Annual Report 2001

Low Energy Housing in Ticino

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SUMMARY

In the county of Tessin, very few low energy houses have been constructed in comparison to the German part of Switzerland, although the climate is rather temperate and sunny in winter. The "Vitali-Velti house", located in the village of Monte Carasso near Bellinzona, is designed to be a low energy house.

The main objectives of the project are to establish a monthly heat balance of the house, assess the thermal comfort, assess the house in the view of sustainable development (analysis with the *OGIP* program) and perform an economical analysis to compare the house with a conventional solution. This project is chosen to serve as an example for the IEA Task 28 "Solar Sustainable Housing". The results will also contribute to both the promotion of low energy houses in Tessin and for Minergie information.

The measurement devices were installed in July 2001 and measurements will continue until July 2002 for the analyses foreseen in the project. The first measurements showed that the thermal behaviour of the house is perfectly adapted to guaranty comfortable conditions inside the house during Summer. Due to the design of the house (large heat capacity, building envelope well insulated) and the correct behaviour of the occupant, no overheating occurred.

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Goals of project

In the county of Tessin, very few low energy houses have been constructed in comparison to the German part of Switzerland, although the climate is rather temperate and sunny in winter. The "Vitali-Velti house" is one of the few examples of low energy housing. Its interesting yet simple energy concept, and the possibility to perform measurements, provided the motivation for the project.

The "Vitali-Velti house" is located in the village of Monte Carasso, near Bellinzona. The site is in a densely constructed area at the bottom of the south-facing valley. The project illustrates that low energy housing can and has to take into account the local limitations (shape, surface toward south, near and far shadows, etc.). Architecture, aesthetics, costs, reliability and simplicity are important!

The "Vitali-Velti house" is a massive construction, two-family house with a heated floor area of about twice 200 m^2. The exterior walls are insulated with 15 to 18 cm of insulation. Care has been taken to reduce thermal bridges as much as possible. An air controlled ventilation with heat recovery has been installed to save energy and provide good air quality. Large windows have been integrated in the south-east façade. The heating demand seems to be very low (calculated to 70 MJ/m^2y with *Lesosai*) and is covered by only a wood stove in each house which heats the air and a murocaust. The saving from not installing a conventional heating system counterbalances the extra cost for the improved envelope of the building, the two air controlled ventilation units and the two solar hot water systems (system "Solkit"). The south-east and north-west façades of the house are shown in fig. 1.

Fig.1 South-east and north-west façades of the "Vitali-Velti house"

This project will serve as an example for the IEA Task 28 "Solar Sustainable Housing". The results will also contribute to both the promotion of low energy houses in Tessin and for Minergie information.

The main objectives of the project are to establish a monthly heat balance of the house, assess the thermal comfort, assess the house in the view of sustainable development (analysis with the *OGIP* program), perform an economical analysis to compare the house with a conventional solution and produce documentation for the Task 28 and Minergie information in Tessin.

The completed objectives for 2001 are **the installation of the measurement devices and datalogger for the assessment of the thermal balance of the house and the first results of the measured thermal behaviour of the house during the summer.** At the 4th IEA Expert Meeting of SHC/BCS Task 28/38 that took place in Bregenz (26.-28. September 2001), the "Vitali-Velti house" has been chosen as an example in the Subtask D book "Measurement and Evaluation".

Works done and achieved results

The installation of the measurement devices and datalogger concerned the following actions:

Air temperature and humidity

Five *Ecolog Elpro* dataloggers were installed to measure the air temperature and relative humidity of the living/dining room of each house (ground floor in the south part of the house), the second floor of each house (in the north part of the house) and the outside air in the garden, in a ventilated space protected from sun and sky.

The temperature measurements have an accuracy of 0.1-0.2 K and the relative humidity of 1-2 % (certificate of calibration). The measurement accuracy was controlled with all the datalogers placed in an insulated box. Measurement started in July 2001 and will continue until the end of July 2002. Measurements are taken every 20 minutes.

Inside surface and air temperature

A datalogger *DAU 32/6* with 6 PT100 sensors is used in the Velti house to measure air and surface temperature in the living/dining room (near the wood stove and the south windows at the south-west wall) and in the living room on the first floor (at the south-west wall in a space protected from the sun). For each floor three temperatures are measured: the air temperature at 0.5 and 2 m high at a distance of 10 cm from the wall, and the surface wall temperature at 2 m high. These measurements will provide additional information such as a vertical temperature stratification and the difference between air and surface temperature. They also will help to detect wood stove operation, possible direct solar gains and nocturnal window openings during the summer for cooling. In Fig. 2, the emplacement of the temperature measurements can be seen in the living/dining room (left hand picture) and in the living room at the first floor (right hand picture).

Fig. 2 Measurements of the air and surface temperature at the south-west wall in the living/dining room (left hand picture) and the living room at the first floor (right hand picture)

Temperature measurements were calibrated in a thermal bath with a stabilised temperature. The datalogger performs measurements every 5 seconds and mean hourly values are stored. Measurement started in July 2001 and will last until the end of July 2002.

