architect: White Architects AB
Contract: Controlled turnkey
Contractor: Tuve Bygg AB
Costs: €2,800/m² habitable floor area
References: pp 34-35

Materials: The Nordic Swan certification was a way to achieve a high environmental standard with a sharp focus on the choice of products and materials, since the system strives to make it easy for the consumer to choose the best products from an environmental standpoint. Construction materials impact the environment when they are produced, installed on the site, and incorporated into products that are prefabricated off-site. These aspects were thus monitored before the materials were used in the project. One example of the high standard was that during the construction process it turned out that wood products that had been certified as sourced from well-managed forests, in terms of environment and social conditions, did not always meet the Swan requirements. Some products had to be replaced because some countries lack the required tracing and documentation of the timber's origins. As a tool in the practical work of selecting materials, the design team used SundaHus, which allows users to tailor their demands for products to the individual project, and also includes a database with ratings of a huge number of products. In order for Familjebostäder to demonstrate their fulfillment of the Swan certification's requirements in terms of materials, they established special routines on the site: all the products delivered to the construction site were checked off against a list they made of approved materials. If the product wasn't on the list it wouldn't be allowed on the site.

Healthy Indoor Environment: Human health is an important part of the Swan certification. All of the materials used on Riksdalersgatan were chosen for being good for the health of people as well as the planet, and therefore creating healthy buildings. The precautionary principle was used throughout the construction process to minimize the risk of health problems such as allergies, hormonal disturbances, and disease. Familjebostäder is satisfied that, thanks to their meticulous control of the materials, they were able to ensure that the buildings have a good indoor environment free of harmful emissions. Even the air infiltration rate and the

humidity level are monitored on site with extra care in the Swan certification process since stagnant moisture can lead to health problems. If, in spite of all their efforts, a product used in the project were later to be shown to be harmful, the location, amount, and content of each product used is well documented to make it easier to remediate the problem. Other health-related measures emphasized by the Swan certification include good sound insulation and good ventilation. One of the three buildings on Riksdalersgatan even includes twelve non-smoking apartments, which makes it easier for residents to live a healthy lifestyle. These apartments have turned out to be popular and highly sought-after.

Waste Management: Waste management is an environmental aspect with which the design team worked in several ways on this project. During the construction process, construction waste was sorted into five different types. For residents of the completed buildings, household waste can be sorted into twelve different types, and Familjebostäder periodically reminds its tenants of the importance of sorting. The developer also feels that the strict material demands are important from a life-cycle perspective, since they ensure there won't be any environmentally dangerous materials to deal with in future renovations or demolition of the building.

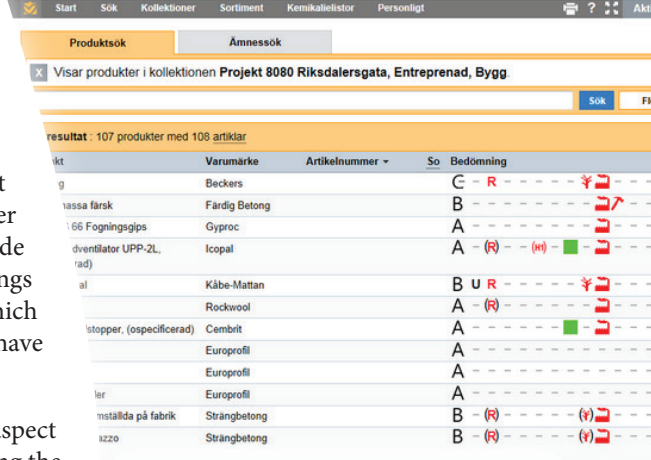
Land Use/Physical Connections: The buildings were constructed on previously developed land, so no agricultural land or existing ecosystems were lost. The project adds density to the built environment with good access to public transit, which helps physically to integrate the new housing units well with the city.

Security and Safety: The story of how the site was developed for new housing is interesting. Familjebostäder had for some time owned a parking structure on the property, and it was considered dangerous, worn out, and dark. It was determined that the time had come to do something different there. The goal of the new land-use plan was to add density to the area, in part in order to increase the sense of security. One idea was to build on top of the existing parking structure, but because of structural problems it was instead demolished to make way for a new structure with housing on top. The new development made the area around the site safer with more light and more eyes on the street from apartment windows and people walking.

Energy: The heating for the building uses heat recovered from the exhaust air complemented by district heating. Below is a table of the building's annual energy use measured in kWh/m² heated floor area.

