ASSESSING BEMS SYSTEMS

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ABSTRACT

Building owners and design offices wish to be provided with relevant and objective data on the quality of BEMS systems (Building Energy Management Systems) available on the market. As for BEMS manufacturers, they would like to have their products recognised in terms of quality.

To reach this twofold objective, CSTB and EDF (French Electricity Board) have developed a procedure for assessing these systems. This procedure is based on tests performed on CSTB's SIMulator for Buildings And Devices (called SIMBAD). The main functions of BEMS systems (heating or air conditioning control, programming, load shedding, alarms, monitoring...) are being assessed taking account of the point of view of a future user.

After analysing the main criteria necessary for high-quality BEMS installations, this paper describes the procedure, then the first results obtained by testing two types of BEMS. The assessment report, which is an actual information tool on the systems, is then presented.

1. WHY ASSESS BEMS SYSTEMS?

In France, thirty companies or so market Building Energy Management Systems. Each of the products proposed has a number of functions, and we notice that decision-makers encounter great difficulties in selecting a system suited to their needs. The information supplied by manufacturers sometimes focuses on the very characteristics of the systems rather than on their ability to meet users' needs.

Based on these facts, the CSTB and Électricité de France decided to develop a procedure making it possible to assess the ability of BEMS systems to manage electrically operated installations.

The assessment procedure was designed to achieve the following three purposes:

- to supply manufacturers with relevant information so that the quality of their products can be recognised and functions improved, where necessary,
- to provide decision-makers with objective information on the basic functions found on almost all of the installations,
- to prepare for the future evolution in terms of standardisation and regulations. It seems important, indeed, to provide for operating assessment procedures regarding control systems and building energy management systems, as was the case with the other factors taken into account in the thermal engineering regulations (envelope, ventilation systems...).

2. REALISTIC, REPRODUCIBLE AND SHORT-TERM TESTS.

Building Energy Management Systems are multi-function products designed to meet the various users' needs. An overall assessment had then to be ruled out since it did not take this diversity of needs into consideration. Therefore, we decided to carry out an assessment function by function, which enables the user to compare different systems by laying stress on the functions regarded as being of great importance to a given application. This function by function approach also enables us to take account of the choice made by industrialists to optimise such and such types of functions depending on the different markets aimed at.

A minimum of three conditions shall be fulfilled to carry out a relevant assessment:

- the BEMS system has to be tested under real conditions, by connecting it to a building and to a heating and air conditioning installation in order to check, for instance, the level of comfort or the energy consumption obtained,
- tests shall be reproducible,
- the duration of the tests shall be long enough to assess the system correctly, but not too long for testing costs to be reasonable.

3. TESTS PERFORMED THANKS TO A BUILDING SIMULATOR.

Carrying out the tests on site would have been a way of getting closer to real conditions, whereas it would not have resulted in short and reproducible tests.

The use of the « SIMBAD » SIMulator for Buildings And Devices developed by the CSTB has made it possible to meet these three conditions. SIMBAD is a data processing environment able to simulate the behaviour of a building and its technical equipment, to which a control or building energy management system can be connected by way of an interface [2, 3, 4].

This environment comprises a PC and simulation software. The latter includes a set of models which make it possible to represent in detail a wide range of heating and air conditioning installations.

The interface made up of a data acquisition and control station, makes it possible to couple the BEMS actual input-output with the probes and actuators simulated by the PC.

