Indoor Environmental Quality og the first European ModelHome 2020

Home for Life

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Indoor Environmental Quality of the first European Model Home 2020 : Home for Life

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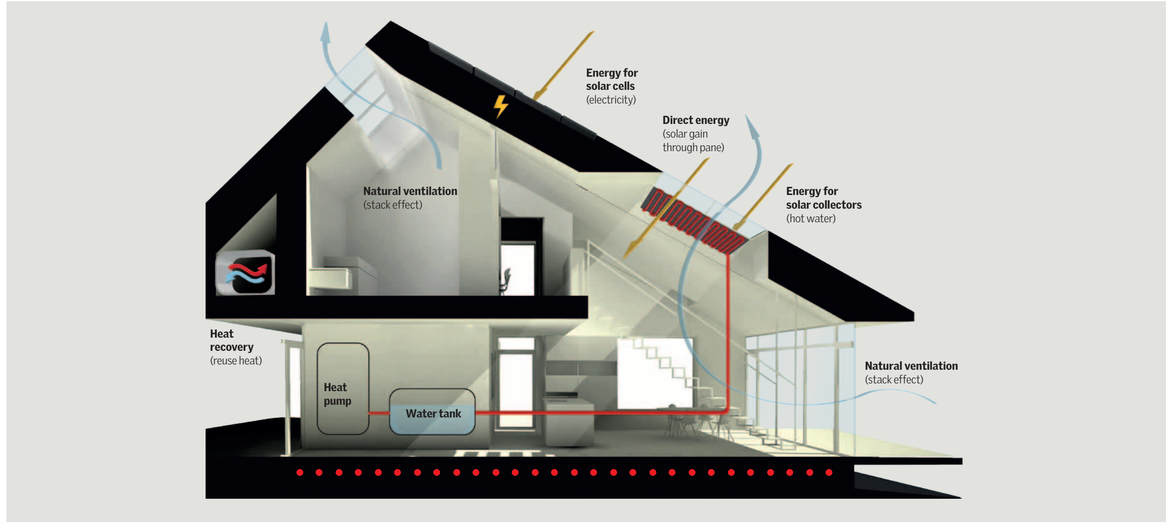
Introduction

Based on the Active House vision it was the intention to develop buildings that give more than they take by uniting carbon neutral buildings with good IEQ adapted to the surrounding environment. The ModelHome 2020 project was started as an extensive living laboratory to test the vision. The purpose of the project is to demonstrate different solutions and approaches to the challenge of combing a healthy and comfortable indoor environment with carbon neutrality. The project is unfolded through design and construction of six demonstration buildings in five European countries from 2009 to 2011.

We present measurements of the IEQ of the first realised ModelHome2020 through considerations and analysis of both quantitative and qualitative aspects. This first house, Home for Life, is constructed in Denmark and has been tested for a one year period by the Simonsen family.

"Home for Life". South facade

Photo: Adam Mørk



Daylight, ventilation and energy concept

Method

A mixed methods approach was used, which combine quantitative methods from natural and engineering science with qualitative methods from the artistic and humanistic sciences. The analysis focus on the main kitchen/dining room as this is representative for the results obtained, and is also the most used room of the house.

Results

Daylight

The daylight factor calculations show an average daylight factor (DF) above 5% in the main rooms on the ground floor and in most of the bedrooms at the upper floor. Especially the kitchen/dining room at the ground floor receives high daylight levels.

Through the semi-structured interviews the occupants verbalise the quality of having high daylight levels: "The best thing about the new house compared to the old is the daylight. The daylight is better" and "What characterizes the house is the huge intake of daylight – and that is what I want!"

The well-lit house influences the way the occupants use the electrical light and they experience using considerable less electrical light than in their previous house: "It is very obvious! We actually don't switch on the electric light. Of course we do it at night. When it becomes dark outside it is necessary, but we actually don't switch on the electric light much."

Thermal environment

When evaluated against EN 15251 the kitchen/dining room meets cat. III when both overheating and under heating is considered, while it meets cat. II when only overheating is considered.