	Calculated prior construction, kWh/m²	Measured year 2012, kWh/m²
Heating	24,9	30,4
Domestic hot water	18,9	24,3
Building electricity	14,9	15,5
Total	58,7	70,1

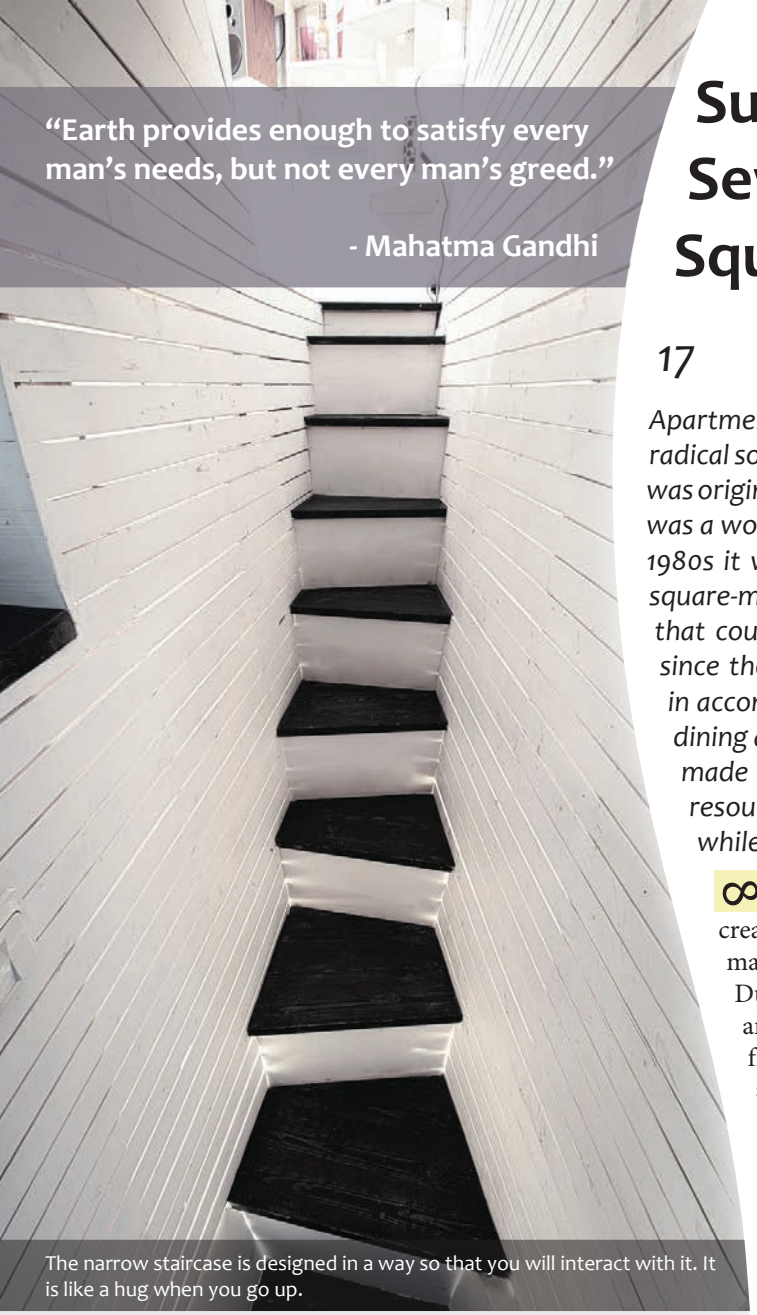
Familjebostäder expects some reduction of the energy need for heating when the concrete dries out (up to three years).



Different symbols in the SundaHus database inform us about important properties of the potential materials to be used. Bild: SundaHus, 2014


Previously, the property was a parking deck that was considered as dangerous, worn out, and dark. Photo: Familjebostäder, 2007


One of the developments three buildings with a view to the courtyard. Photo: Krister Engström, 2012



"Earth provides enough to satisfy every man's needs, but not every man's greed."

- Mahatma Gandhi

The narrow staircase is designed in a way so that you will interact with it. It is like a hug when you go up.

Sustainable Living on Seventeen Well-Designed Square Meters

17

Apartment 17 is an experiment in which the resident sought radical solutions in terms of living and volume. When the building was originally constructed in 1875 in central Gothenburg, the room was a woodshed for the larger apartments in the building. In the 1980s it was converted into a studio apartment. Its seventeen-square-meter plan now holds a complex and beautiful apartment that could actually be considered thirty square meters in size, since the 3.6-meter ceiling height has been used to the fullest in accommodating a hall, bathroom, closet, bedroom, kitchen, dining area, workspace, and living room. Most of the interior is made of wood and reclaimed materials, and contributes to a resource-conserving lifestyle with low environmental impact while also taking good care of the one who lives there.