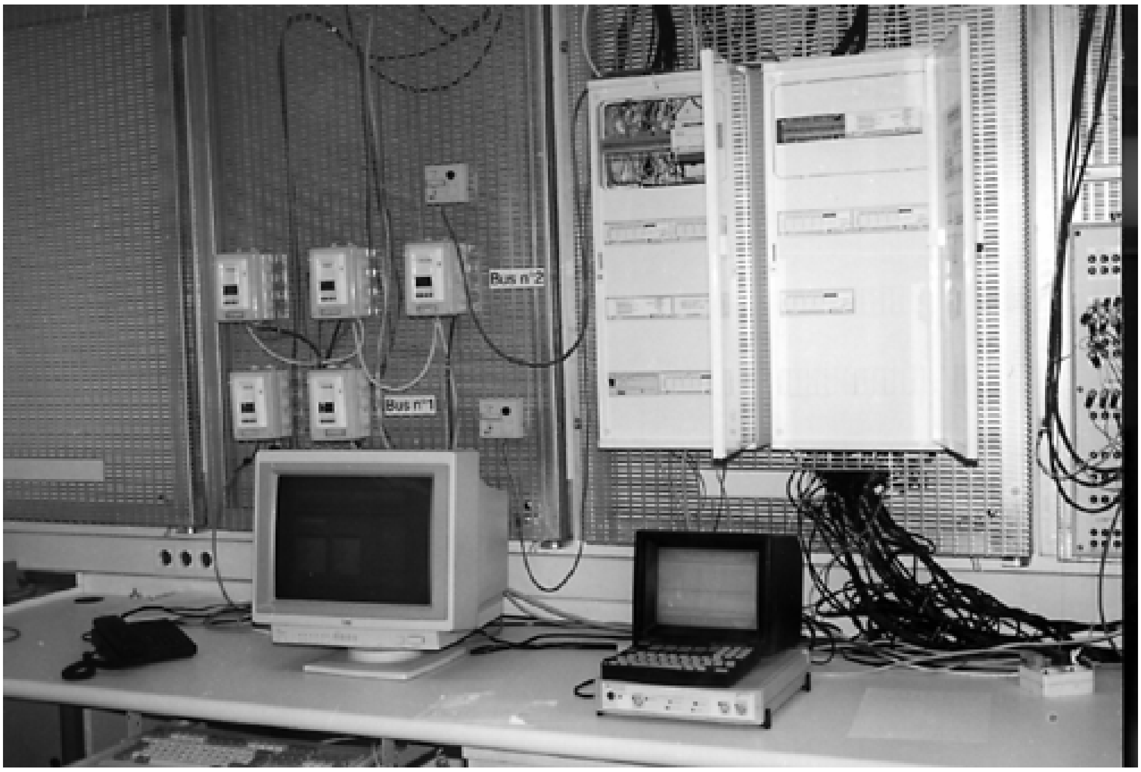

Figure 1 : A BEMS system connected to SIMBAD

The simulator's architecture is as follows:

