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Brogården, Sweden

Case Study 64

Skanska Sweden used passive house techniques to refurbish rundown apartment buildings in Brogården, Alingsås, Southern Sweden, into modern and energy efficient homes.

Aspects of Sustainability

This project highlights the following:

Social Aspects

Human Resources
Corporate Community
Involvement
Business Ethics
Health and Safety

Environmental Aspects

Energy and Climate
Materials
Ecosystems
Local Impacts

Economic Aspects

Project Selection
Supply Chain
Value Added



“Through the retrofit the buildings in Brogården have been granted a new, sustainable life. The success factors have been a sustainable and holistic approach and a work process where people with many different skills have contributed to the end result.”

Ing-Marie Odegren, CEO of AB Alingsås shem.

Project Introduction

Brogården is a residential area in Alingsås that consists of 299 apartments in 16 three-storey buildings. The neighborhood was originally constructed between 1971 and 1973 as part of the “Million Program” in Sweden. The program involved the construction of one million new homes in ten years to raise housing standards and meet an acute housing shortage. However, 35 years later the Brogården apartments were in a poor state of repair with crumbling brick facades and poor insulation, which caused drafts and low indoor temperatures. The apartments also had dysfunctional ventilation systems and were not considered suitable for elderly residents due to the poor indoor environment.

Skanska is refurbishing the Brogården apartments between 2008 and 2013 for the public housing company, Alingsås shem, as part of a project worth around US\$ 55 million. The project involves the extensive renovation of the buildings with passive house

techniques, and includes the installation of new façades and roofing, thicker insulation and new ventilation systems. Each building is protected during construction by a plastic case to prevent moisture damage and ensure construction quality. The redevelopment of each apartment building takes around 8 months to complete and two or three projects are conducted simultaneously to ensure that the renovation of all 16 buildings will be completed by 2013.

The Brogården apartments were redeveloped with passive house techniques. The buildings do not use conventional heating systems and require very little energy for space heating. Under normal conditions the apartments are sufficiently warmed by the heat generated from human occupants, electric lighting and domestic appliances. The apartments are more airtight and better insulated than conventional buildings, and are equipped with highly efficient heat recovery ventilation systems. The Brogården project won the 2014 Sustainable Energy Europe award in the “living” category.

Contributing Toward Sustainable Development

The Brogården apartments are energy efficient and source what little heating they require from a renewable district heating system. The apartments were also redeveloped to be more functional and flexible, and to promote high quality indoor environments for residents. Skanska developed the project in close cooperation with the client and other project partners as the project progressed to promote innovation. Skanska also educated project partners throughout the project and public study visits were arranged to raise awareness of energy efficient housing renovation projects. The Brogården residents were kept informed of the project progress and the construction team worked to minimize disturbance for local residents. Local workers and subcontractors were prioritized for the project and the entire project team abided by high standards of health and safety. Environmental impacts were minimized during construction and waste was recycled off site.

Social Aspects

Project partner collaboration

Skanska developed the project in partnership with Alingsås shem as part of a 5-year collaboration. All major project partners, including the plumbing, electrical and ventilation contractors, were involved from the planning stages to allow them to contribute to the project with their expertise. The project team also shared experience from the project by documenting and discussing progress



and potential design improvements to promote innovation as the project progressed. Following the first project stage, the team organized a two-day study trip to a manufacturing plant to investigate how the factory management constantly analyze and improve processes. The study trip was followed by a half-day seminar for the team to document their experience from the first project

stage. Skanska worked with project partners and material suppliers to improve the ventilation system and wall structure following the seminar.

Stakeholder communication

Communication with Brogården residents was a vital component of the project as the redevelopment involved relocating residents to temporary accommodation whilst their apartments were renovated. A monthly newsletter was established in cooperation with Alingsås shem and the residents association to keep Brogården residents informed about the redevelopment. The newsletters provided information such as the project schedule and construction updates for specific buildings, and were accessible on Alingsås shem's website. A show apartment was created in the first completed building, which allowed Brogården residents to visit and understand how their apartments were to be redeveloped. The show apartment was also used for project study visits and as a meeting place for project partners.

Occupational health and safety

There had been no serious accidents on site as of November 2009 and the Lost Time Accident Rate was zero. The construction team followed the safety procedures of all project partners. An electronic ID reporting system was used on the project, which recorded who was on site at any given time and ensured that only authorized personnel that have completed their safety introduction could enter the site.