Efficient Resource Management: The project is full of creative ways to efficiently manage resources. The small floor area makes it possible to use very little energy per person for heating. During the renovation process, existing materials were preserved and reused to eliminate waste. Everything was saved—lumber from the bathroom framing, boxes, cabinets, a kitchen counter, and the steps that lead up to the sleeping loft. The materials were kept in a corner of the room and incorporated successively into the new interior. For example, the steps were used in the construction of the narrow staircase, the bathroom lumber was reused in the bedroom, and the kitchen counter was refinished to suit the new design before being installed again.

Materials: The reuse of lumber and interior components kept the use of new resources to a minimum. Most of the materials brought into the apartment were of wood. Wood is a renewable material, and all the lumber used here came from Sweden, thus eliminating unnecessary transportation. Almost all of it was solid milled lumber rather than glued or otherwise processed products that require lots of energy and environmentally damaging chemical processes to manufacture. According to the designer, these choices stem from the project's nature, which fundamentally questions the way we live and examines the entire life cycle of a home from beginning to end.

Project: Interior renovation of resident-onwed apartment
Year of construction: 1875
Renovation completed: 2013
Address: Chalmersgatan 3, Gothenburg
Area: 17 m² habitable floor area and 3.6 m ceiling height
Owner and resident: Private
Designer och craftsman: Torsten Ottersjö and Lars Isestig
Costs: €53,500 for materials and manpower
References: p 35

Lifestyle: In addition to the fact that the renovation process adopted several principles to minimize the use of resources, the apartment also facilitates a low-impact lifestyle for the person living there. The designer asserts that what is really needed in a home is concentrated thoughtfulness, a place that cares about you and that in the long run leads to less daily material consumption. In the apartment, all of the interior furnishings are built in except for something to sit on at the workstation, which means the resident doesn't need to buy furniture. The minimal floor area in practice limits the potential for consumption of stuff.

The person who lives in the apartment made an active choice of where to live. The central location in Vasastan had less floor area than a suburban apartment would have, but came with proximity to work and urban life. That agrees with the designer's assertion that a small apartment centrally located supports contact and community among people through their use of neighborhood services. The apartment's resident enjoys living in a smaller and well-designed apartment that includes only everything that's needed.

The whole apartment is organised around a staircase that leads in form of a spiral from the bedroom, via kitchen, dining area and office, up to the couch in the living room where the picture is taken from.

Communication: Throughout the entire construction process, the designer collaborated with the resident, and they shared a productive dialogue on needs, desires, and design. Early on they agreed to a basic configuration in which the bed would be on the bottom, since one doesn't need much space while sleeping. The designer then worked with full-scale drawings in the apartment, since the project was too complex to be adequately addressed from the drafting table. The resident cleaned up the site on weekends and used it physically in the way it would be used in the future. That led to reflections communicated to the designer, who then made changes to incorporate the resident's feedback and requests. For example, one corner was changed after the resident bumped into it while climbing the stair. Thus the resident's body and personalized movement pattern was the basis for dimensioning the project. The open communications contributed much to the success of the project.

All of the interior furnishings are built in except for a stool at the workstation, meaning the resident doesn't need to buy furniture.

Beauty: This project transformed a poorly organized space into a beautiful place to live, into a home that fulfills more than the basic comforts of warmth and shelter. Immediately upon entering we can feel the beauty of the apartment in our bodies, and get a sense of what a pleasure it is to live here. The apartment is designed to give you a hug, and it does just that. The interaction between the space and the inhabitant is important, and the beautiful wood surfaces will in time be marked by traces of human activity, a record of the resident's personal story. The design conveys other stories as well: the reclaimed materials contribute to the character, and the lines between the wood ribs seem to tell a tale of infinity and openness.

The bedroom is placed in the bottom of the room because it doesn't need so much headroom. Photos: David Relan, 2013

"Ants don't produce waste. They don't need to minimize waste. They produce nutrients. Again it is a design question."

- Michael Braungart

An Owner-Built Low-Cost Home for a Healthier and Freer Life

Utsikten Eco Village: House 7

Utsikten is an eco village on the west-coast island of Orust that comprises sixteen lots built with widely varied single-family homes. Some are pre-fabricated houses ordered from catalogue firms, while others are custom-designed by architects, but they all share a distinct ecological profile. House 7 was both designed and built by the family who owns it. The design is based on ideas for living with healthy materials that would require very little energy to produce. The result is a pleasant and welcoming house with curving lines and well-wrought details made of wood, straw, and reclaimed construction materials. The natural world is a constant presence in the village. Gardening has become a natural part of daily life, alongside the other local cycles of water and waste.

About half of the lumber used in the house comes from trees that were felled and milled on the site in the family's own sawmill .