Scheduler

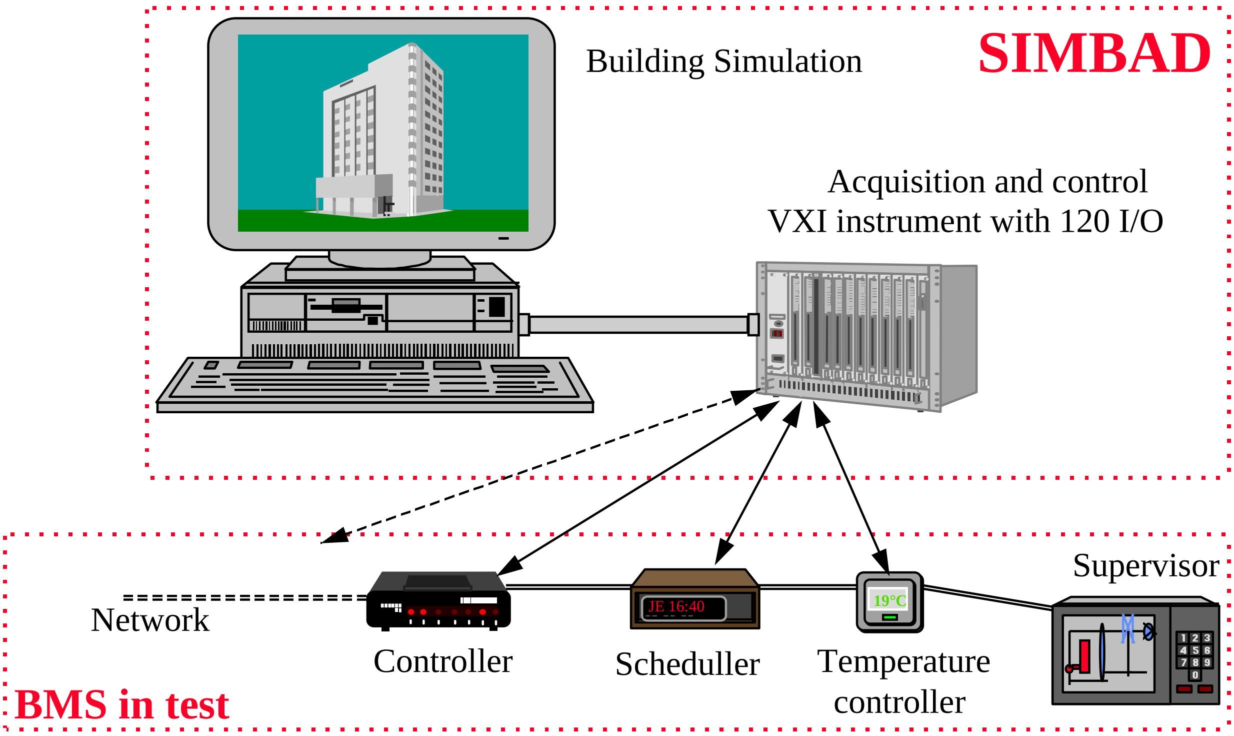

Figure 2 The simulator's architecture

To perform tests, instead of being connected to a real building, the BEMS system is connected to the digital building which SIMBAD constitutes. In this way, as if it were installed in a real building, the BEMS system possesses data concerning the state of the building and of its equipment (measurements of temperature, of electric current drain, technical alarms, ...). It can control the digital equipment as if it were controlling real equipment [5].

SIMBAD can represent a large variety of buildings along with heating and air-conditioning equipment. To perform the first tests, it was configured to represent a medium sized non residential building, equipped with an electric heating installation or an air-conditioning installation using fan coils. The systems for producing domestic hot water, the lighting as well as an electric kitchen are also taken into account.

This installation is typical of what may be found in small and medium sized buildings, a market sector for which the BEMS system use is growing substantially.

4. THE STEPS IN THE ASSESSMENT.

The assessment included the following steps:

- a set of specifications, describing the functions which are to be assessed and turned over to the manufacturer of the system tested,
- the manufacturer configures and parameterises the system to comply with the specifications (the manufacturer can decide to comply with only some of the functions described in the specifications),
- the system is coupled to SIMBAD jointly by CSTB and by the manufacturer and is then tested by CSTB which drafts an assessment report,
- this assessment report is turned over to the manufacturer which can then disseminate it to its customers.

The functions tested are the conventional functions of a BEMS system. They include:

- control of the heating or air-conditioning system to ensure comfort while controlling consumptions,
- control of lighting and domestic hot water and of the air-conditioning plant,
- management of the electricity load
- use of a supervisory system (supervisor), placed in the building or at a distance via the switched network,
- management of alarms,
- archiving and use of data.

The tests are conducted during three periods of a few days each, representative of the periods of winter, inter-season and summer (only for the test of systems managing fan coils).

The meteorological conditions for these periods, as well as the operating conditions simulated, are varied enough to make it possible to test each of the functions of the specifications.

The data representative of the building's behaviour and of its equipment, are stored on disk and are used off-line.

5. THE ASSESSMENT REPORT.

The results of the assessment are presented in a detailed report which, for each function assessed, gives the operating method, the results obtained and the analysis of the results.