Measurement of the heat recovery ventilation unit

A separate datalogger *DAU 32/6* is used to measure the heat recovery ventilation unit of the Velti house. Four temperatures with PT100 sensors and two status are measured. The temperatures are measured in the four air ducts that are connected to the heat recovery unit (outside air intake before and after the heat recovery unit, but before the post heating unit. The expulsion air is also measured before and after the heat recovery unit. The two status measurements count the operation time of the fans and the electric resistance used for the post heating). Temperature measurements were calibrated in a thermal bath with a stabilised temperature. The datalogger performs measurements every 5 seconds and mean hourly values are stored. The datalogger is operational since August 2001. However, the ventilation unit is only used when the house is heated, thus the measurements will be of relevance only during the heating period.

Energy consumption

Two electric meters were installed to measure the electric consumption of the two domestic hot water systems (auxiliary electric energy and electric energy of the solar collector pump).

A reading of the electric meters, including the electric meters of the two houses, is performed on a monthly basis.

First summer measurements

The first measurements comprise the hottest period of Summer 2001. In Fig. 3 the temperatures measured with the *Ecolog Elpro* dataloggers are shown for the hottest days.

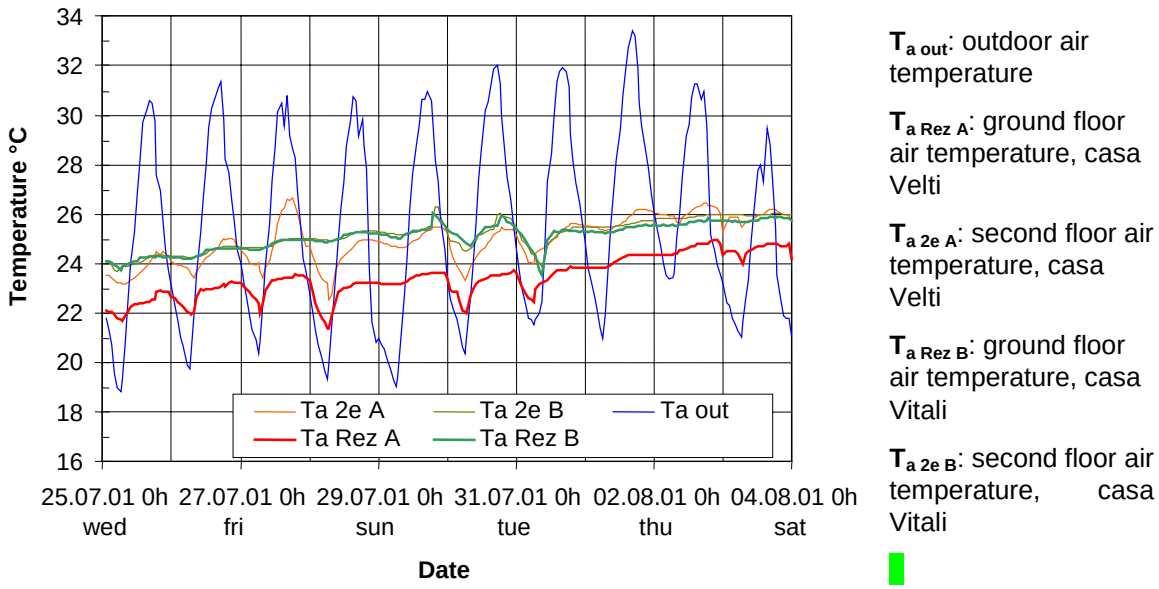
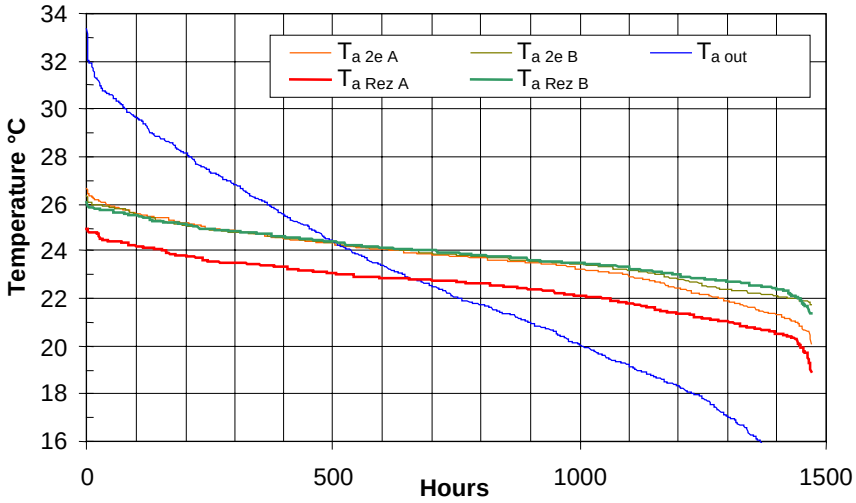


Fig. 3 Measured temperatures with the Ecolog Elpro dataloggers during the hottest days of Summer 2001

In Fig. 4, the classified air temperature are shown from July 6 until September 5. It can be seen that the air temperature in the house remains in the comfortable range, although the outside air temperature exceeded 30 °C every day and never dropped below 19 - 20°C during a period of 10 days.



