Maison air et lumière a case from model home 2020 project

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Maison air et lumière a case from model home 2020 project

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Good thermal comfort in new low-energy houses with large window areas

When energy upgrading existing houses, it is important to avoid pitfalls like e.g. overheating by involving experience gained from energy efficient new buildings. Maison Air et Lumière (**Figure 1**) is one of five European houses built as part of the Model Home 2020 project (see link below). The house was completed in 2011 and a family lived in it for a year. During that year of occupancy, detailed measurements of energy consumption and indoor climate were undertaken.

The house follows the Active House principles (see link below). This means that energy consumption, indoor climate and connection to the outdoor environment must be balanced. The calculated heating requirement for the house is 14.2 kWh/m². Special focus is on good daylight conditions and fresh air through natural ventilation. Most rooms have a daylight factor of above 5%. This in itself means a higher risk of overheating in summer than for older houses with less daylight and less insulation. The results shown here are from Maison Air et Lumière, but are also representative of the other houses of the Model Home 2020 project. In Maison Air et Lumière, ventilation is a hybrid solution. Mechanical ventilation with heat recovery is used during cold periods and natural ventilation in periods when the outdoor temperature is high enough to make heat recovery unnecessary – which is about 25-30% of the year. The ventilation is demand-controlled based on temperatures and CO_2 all year round.

To avoid overheating, the house has overhangs, automatically controlled external solar shading and controlled

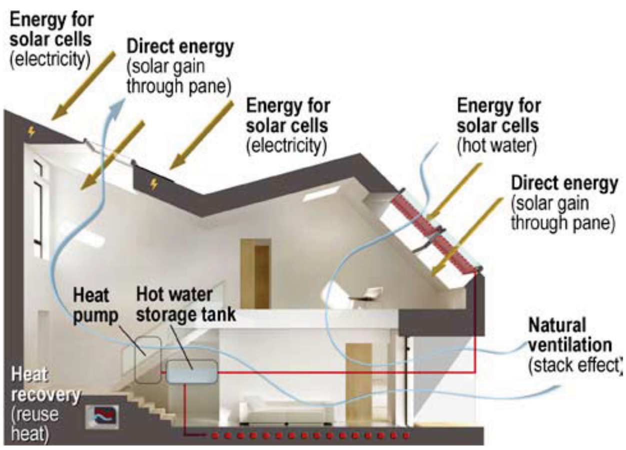

Figure 1. Maison Air et Lumière and its daylight, ventilation and energy concept. Architects: Nomade Architectes.