This document is intended for the manufacturer. It enables it to check the behaviour of the various functions utilised, both separately and in their interaction with each other. This is a tool for improving product quality.

These results are then summarised in a 6 page document which is designed to:

- help manufacturers improve their products,

- supply decision makers with important information, in a standardised format, concerning the system assessed.

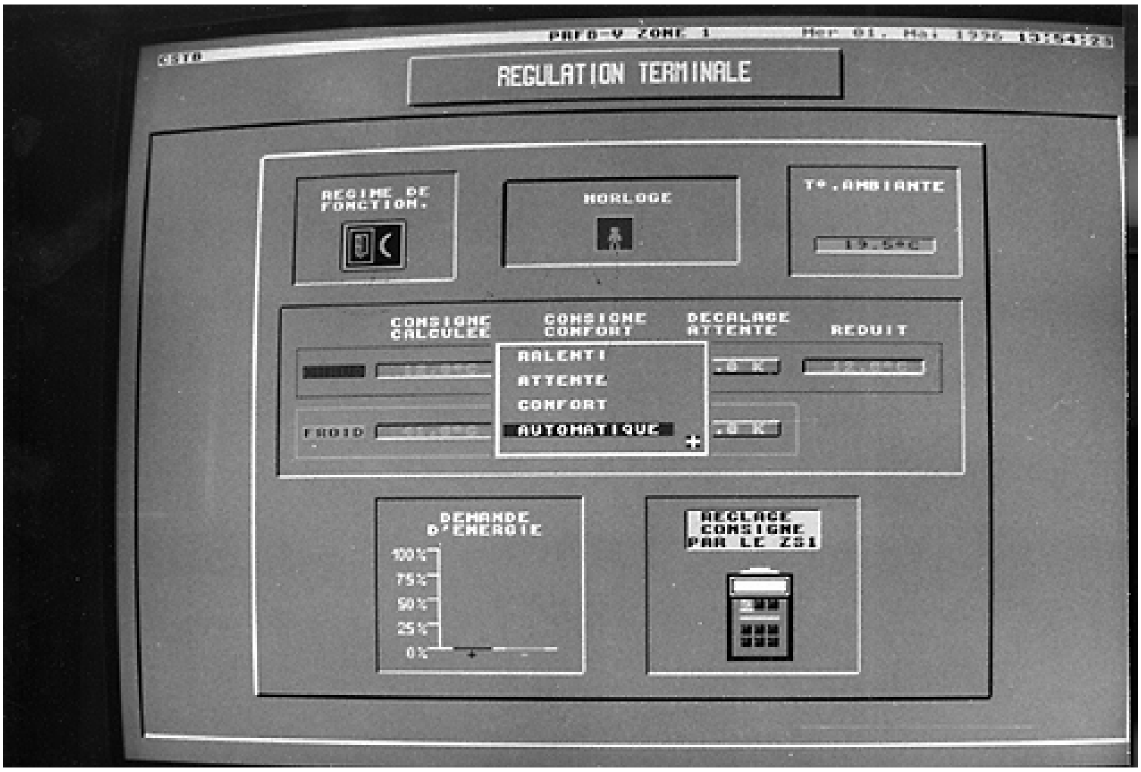

Figure 4: View of a supervisor

After reviewing the principle of the tests carried out, this document successively presents:

- a brief description of the system tested,

- the results of the functional tests,

- an assessment of the system's user-friendliness, whether in an ordinary application or in a more advanced application.

The results of the functional tests are presented in the form of tables, showing the results of the tests of about forty functions. Among them are:

- 8 functions of managing heating and air-conditioning: zone control, weather compensation, scheduling with optimal start, ...

- 5 automatic controller functions: central and local overdrives, time-based scheduling, ...

- 6 electric heating management functions: load shedding, metering, tariff slaving, ...

- 10 technical management functions: alarms, supervision, archiving and use of data.