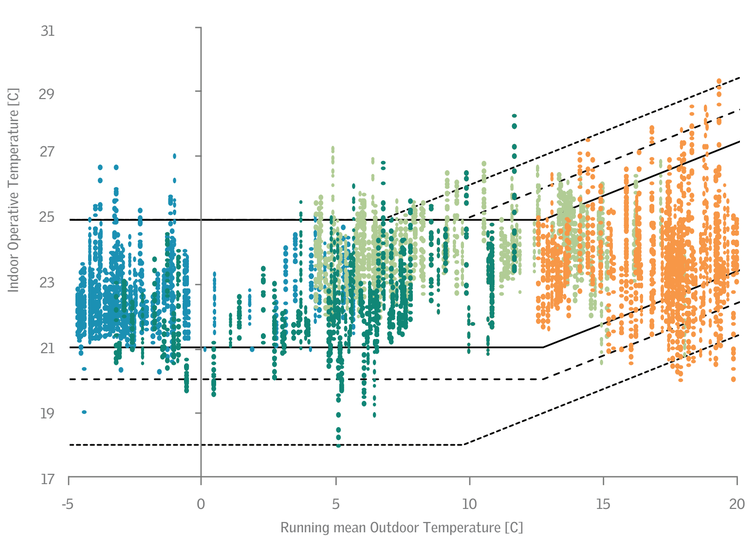
The family experiences large temperature swings relating to whether the sun falls directly into the house or not and express this experience as a deterioration of the indoor climate: "So temperature fluctuations are much more dependent on whether the sun or not is outside."

Indoor Air Quality

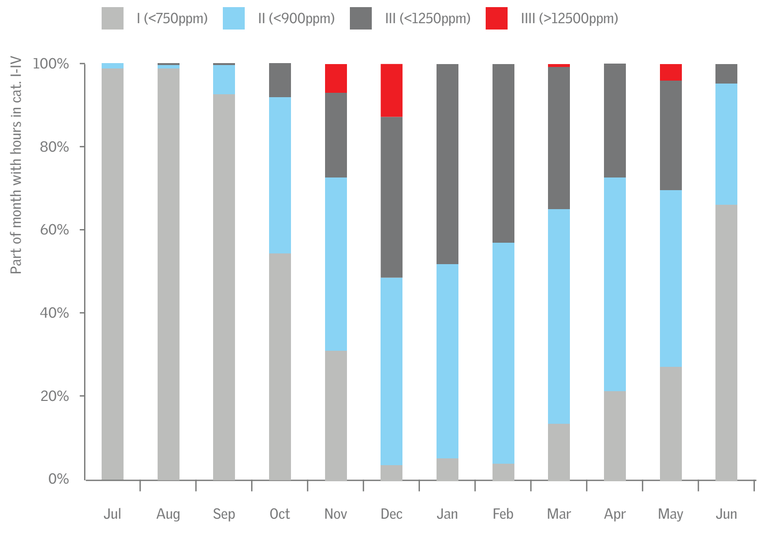
The CO_2-level is used as indicator of air quality. The CO_2 concentration in the kitchen/dining room was above 1200 ppm for 210 hours during the measured year. The kitchen/dining room meets cat. III of EN 15251. The natural ventilation scheme during summertime provides low CO_2 levels, whereas the CO_2 levels during wintertime were higher.

"There is much more CO_2 since we do not get aired out automatically. And it is clear that when I've been here and open doors, typically so you can see that the CO_2-level goes down. It improves the CO_2 levels." The quote illustrates how the family has developed a dependency of the information screen – they have a firm belief that the quantitatively measured CO_2-levels solely determine their health, but they are not able to judge if a specific CO_2 level is too high; they often react on a rising trend. They air out for long periods even though the change of air is not needed and has no effect regarding health.

Calculated daylight factor iso contours for ground floor (left) and upper floor (right).



Operative temperature in the kitchen/dining room depicted vs. outdoor temperature and comfort range limits according to the adaptive method of EN 15251.



Monthly CO_2-levels in the kitchen/dining categorised according to EN 15251.

Discussion

The adaptive evaluation approach of EN 15251 of thermal environment seems in accordance with the family's experience of the thermal environment. The building is free running during the summer time, as it is naturally ventilated, and the family could control solar shading and open windows on room level, giving them control over their environment, which generally contributed to increasing their satisfaction.

Results on thermal comfort show both some underheating and some overheating. The overheating occurred mainly in the spring period when the automatic external solar shading remained in "winter" mode, indicating that the family either trusted that the "system" was working correctly, or was unable to make efficient use of the shading. Another explanation could be that they simply enjoyed the elevated temperatures along with the light after a long Nordic winter, and preferred the view out. Their statements support the last explanation.

The calculations of daylight performance showed high daylight levels, and the occupants particularly expressed satisfaction with the daylight conditions in the house.

It is challenging to present the IEQ of a house through both quantitative and qualitative aspects due to the differences in their representation. Can a recorded quotation weigh as much as a measured number? Qualitative recordings provide insight into what the family actually liked and disliked in their house.

Poster for CISBAT, 14-16 September 2011, Lausanne, Switzerland