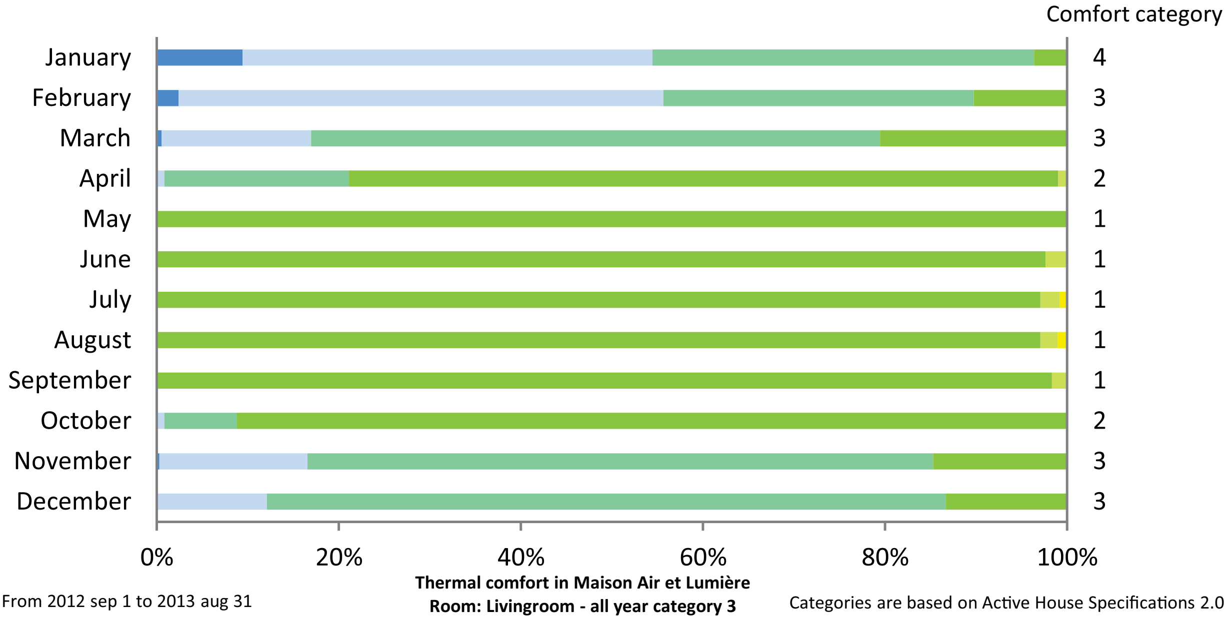

Figure 2. Thermal comfort categories for kitchen-dining room on a monthly basis. The categories refer to the Active House Specification. For the summer situation, category 1 allows a variation of +/- 2°C of the temperature around the optimal temperature, while category 4 allows a variation of +/-5°C. The figures at the right side of the diagram state a total category for each individual month. To obtain e.g. category 2, at least 95% of the hours in the period must be in category 2.

natural ventilation (ventilative cooling). The results are very positive. The Active House Specification, 2nd edition, is used for the evaluation; see REHVA Journal May 2013 pp 10 – 14 for a description of the criteria.

Figure 2 shows the monthly spread of thermal comfort in the room with the strongest inflow of light, i.e. the living room. During the summer months, the room was in category 1 with only a few hours in categories 2 and 3. In winter, the room is in categories 2 to 4. To obtain category 1 in winter, the indoor temperature must be above 21°C. The occupants themselves chose to have a temperature below 21°C.

Active use of natural ventilation (ventilative cooling) and solar shading played an important part in maintaining good thermal comfort in summer. Windows and solar shading were automatically controlled, but allowed the occupants to overrule it. **Figure 6** is a carpet plot showing every hour during the year as a coloured rectangle with date by the x-axis and time of day by the y-axis. The figure shows two things: 1) when the windows in the living room were open and 2) the category of thermal comfort.

The diagram shows to what degree natural ventilation has helped maintain an acceptable thermal comfort. As seen from **Figure 2**, there were some hours with temperatures below category 1, particularly in January, but also in February and March. **Figure 3** shows that windows were

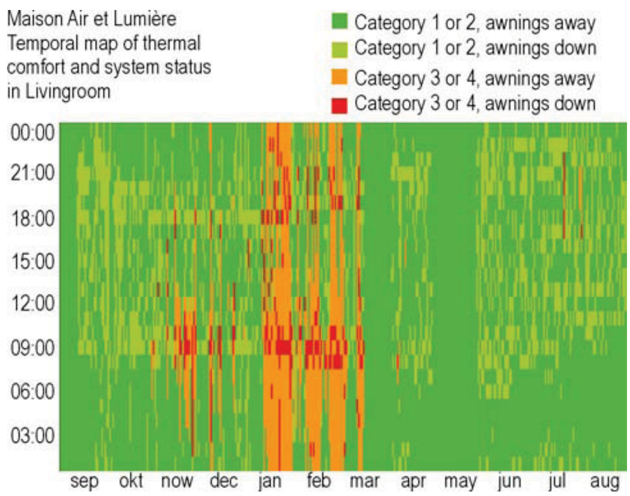

Figure 3. Carpet plot for living room showing comfort category in combination with window position (open or closed).

closed during these periods, so the reduced temperature was not caused by draught.

During daytime, the windows were open for a large part of the time from June to August. In this period, the windows were also open during the night in order to utilise night cooling; the windows were used 2–3 days per week, with an average use of four hours per night. In summer, there is a coincidence between periods with good thermal comfort and open windows. This indicates

