

# Evaluation of indoor environment quality in Norway's first Passive House School

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## 1 Introduction

It is many years since the Passivhaus concept was developed by Dr. Wolfgang Feist at the Passivhaus-institut in Germany. There are now many Passivhaus buildings, especially in Germany and Austria. In Norway, the situation is a bit different. Low energy buildings have been in focus for a while, but interest in the Passivhaus concept has appeared only recently. In 2010 the Norwegian passive house Standard for residential buildings was published, and there is an upcoming standard for commercial buildings.

Marienlyst School is the first school in Norway built to meet the Norwegian Passive House definition, with a net annual heating demand below 15 kWh/m<sup>2</sup> (Dokka et al 2009). The school was taken into use in 2010 and is situated in the city of Drammen, near Oslo. It is a junior high school with 8<sup>th</sup> -10<sup>th</sup> grade students. The school has about 470 students and 50 employees.



Figure 1: Marienlyst junior high school

## 2 Methods

The indoor environment quality at Marienlyst junior high School has been evaluated. The evaluation has an interdisciplinary approach with a survey supported by interviews and

physical measurements of indoor climate parameters like temperature, CO<sub>2</sub> and humidity.

The survey is based on the "Örebro model" and the MM questionnaire developed in Sweden about 30 years ago by Örebro University Hospital (Andersson 1993). The MM 040 SP1 questionnaire modified to Norwegian schooldays is used for the employees. As for the students, the questionnaire used is referring to the method developed by (Jerkø et al.2006). It is based on the Örebro model, simplified for easier understanding for and feedback from young students at schools in Norway. The reference material for this method is based on Norwegian studies.

The surveys were carried out in December 2011.

## 3 Results and Discussion

The student survey was presented to classes. 309 of 324 present students completed the questionnaire. This gives a response rate of 95,4%.

In the method developed by (Jerkø et al 2006), the questions in the questionnaire are grouped in 5 indexes. For every question the results are evaluated in a condition from 0-3, so also the indexes. Condition 3 is unacceptable, see table 1 for further explanations.

The main results are given in table 1.

Table 1: Explanation condition

Condition	Explanation
TG 0	Very good - no symptoms
TG 1	Fit for use -weak to medium symptoms
TG 2	Questionable - medium to strong symptoms
TG 3	Unacceptable

Table 2: Main indices

Index	Question	Mean School	Normal mean	Condition
Indoor environment related health symptoms	H1 - H12	29 %	28 %	1
Thermal climate	T1 - T5	21 %	21 %	0
Indoor air quality	T6 - T8	33 %	30 %	1
Noice quality	T9 -T13	25 %	23 %	1
Quality of light	T14 - T16, + T19	25 %	14 %	3

The indices show good results for all categories except quality of light. This include the questions *Is the light good enough at you workspace?*, *Are there reflections from the blackboard?* and *Is there annoying light from the sun?* The findings correspond with findings in the question in *Is there annoying heat from the sun?*

All questions above are given condition 2. Given the comments from the students, this is caused by the shading not working properly. The question of overheating often addressed as a passive house problem is so far not confirmed. Regarding the condition for each question, the only one given condition 3 is static electricity. This is also commented by the students. Normally such problems are connected to floor covering used and relative humidity.

#### 4 Conclusions and further work

So far the results show no more problems in a Passive House School then in a normal school. And there are no indications of overheating. The results are still being analysed in more details. Normally, working with the indoor environment surveys, we are looking for what is worse than normal. This time, evaluating a Passive House School, we are also looking for what is better than normal, and if there are some special focus areas typical for this kind of buildings. Results from the evaluation of this first Passive House School will be of great interest for researchers, building designers, owners and operators, and occupants. The knowledge may even influence on the Norwegian building codes.

Results of further analyses will be published in an article when ready.

#### 5 References

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- Anderson K. 1993. The MM-questionnaires – A tool when solving Indoor Climate Problems. Örebro Medical Center Hospital. Sweden.
- Dokka, TH, et al (2009): Kriterier for passivhus- og lavenergibygg – Yrkesbygg (In Norwegian: Criteria for passive houses and low energy buildings - non-residential buildings) Project report 42-2009. SINTEF Building and Infrastructure. ISSN 1504-6958, ISBN 978-82-536-1107-5.
- Jerkø,S., Mysen, M, et al (2006): *Skolemiljø for læring – veileder for skoleeiere. Om inn klima og helhetlig fysisk miljø* (In Norwegian: School environment for education – guide for building owners. About indoor air and overall physical environment). Project report 404-2006. Norwegian Building Research Institute, Norway. ISSN 0801-6461, ISBN 82-536-0924-8.
- Passivhaus Institut, [www.passiv.de](http://www.passiv.de)  
Passipedia, [www.passipedia.de](http://www.passipedia.de)
- Standards Norway: NS 3700:2010: Criteria for passive houses and low energy houses. Residential buildings. 2010. ICS 91.040.01;91.120.01
- Örebro model and MM questionnaire: Örebro University Hospital, Sweden. [www.orebroll.se/amm](http://www.orebroll.se/amm)