Project: New construction of single-family house in eco village
Completed: land purchased 2001, construction completed 2008
Address: Lilla Krossekärr, Orust
Area: ca 105 m² habitable floor area
Owner, designer and constructor: Private family
Costs: €42,000 land + €42, 000 house
References: p 35

Materials/Collaboration: In the construction of House 7, a single-family home in the Utsikten eco village, the focus was on the materials. The planning began five years before construction got started. Throughout that time the family gathered construction materials from various places. For example, they salvaged some forty transom windows from Vänersborg Hospital that were being thrown away. The design of the house was based on the collected materials and products. The family designed it themselves, with some help from an architect who was hired by the entire eco village together. The result is a well planned house into which the reclaimed materials are carefully integrated. There are many fine details, and curving lines are a recurring theme, creating an environment that feels good to be in.

The goal was to create a house using healthy materials that require little energy to produce. Using the reclaimed materials was one strategy to achieve that goal. In addition, the house is built with a wood frame insulated with hay bales that are clad inside and out with wood boarding. The construction took two years and was executed entirely by the family, apart from a little help from some friends and relatives. The decision to build it themselves meant that certain construction details were designed to use only components that could be lifted into place by two people. The choice of insulating with bales of hay was also convenient because they're easy to work with. The family bought an old sawmill for the project, and about half of the lumber used in the house comes from trees that were felled and milled on the site. Even the clay used in the mortar was sourced from their own lands, while the hay bales came from the plains of Västgöta County.

Affordable Costs/Efficient Management of Resources: Because the family both designed and built the house themselves, used a lot of reclaimed materials, and relied a great deal on their own labor, they were able to achieve a very low construction cost—€42,000 for the house and another €42,000 for the land. The restraint they showed with money and resources, consuming only what was absolutely necessary, is also reflected in the floor plan. The house is compact—only 100 m^2—and in retrospect they sometimes feel it would have been good to have an extra room, and some of the dimensions are perhaps too minimized. But their attitude to the house and to natural resources also means that they see the home as a continuous process in which rooms can be added as the need arises, for example, reclaimed windows can be replaced with newer, more energy-efficient ones when they can afford it.

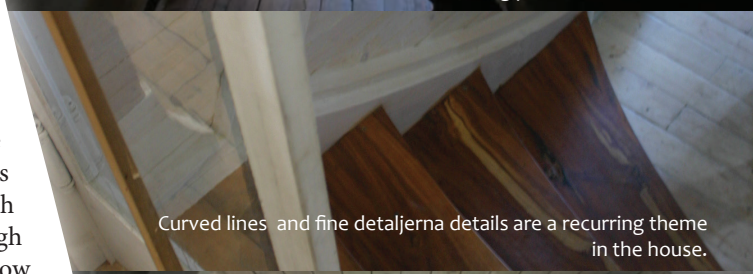
Energy: Energy efficiency was not the primary focus of this project, but the building is compact in terms of ceiling height and volume as well as floor area, so it warms up quickly. The heating system comprises a large accumulator tank for water heated by solar collectors and a furnace for biofuel that comes in part from the site.

Lifestyle, Health, and Nature: The site is ripe for gardening. Initially the family had no intention of doing so, but it was only natural in a place like this. They have a composter for organic kitchen and garden waste to make fertile soil for the garden, but say that "it never really fills up." Everything here is suddenly a wealth of small riches: in the village there are both pigs and sheep, but at this point the family has no animals, though they're considering eventually getting some chickens. For now they spend their time working on the house and the garden.

Water/Waste Management: Drinking water is pumped up from the lake, and then goes through a treatment system that is shared by the whole village before being distributed to individual households. Drain water is treated after use in a so-called root zone system—a bed planted with reeds—before filtering down to the lake again. Having such a local water treatment system that the residents understand creates a feeling that you'd never consider pouring something suspect down the drain because you know it's getting mixed with what will eventually be your drinking water.

The house has a urine-separating flush toilet. This was actually the only feature required of every house in the eco village. Feces are collected in this case under the house, where they are stored and composted, broken down by worms. The finished compost is shoveled out twice a year and used on the landscaping but not in vegetable gardens.

The hall has a higher ceiling height, the rest of the house is just over 2.10 m but without being perceived as too low.



Curved lines and fine detaljerna details are a recurring theme in the house.

The windows in the living room are originally transom windows from Vänersborg Hospital. Photos: Liane Thuvander, 2014.

Zero-Energy Preschool as a Long-Term Teaching Method

"Education is the most powerful weapon which you can use to change the world."