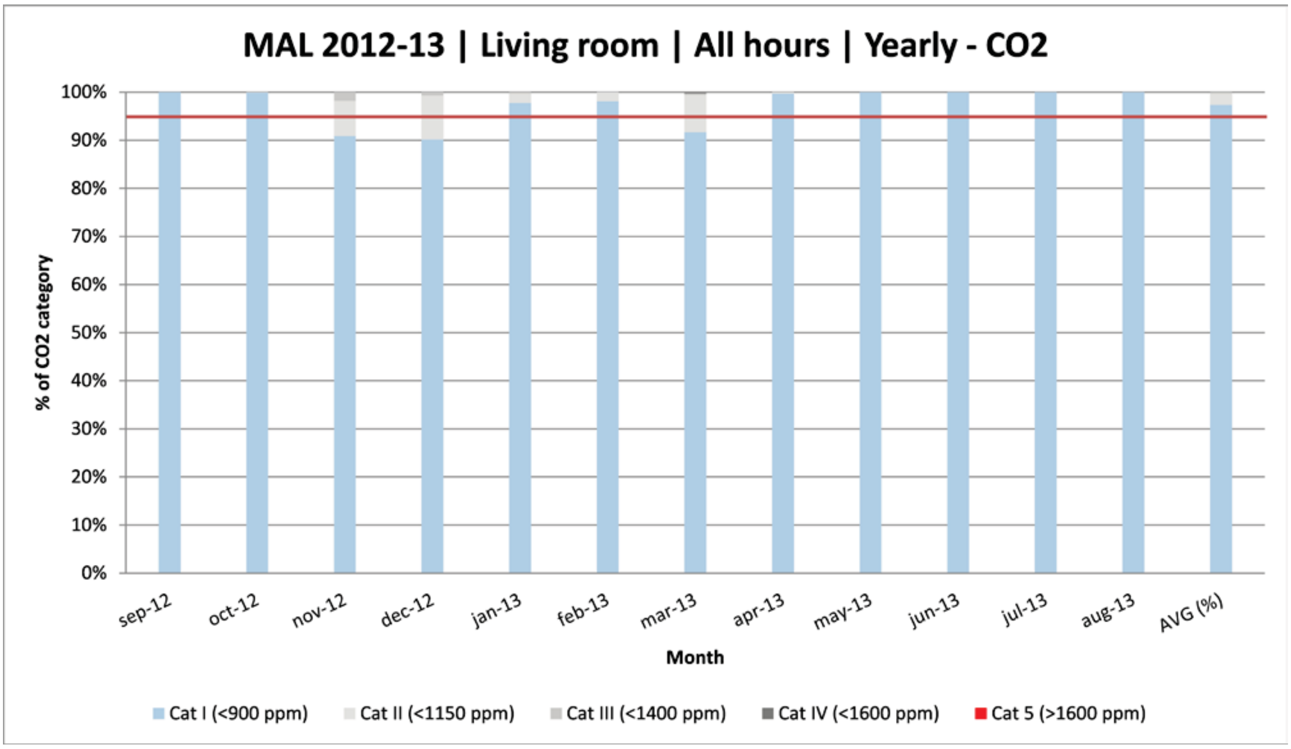

Figure 4. CO_2 levels in living room divided into categories as defined in Active House Specification. Values are the absolute, measured values.

that it is generally possible to prevent overheating in houses with high daylight levels, despite the particular risk of overheating in this type of house. The results from the other rooms in the house show the same tendency as the kitchen-dining room.

The results also show good air quality, expressed by a low CO_2 level in the living room, **Figure 4**. The air quality is best in summer when natural ventilation is used to prevent superheating and the air change rates are higher than in winter. In winter, the CO_2 levels increase to above 900 ppm for approx. 10% of the time, which is considered satisfactory. Similar results were found in the other rooms of the house, however, with the exception of bedrooms. In these rooms, the CO_2 level increased to category 2 during winter.

Even though Maison Air et Lumière is a new building, the experience gained is relevant for the energy upgrading of existing houses. Good air quality can be obtained through energy efficiency by combining mechanical and natural ventilation. It is possible to combine good daylight conditions with good thermal comfort by applying a suitable control strategy for dynamic solar shading and natural ventilation.

Conclusion

In a strategy to increase the number of homeowners who venture into a major energy upgrading of their house, the demonstrated positive side effects, more than energy savings, should be included in the communication to motivate homeowners. The barriers should be reduced by "taking the homeowners by the hand" and helping them to choose relevant energy-saving solutions as well as clarifying the financial consequences and opportunities.

Experience gained from new low-energy houses shows that low energy consumption can be obtained simultaneously with good thermal comfort, good daylight conditions and good air quality by means of a combination of controlled external sun screening and natural ventilation. ■

More information

Maison Air et Lumière: http://www.velux.com/sustainable_living/demonstration_buildings/Maison_Air_et_Lumiere

Active House Specification: http://activehouse.info/about-active-house/specification