For each of the functions tested, it is indicated whether the system is working satisfactorily, partially satisfactorily, unsatisfactorily or if the function is not being carried out at all. A brief commentary specifies the reasons for the classification selected.

The presentation, in the form of tables of the various functions, was designed to enable the reader to quickly correlate the system's performances with its own needs

6. RESULTS OBTAINED.

At the end of 1996, two different BEMS have been tested and two other tests in preparation. The first BEMS includes controllers from different manufacturers connected through BatiBUS. Space heating is performed by direct electric convectors. The second BEMS includes controllers from one manufacturer connected through proprietary buses. Air conditioning is performed through fan coils.

3 examples of results are described below.

TERMINAL REGULATION

The procedure applied here corresponds to the plan for a test to assess the terminal regulations of group WG2 of CEN TC247.

The purpose of this test, for various building loads, is to check, in dynamic mode and in static mode, the accuracy and the drift, when loaded, of the terminal regulation systems. The results obtained from the various parameters make it possible to determine the class of each product.

RESULTS OBTAINED IN HEATING MODE

The results presented concern three different types of terminal regulations.

The time-bases of each system are as follows:

Product	A	B	C
Time-base (sec)	60	300	30

The following graphs show the results obtained for each product. The evolution of the inside temperature during the test and the operation of the convector are observed.

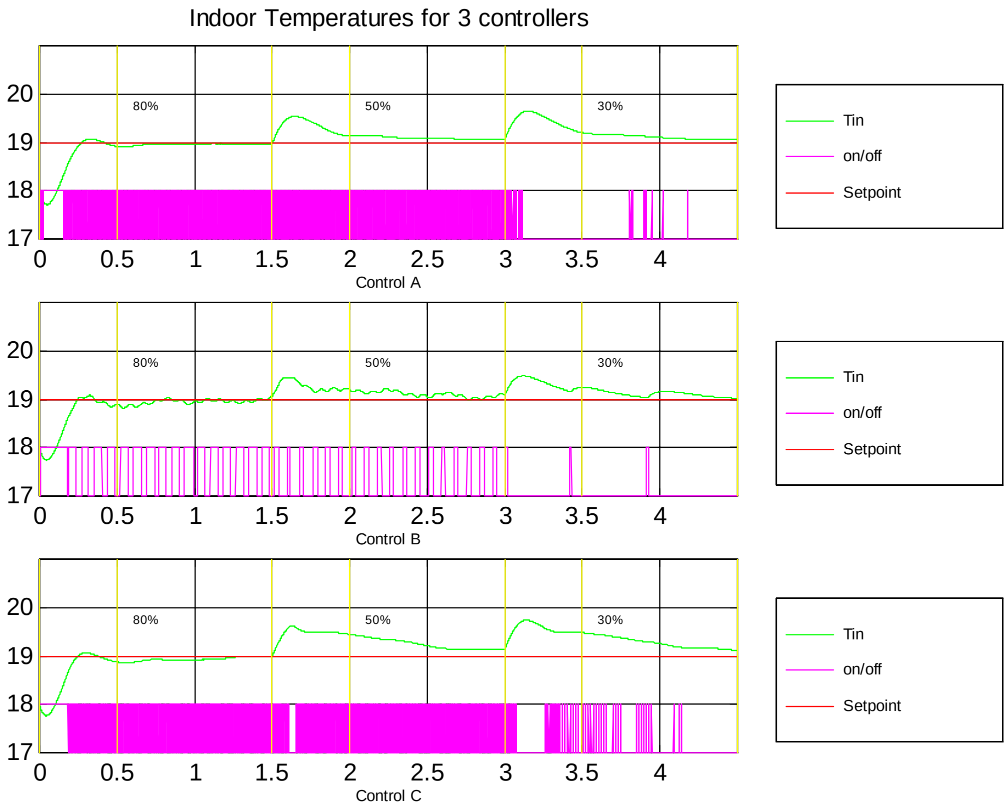

Figure 6: Results obtained in zone temperature control of the heating system

The accuracy of the three controllers is quite good in steady state. The amplitude of indoor temperature variation is lower than 0.4°C.