Reduced public disturbance

The Brogården buildings are arranged around central gardens, which were designated off limits during the construction project to preserve the gardens and to minimize disturbance for the surrounding buildings. All site deliveries were made to the rear of each building and site offices, a project canteen and storage rooms were temporarily established in buildings under renovation to avoid constructing outdoor structures and causing disturbance.

High quality indoor environments

The redeveloped Brogården apartments incorporate passive house techniques and are superinsulated, which provides comfortable indoor environments with a constant temperature throughout the year of around 20 °C. Each apartment

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has its own fresh air ventilation system, which ensures good air circulation by removing stale indoor air from the bathrooms and kitchens and introducing fresh outdoor air into the bedrooms and living rooms. Good indoor air quality was also promoted by incorporating low-VOC and non-toxic materials into the project that were checked against Skanska Sweden's chemical substance database.

Constructing functional and flexible buildings

The apartments are designed to be functional and flexible to better meet the needs of various households now and in the future. None of the buildings had elevators prior to the redevelopment, but now around 60 percent of the apartments have elevator access. The steps at the entrances of each building were also replaced with a slope to improve accessibility. Designated indoor storage spaces for prams and wheelchairs have also been added, and more modern kitchen layouts and larger bathrooms were incorporated to meet the needs of modern households. The apartments have the latest IT infrastructure and every room has a socket that can be connected to a telephone, TV or computer to allow various room uses and apartment layouts. The apartments were almost all identical prior to the project and Skanska has increased the variety of apartment types to offer more choice and individuality for residents.

Raising awareness of energy efficient housing

The Brogården buildings were the first apartments from the Million Program to be renovated with passive house techniques. The project has consequently been the subject of intensive media attention in Sweden, as there is huge potential to

renovate similar apartment buildings from the Million Program. Over one hundred articles had been written about the project even before construction work began. A series of study visits were held during the project, the first of which involved over 200 participants. The King of Sweden, Carl XVI Gustaf, and the Swedish Prime Minister also visited the project in 2008 to learn about the huge potential for using passive house techniques to renovate energy inefficient buildings in Sweden.

Sustainable urban planning

The Brogården residential area is situated around 1 km from the town center of Alingsås's and is close to a range of public services and amenities. As part of the Brogården refurbishment project, the neighborhood is being improved for residents by making the area more child-friendly, creating communal meeting places and further improving access to shops and amenities. The area also has extensive cycle provision and good access to bus routes.

Economic Aspects

Local workers and subcontractors

There were around 40 workers involved in the project, including 15 Skanska personnel and 25 subcontractors. Most of the project staff came from Alingsås's and the rest from within 30 km of the site. Local subcontractors included the plumbing contractor, which was a local company from Alingsås s, and the electrical contractor, which was a national company with an office in Alingsås.

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Regional construction materials

Many of the construction materials were sourced from the surrounding region, which benefitted the regional economy and reduced transport emissions. Regional construction materials included insulation from Skövde, around 120 km from the site, and the majority of the timber used on the project, which was sourced 30 km from the site.

Vocational training

The entire project team participated in a training day prior to construction that covered all aspects of the project and included passive house training. During construction the team stopped work at various stages to educate the workforce on specific aspects of the project. Skanska also held a training course that explored the potential for low energy buildings that are capable of generating their own energy. Students from Chalmers University in Gothenburg were involved in the project as part of their dissertation work to investigate construction cost comparisons and the production aspects of passive house techniques.

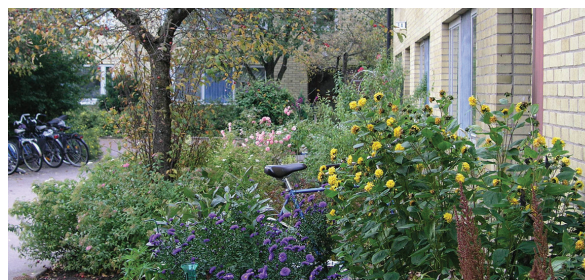
Financial savings due to energy efficiency

The Brogården renovation project cost around 25 percent more than a conventional renovation project due to the passive house techniques used. However, the refurbished Brogården apartments consume around 75 percent less energy in total than prior to the redevelopment and enable occupants to make significant financial savings throughout the life span of the buildings. Alingsåshem negotiated a rent increase of US\$ 40 per m² with the Brogården residents, which will ensure that the investment for the redevelopment is repaid between 6 and 10 years. The new apartments are also equipped with individual water and electricity meters, which enable residents to monitor and control their resource consumption and make further financial savings. The Brogården residents paid a flat fee for electricity and heating prior to the refurbishment and had no incentive to reduce energy consumption.