- Nelson Mandela

The white exterior walls consist of 600 mm thick sandwich panels. Photo: Ida Olsson Bjärmark, 2013

PROJECT: New construction of a zero-energy preschool
COMPLETED: 2013
ADDRESS: Transistorgatan 2, Gothenburg
AREA: 1,400 m² gross floor area
DEVELOPER AND PROPERTY MANAGER: Lokalförvaltningen in Gothenburg
ARCHITECT: Wahlström & Steijner arkitekter AB
CONTRACT: General contract with elements of business partnering
REFERENCES: p 35

Transistorgatan preschool

Transistorgatan Preschool is a new building with no net energy consumption. The owner is the municipal developer and property manager, Lokalförvaltningen, which strives to achieve a very high base standard for all of its properties and demanded even more of this preschool project in order to learn ways to advance their own expertise in environmentally friendly construction. Beyond the ambition to build a zero-energy building, they also wanted to use various kinds of visualizations to inspire the children to live and take action for the sustainable use of energy in society.

ENERGY: In order to advance their standing in the field of sustainable construction, Lokalförvaltningen works to maintain a high minimum standard for all environmental aspects of all of its buildings. They demand that new buildings use less that 45 kWh/m² annually for heating, domestic hot water, and building electricity, which is a more aggressive requirement than the City generally demands of new buildings on municipal land. As a way to accumulate experience and evaluate what further steps they might take to build more sustainably, they set the bar even higher for the Transistorgatan Preschool, aiming for a zero-energy building—one that produces just as much energy over the course of a year as it uses. To achieve that they created an energy-efficient building with low usage and complemented it with energy-generating solar panels on the roof.

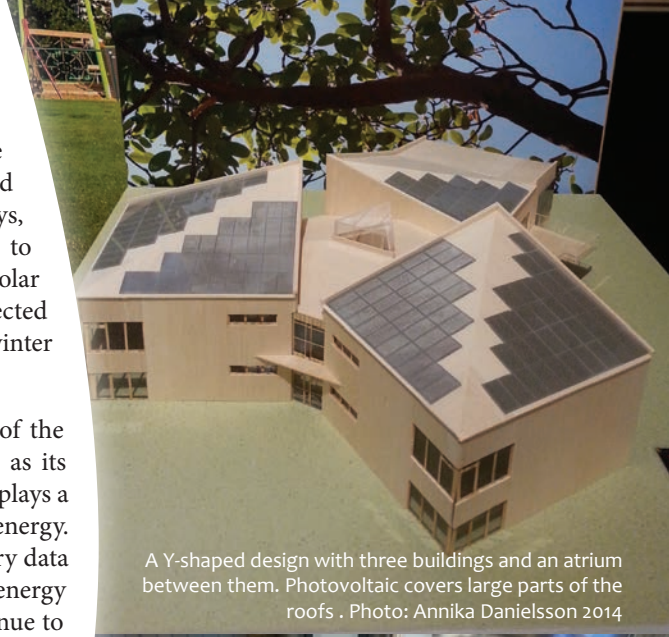
The school's final Y form comprises three two-story building volumes grouped around a covered atrium. The form first came up in a preliminary study that showed it to be an energy-efficient configuration with relatively little façade surface compared to the floor area. The exterior walls are 600-mm-thick insulated concrete sandwich panels. Their thickness, together with the solar panels, the heat recovered from a mechanical system with heat exchanger, and the form of the building all contribute to achieving the zero-energy goal. The preschool has a large entrance with a stair hall that serves as a big air lock to keep out cold drafts. It has turned out to be better from an energy performance standpoint than having several small air-lock entries, which often end up being propped open in practice. In addition, the waste energy from the commercial kitchen's refrigerators and freezers is recovered to preheat the radiator system. The zero-energy calculus includes energy for heating, hot water, and operating pumps and fans, but not school activities such as electricity for the kitchen, computers, and lighting. On the other hand, they try to minimize the energy used on these things with induction cooktops, daylight-adjusted lighting, and a drying room with a dehumidifier instead of a dryer.

Lokalförvaltningen also wanted it to be as beneficial for the environment as possible—to minimize its overall carbon footprint. That led to a systems approach to decision making that weighed in the climate impacts of different forms of energy and the time of day each would be used. For the hot water system and extra heat on cold winter days, they installed hydronic radiators and radiant floor heating linked to the municipal district heating network. A geothermal system and solar collectors in combination with a heat pump were also discussed, but rejected because they use electricity to produce heat, and needed it mostly in winter when 'dirty power has to be imported.

