



Passive house-concept apartments: sustainability evaluation in a case study of Stockholm, Sweden



Image: Blå Jungfrun energy efficient apartment project in Stockholm, 2010
(Source: 4)



Keywords:

- Sustainable urban housing
- Passive house
- Energy evaluation
- Economic viability
- Social inclusion
- Sustainable development goal 11 (SDG 11)



What?

The objective of the study has been to describe and analyze a pioneer apartment complex and passive house standard residential development in Stockholm, Sweden. The analyses is based on the case study of Blå Jungfrun passive house-concept project in Stockholm.

Why?

Global warming, climate change, increasing energy costs, and decreasing resources availability are among the reasons, which have caused a focus on the building of environmentally friendly houses.

How?

By applying Case study method and through a blend of qualitative and quantitative research methodology; interview study, the economic evaluation software OekoRat, and post-occupancy evaluations for the annual energy requirements of the apartments.



In June 2006, the Swedish government stated a goal, to reduce the energy consumption in buildings with 50% until the year 2050 [1].

Swedish passive house definition

Forum för Energieffektiva Byggnader (FEBY) Passivhus defines passive houses as:

“Low energy buildings that aim to perform better than new built buildings regulated in BBR 16 (BFS 2008:20)” [2].

Earlier experiences of Swedish passive house projects:

In Växjö and Färgelanda (1981)

In Göteborg, Lindås project (2001)

Blå Jungfrun energy efficient apartment project in Stockholm

- It is a passive house standard residential development with a total of 97 rental apartments.
- The planning phase of the project started in October 2008 and tenants moved into the buildings during the second and final quarter of 2010.
- Development type consists 4 blocks of 5 and 6-storeys high.

The amount of energy consumption

After the first year of the tenants' occupancy of the apartments, the amount of energy consumption was calculated by the housing company. The calculations showed that the energy consumption for heating has been reduced around 85% in comparison to the standard of BBR, legislation 2009 [3].



Image 2: Blå Jungfru project (Source: 4)

Energy consumption per year

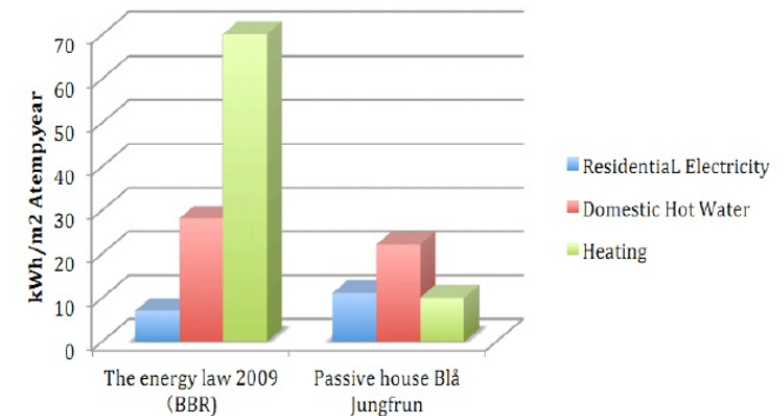


Image 3: [3]



Energy requirements of the Blå Jungfrun passive apartments

Table 1. The measured energy requirement of Blå Jungfrun passive houses for 2011 (Source: 4)

Residential electricity	9 kWh/m ² a
Heating ventilation and VVC (district heating) & Dehydration of concrete (electricity or district heating)	19 kWh/m ² a
The heating electric radiators	4 kWh/m ² a
The warm water (apartments and laundry)	27 kWh/m ² a
The household and laundry electricity	33 kWh/m ² a