Environmental Aspects

Minimizing environmental impacts during construction

The Brogården construction site was certified according to Skanska's internal Green Workplace (Grön Arbetsplats) environmental management



system, which is aligned with Skanska Sweden's ISO 14001 certification. The system surpasses Swedish building regulations in terms of emission standards for site machinery, the use of energyefficient construction lighting, requirements for chemicals and waste management. Energy use is also continuously monitored during construction and waste is avoided by providing tap water rather than bottled water to the team.

Waste recycling

Waste was sorted on site into different streams and around 85 percent of construction waste was recycled to avoid landfill. Around 25 percent of waste was reused off site as fill material and 5 percent of the waste materials were recycled as metal. Wood waste and other combustible waste, which accounted for around 20 percent and 35 percent of the waste respectively, were sent to the local district heating plant to generate energy. The Brogården project also promoted resource efficiency by recycling and reusing existing buildings rather than constructing entirely new buildings.

Energy efficient housing

The Brogården renovation project has reduced the average total apartment energy consumption by 75 percent and the energy used for heating by almost 80 percent. The apartments have been made airtight with plastic sheeting and superinsulated with thick insulation. The walls are insulated with around 440 mm of polystyrene, mineral wool and insulating board, compared with 100 mm of insulation prior to the redevelopment. The walls now have a total thickness of 520 mm including the façade. The walls have a u-value of between 0.11 and 0.095 W/m²K, compared to around 3.0 W/m²K prior to the redevelopment and around 0.22 W/m²K for an average Swedish new build. The roof has between 400 and 550 mm of insulation, which is 100 to 200 mm more than a conventional Swedish building. 140 mm of insulation was added to the existing foundations of the apartments to provide a u-value of 0.2 W/m²K. Insulated doors and xenon gas-filled triple glazed windows with an average u-value of 0.85 W/m²K or

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lower have been used. Windows with less than 1.2 W/m²K are considered to be energy efficient in Sweden.

The old balcony concrete bases were removed as they were connected to the apartment floor and acted as thermal bridges that removed heat from the apartments. New balconies were hung from the external wall to prevent thermal bridges and minimize the potential for heat loss. The newly insulated walls also have minimal thermal bridges. New heat recovery ventilation systems were installed, which recover around 85 percent of the energy from outgoing air. The ventilation systems can also provide additional heating, which is supplied by an efficient wood-fuelled district heating system. The system is required up to 10 days per year. Alingsåshem also installed energy efficient domestic appliances in the apartments.

Water efficiency

The apartments have been equipped with low flow toilets and fixtures and hot water is individually metered. Such measures have decreased water consumption by around 15 percent compared with before the project and Alingsåshem intend to monitor water efficiency in the future.

Durable building materials and techniques

Natural clay freeze-resistant bricks replaced the crumbling brick façades. The clay bricks will better withstand the weather than the old façade and single bricks can easily be replaced if they become damaged, which avoids the need to replace an entire façade. The foundations have been protected

against moisture damage as they were susceptible to damp prior to the redevelopment. The roofs have also been reconstructed and strengthened to cope with heavy loads of snow.

Renewable heating

The buildings are connected to the Alingsås district heating system, which provides heating for domestic hot water and supplementary space heating when required. The district heating system is 99.5 percent renewable and is primarily fuelled by wood pellets.

Reducing carbon dioxide emissions

The Brogården project has reduced carbon dioxide emissions by halving the total energy consumption of the buildings. The apartments annually consume around 120 kWh/m² less than prior to the redevelopment, which equates to a carbon dioxide saving of around 22 kg/m² per year (not adjusted to local energy generation).

Learning From Good Practice

Brogården is the first multi-family dwelling in Sweden to be renovated using passive house techniques. There are around 400,000 apartments from the Million Program in Sweden, which are similar in design to the Brogården apartments and are characterized by dilapidation and energy inefficiency. There is huge potential to use passive house techniques to redevelop these and other apartment buildings from the Million Program as well as similar buildings outside Sweden.