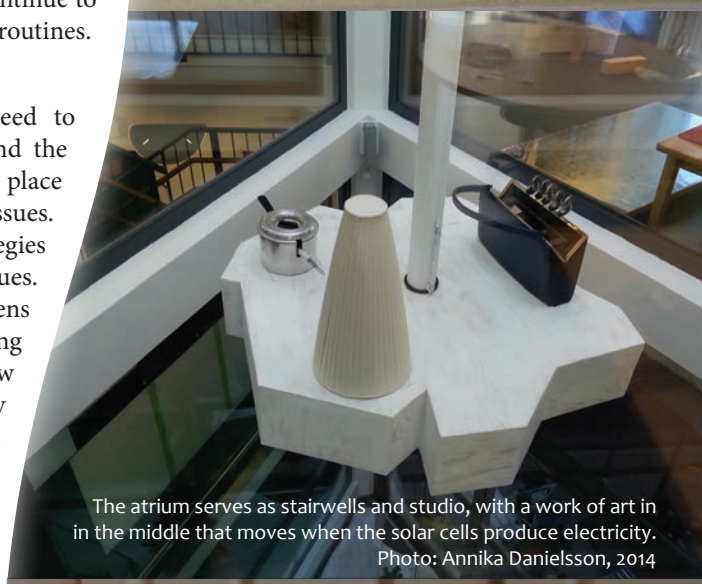
One energy issue that also has been explored is the climate impact of the materials in terms of embodied energy. Lokalförvaltningen sees this as its next step in minimizing its climate impact, since the embodied energy plays a relatively larger role as efficiency measures reduce the use of operating energy. The building has only been in use since the fall of 2013, and preliminary data from autumn 2014 indicates that the solar panels are producing more energy than anticipated. Photovoltaics is a technology that they want to continue to deploy, but they need a written technical specification of operating routines. The energy use in the commercial kitchen also needs to be reduced.

COMMUNICATION: To achieve a sustainable society we need to generally increase the level of knowledge about sustainability, and the Transistorgatan Preschool is making a contribution there. It's a place where from an early age children become accustomed to energy issues. To support their understanding of energy, two visualization strategies are developed that will make it easier to teach kids about energy issues. In the atrium there is an artistic installation with cutlery and screens that move as the rooftop solar panels generate electricity. In the dining hall hangs a digital board that shows an easy-to-understand slideshow for children about energy, as well as tracking the building's energy use and production. The slide show was developed by experts in technology and education, and shows things like the school's relationship to the sun, which is sometimes covered by clouds, and a circular diagram of its electricity generation that begins to shine when the building is producing electricity. The preschool staff sees the building as supporting their work in teaching about energy and environmental awareness. The idea is for kids to be able to follow the building's energy use, come up with their own ideas about how to minimize it, and discuss why they need more energy in the winter and why they can sell electricity.

Lokalförvaltningen has ideas about further developing the slideshow to include small assignments for the children, similar to the system their building manager works with today. For example, when there is a change in the normal energy use, an alarm can alert the children to check if any windows or doors have been left open. Using these visualizations and working thematically with energy in preschool, the goal is to inspire and help the kids to learn about sustainable energy use and behavior from a very early age—behavior they will hopefully bring home to their parents.



A Y-shaped design with three buildings and an atrium between them. Photovoltaic covers large parts of the roofs . Photo: Annika Danielsson 2014



The atrium serves as stairwells and studio, with a work of art in in the middle that moves when the solar cells produce electricity. Photo: Annika Danielsson, 2014

In the preschool , the children learn about energy use and energy production through the building. Photo: Preschool

Reflections About Future Development

A Lot Has Happened in the Last Ten Years

Today more aspects of sustainability are being addressed than ten years ago, when most of the focus was on environmental issues, and technical systems in particular. Environmental aspects, and especially energy efficiency, are now being treated in a more comprehensive way, and today sustainability issues are addressed from a broader perspective that includes social and economic aspects as well.

When it comes to environmental aspects, passive house strategies are being applied to multi-family residential buildings, preschools, and renovation projects, while a decade ago they were only being used on newly constructed row houses and single-family homes. Various certification systems are being used with increasing regularity, which is indirectly leading to better documentation and more systematic development of knowledge on environmental issues. Social aspects have achieved a more prominent position. They are being addressed throughout the entire process, from the initial idea to their use in buildings. Examples include alternative housing forms such as cooperative rental apartments and compact and resource-efficient homes. Several projects have applied a more farsighted economic perspective. As a professional group, the number of consulting engineers with environmental expertise grew to maturity by about 2004. Now there is a need for more skilled operations engineers to manage all the new technical systems being installed in energy-efficient buildings.