$T_{a\ out}$: outdoor air temperature

$T_{a\ Rez\ A}$: ground floor air temperature, casa Velti

$T_{a\ 2e\ A}$: second floor air temperature, casa Velti

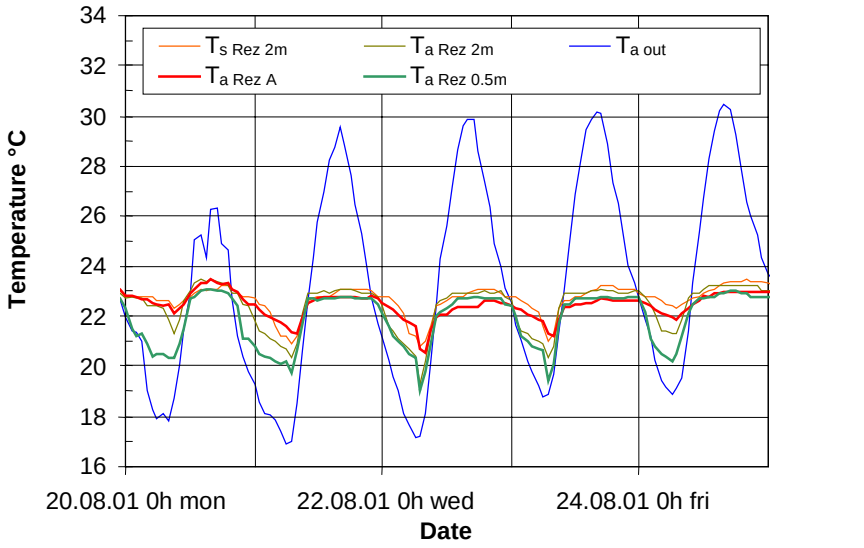
$T_{a\ Rez\ B}$: ground floor air temperature, casa Vitali

$T_{a\ 2e\ B}$: second floor air temperature, casa Vitali

Fig. 4 Classified air temperature in the "Vitali-Velti house" during Summer 2001 (measures from July 6 until September 5)

The air temperature of the ground floor of the casa Velti is 1 to 1.5 K cooler than those of the other floors. This is mainly due to the different way the two houses are cooled during the night (opening on the ground floor in the Velti house and opening on the first floor in the Vitali house).

In Fig. 5, air and surface temperature measurements are shown for the ground floor of the Velti house.



$T_{a\ out}$: outdoor air temperature

$T_{a\ Rez\ A}$: ground floor air temperature, casa Velti

$T_{a\ Rez\ 0.5m}$: ground floor air temperature at 0.5m high

$T_{a\ Rez\ 2m}$: ground floor air temperature at 2m high

$T_{s\ Rez\ 2m}$: ground floor surface temperature at 2m high

Fig. 5 Air and surface temperature in the ground floor of the Velti house.

The temperature sensors at 0.5 and 2 m high are close to the opening used for night cooling. As a consequence, the air temperature drops more than the surface temperature when cooling is performed. It also can be seen that the wall surface temperature is close to the air temperature measured with the *Ecolog Elpro* datalogger. This is due to the fact that the location of this latter is not as close to the opening and thus is not directly influenced by the fresh incoming air.

It can be seen that the temperature of the house is stable when the outside air temperature is higher. It illustrates a correct behaviour of the occupant, who keeps the exterior blinds down and the windows closed. The occupant can set the exterior blinds (Venetian blinds) in a position that cut direct solar gains but let natural and diffuse light enter into the house. The large heat capacity of the house, combined with the well insulated house envelope, is also an important parameter for the stability of the house temperature (large time constant of the house).

National Collaboration

The project is performed in collaboration with the architect office Aldo Velti, viale Stazione 1, CH-6500 Bellinzona.

International Collaboration

Collaboration with the IEA Task 28 “Solar Sustainable Housing”. This project provides a documented example of a low energy house that will be used in the Subtask D book “Measurement and Evaluation”.

Evaluation of the year 2001 and perspectives for 2002

The measurement devices were installed as expected and measurements will continue until July 2002 for the analyses foreseen in the project. The first measurements showed that the thermal behaviour of the house is perfectly adapted to guaranty comfortable conditions inside the house during Summer. Due to the design of the house (large heat capacity, building envelope well insulated) and the correct behaviour of the occupant, no overheating occurred. Contacts and collaboration with Task 28 participants and meetings will continue in 2002.