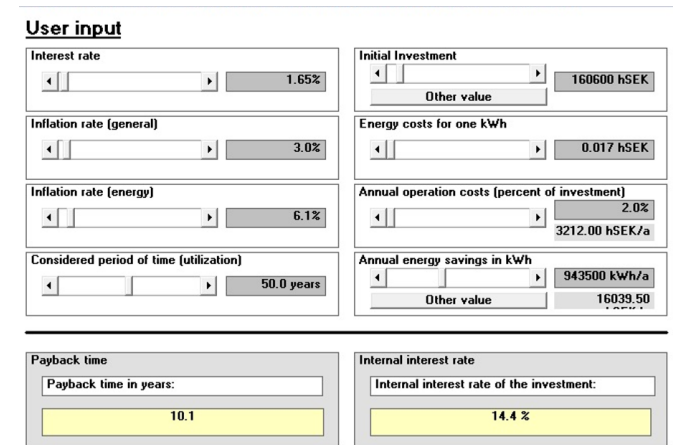
Considering the Swedish criteria for energy consumption, the maximum amount of energy demand for passive apartments (excluding household electricity) is recommended not to exceed 45 kWh/m²a in Southern climate zone of Sweden [5]. Therefore, the measured value of 59 kWh/m²a for Blå Jungfrun in 2011 has not been within the Swedish criteria of the passive houses.

Economic evaluation of the Blå Jungfrun passive apartments

The additional costs of constructing passive houses are invested in energy-efficiency quality of these buildings and are supposed to be paid back through the annual energy savings of passive house during its lifespan.

The main factors that affect economic aspect of the passive house are considered as [6]:

- Initial investment costs
- Annual energy saving
- Energy costs
- Annual operation costs
- Considered period of time (Utilization of building)
- Interest rate
- General inflation rate
- Energy inflation rate



User input

Interest rate 1.65%	Initial Investment 160600 hSEK
Inflation rate (general) 3.0%	Energy costs for one kWh 0.017 hSEK
Inflation rate (energy) 6.1%	Annual operation costs (percent of investment) 2.0% 3212.00 hSEK/a
Considered period of time (utilization) 50.0 years	Annual energy savings in kWh 943500 kWh/a 16039.50
Payback time Payback time in years: 10.1	Internal interest rate Internal interest rate of the investment: 14.4%

The economic evaluation of Blå Jungfrun passive houses in software Oeko-Rat (Source: 4)

Table 2. Factors of economic efficiency for the Blå Jungfrun passive apartments (Source: 4)

Considered period of time	Payback time	Interest rate	Internal interest rate of the investment	Result
50 years	10.1 years	1.65 %	14.4 %	Economic



Specific design aspects of Blå Jungfrun project

Architectural effect and form

Large south-facing balconies

Placement of windows





Tenants of the buildings

Tenants have answered to evaluation questions of the project and they have declared that they are more concerned now and they think more about environmental questions.

However

When these answers and results are compared with the post occupancy energy statistics, it is seen that tenants **have not reduced** the energy consumption.

Although

The energy efficiency awareness of the residents is achieved by installing Smart box for each apartment unit in order to provide energy consumption feedback to tenants.

And tenants know they have to pay for warm water and extra heating that they consume, separate from the reduced rent amounts of the apartments.



Concluding remarks

Involving end-users was never an option in Lindås project (2001) and in a study done on operation phase of that project it was concluded that in developing the next generation of low energy buildings, an interdisciplinary planning that takes the experiences of occupants as well as measurements into consideration is very important [7].

The Blå Jungfrun passive apartments are constructed in Stockholm in 2010 and still the residents are disconnected from the planning phase of the project.

The results of the post-occupancy evaluation forms of the tenants and the results of the energy statistics of the project revealed that the tenants have expressed their sustainability awareness intentions; however they have not acted in an environmentally sustainable manner.

One major problem with housing policies can be that the housing sector is dominated by a “**techno-centric** (top-down policy recommendations)” approach, while the “**eco-centric** (public participation and community involvement)” approach can result in more beneficial outcome [8].



Concluding remarks

The findings of this study show that the environmental, economic, and social aspects of the passive house are closely intertwined.

Energy consumption reductions in buildings mean substantial changes in patterns of energy consumption in buildings with improvements in all environmental, economic, and social aspects of sustainable buildings.

Housing design that does not take into consideration the participation of its inhabitants, cannot be sustainable in long-term.

When bottom-up approaches are not applied to urban housing development and planning, sustainable housing, which contributes in SDG 11 is not achieved even through constructing low-energy buildings.

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Thank you for your attention