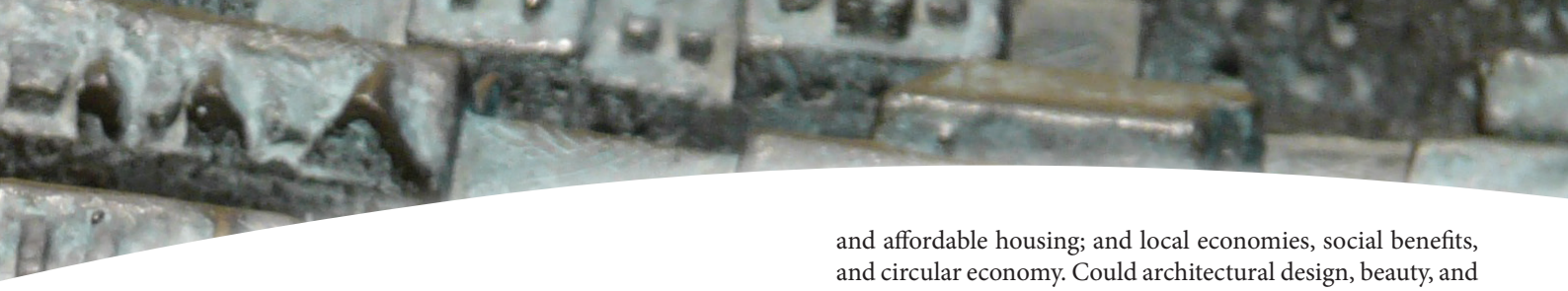
The most prominent features of sustainable construction are still the environmental aspects, and energy issues in particular. This is reflected in our own work, with nearly all the projects presented here checking the box for energy in the table on page 11. It is an important aspect, but it's also important that we don't forget the other aspects of sustainable construction.

A Shift in Knowledge Is Underway, but...

We have tried to find examples that cover as many aspects of sustainability as possible covering the environmental, social, and economic perspectives, while representing a mixture of various types of projects. However, most of the examples are newly constructed residential buildings. We hope to see more renovation projects in the near future.

It is worth noting that none of the examples presented here are from before 2006. Were none of the projects executed between 2003 and 2006 interesting enough? Or is it rather that there were good projects throughout the decade, but the more recent projects have become so advanced that the earlier ones are no longer representative of the leading edge in the field?

The case studies in this booklet stand at the forefront in certain aspects, or stand apart in some other way, but none of them takes every aspect to a new level of sophistication—which would be very difficult indeed. We can't all be great at everything, but everyone can be great at something!



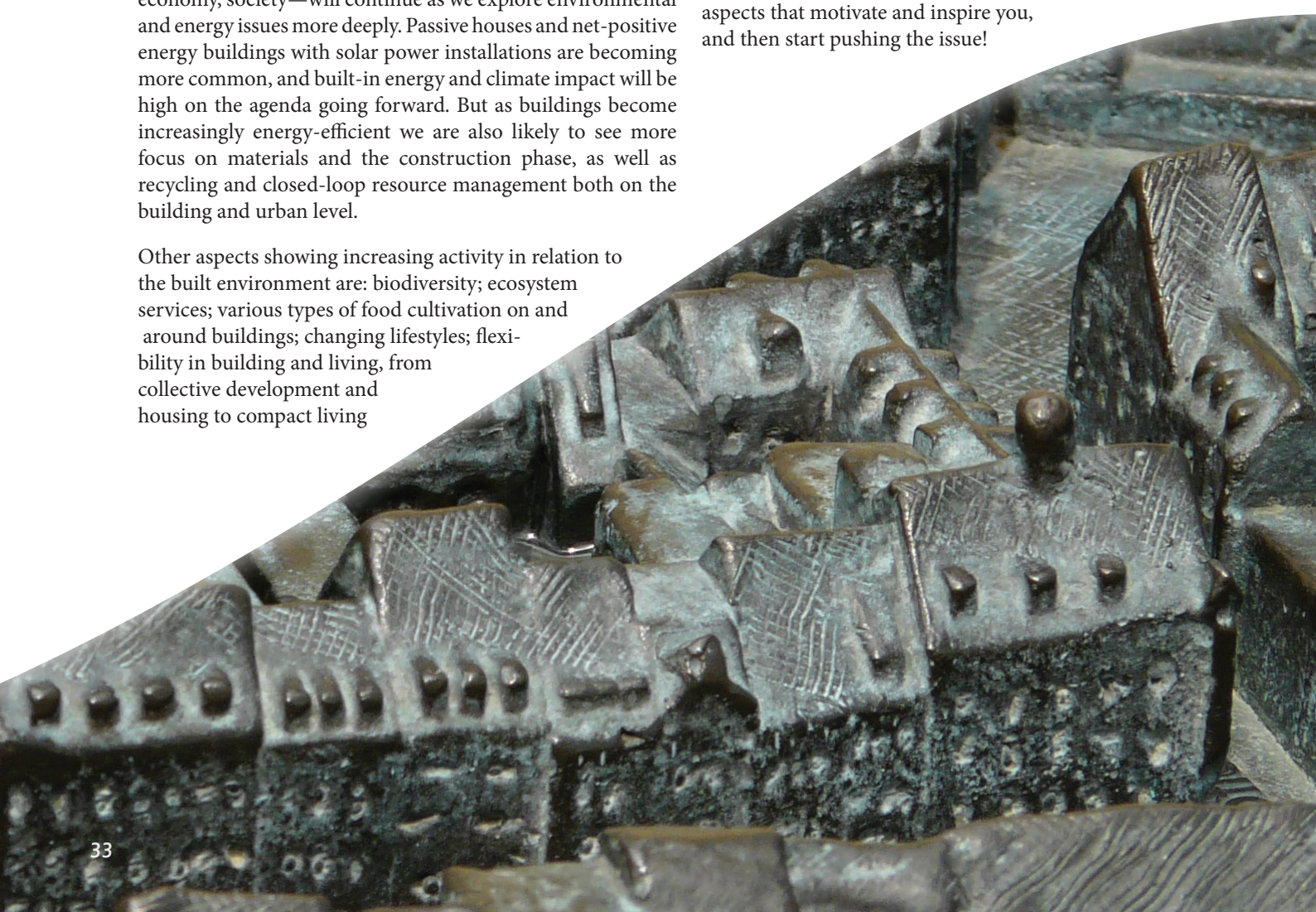
There are also aspects of the field that haven't been discussed in this booklet, including concepts such as resilience, biomimicry, cradle to cradle, and regenerative design. These concepts are increasingly discussed in projects initiated or completed after 2013. We believe that development has a lot to gain by applying all of these concepts. But it's also about values, attitudes, and approaches.

What Comes Next?

The work of integrating the three dimensions—environment, economy, society—will continue as we explore environmental and energy issues more deeply. Passive houses and net-positive energy buildings with solar power installations are becoming more common, and built-in energy and climate impact will be high on the agenda going forward. But as buildings become increasingly energy-efficient we are also likely to see more focus on materials and the construction phase, as well as recycling and closed-loop resource management both on the building and urban level.

Other aspects showing increasing activity in relation to the built environment are: biodiversity; ecosystem services; various types of food cultivation on and around buildings; changing lifestyles; flexibility in building and living, from collective development and housing to compact living and affordable housing; and local economies, social benefits, and circular economy. Could architectural design, beauty, and sentimental value become more important than monetary value? It would be interesting to see guidelines in the future that include qualitative as well as quantitative metrics.

It is important that the stakeholders in the process have the awareness, ambition, initiative, and communication skills needed to motivate and inspire. Every place is unique in its specific conditions and the stakeholders involved. The challenge is to embrace the best practice principles and try to adapt and apply them to each project. Do you want to be part of taking the next step in building for sustainable development in Gothenburg? Make the decision to find the aspects that motivate and inspire you,
and then start pushing the issue!



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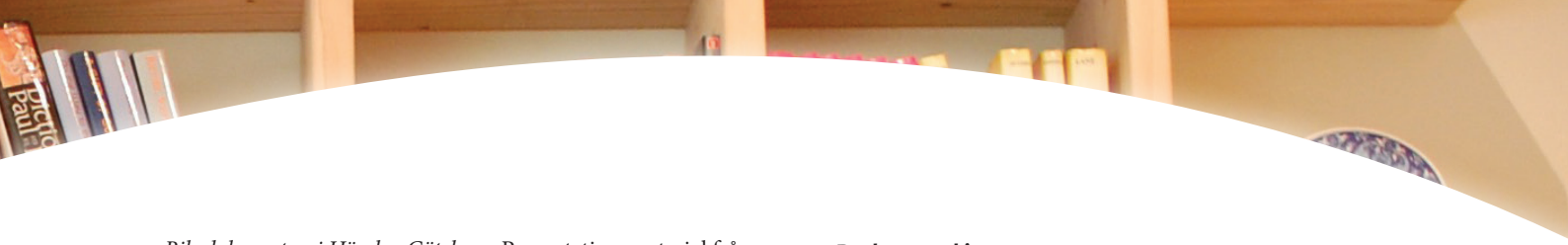

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Background images

Front page: collage of images appearing in the booklet
Page 1, BiG / Kornet: Annika Danielsson 2014
Page 1, Harbor House: Annika Danielsson 2014
Page 1, Katjas gata: Johan Twedberg 2009
Page 1, Brogården: Pernilla Hagbert 2014
Page 2, Trekantsgatan: Fredrik Augustsson 2013
Page 2, Clean green: Annika Danielsson 2014
Page 2, Riksdalersgatan: Krister Engström 2012
Page 2, 17: David Relan, 2013
Page 3, Utsikten Ecovillage: Liane Thivander 2014
Page 3, Transistorgatan preschool: Wahlström & Steijner i.d.
Page 4-5, Artur Czyżewski Interactive Agency 2013.
Page 8-9, Älvsborgsbron: Annika Danielsson 2009.
Page 10-11, Annika Danielsson 2013.
Page 32-33, Hans Braxmeier 2012.
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CHALMERS