The load dependent shift (difference of mean temperature between 20% load and 80% load) is also limited (less than 0.3°C).

During transient stages the temperature variation remains lower than 0.6°C.

The results obtained with the three controllers are slightly different but are good in every case. The three controllers are classified in class 1 which is the class with the highest accuracy and the lowest load dependent shift.

They are well adapted to control of direct electric heating.

IN COOLING MODE

The following graph shows the results obtained for three identical systems of terminal regulation of fan coil, 2 tubes/2 wires. The evolution of the inside temperature during the test, the fan's speed and the position of the three-way valve are observed. The system's time base varies around 35 seconds.

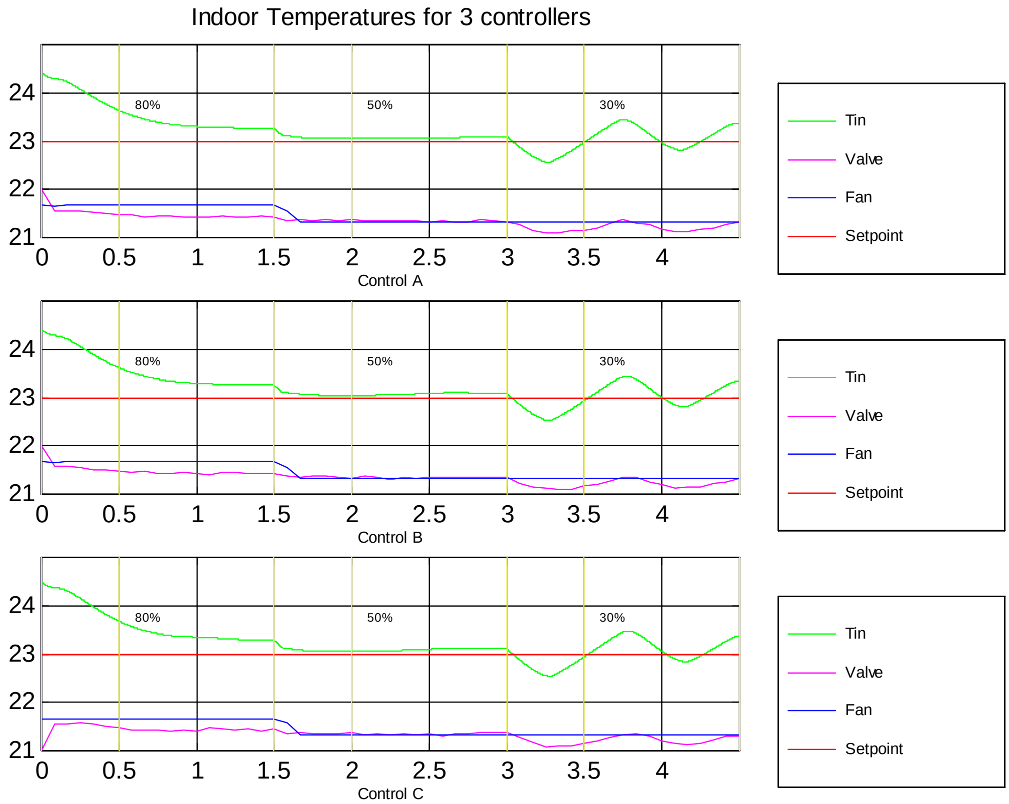

Figure 7: Results obtained in terminal regulation of cooling

A strong influence of the load on the operation of the regulation is observed, in particular, at low mode, some hunting by the three-way valves is observed.

These controllers are also class 1.

OPTIMIMUM START CONTROLLER

The purpose of this function is to obtain comfort at the beginning of occupancy while optimising consumptions.

The following curve shows the results obtained in one of the zones on a Monday morning.

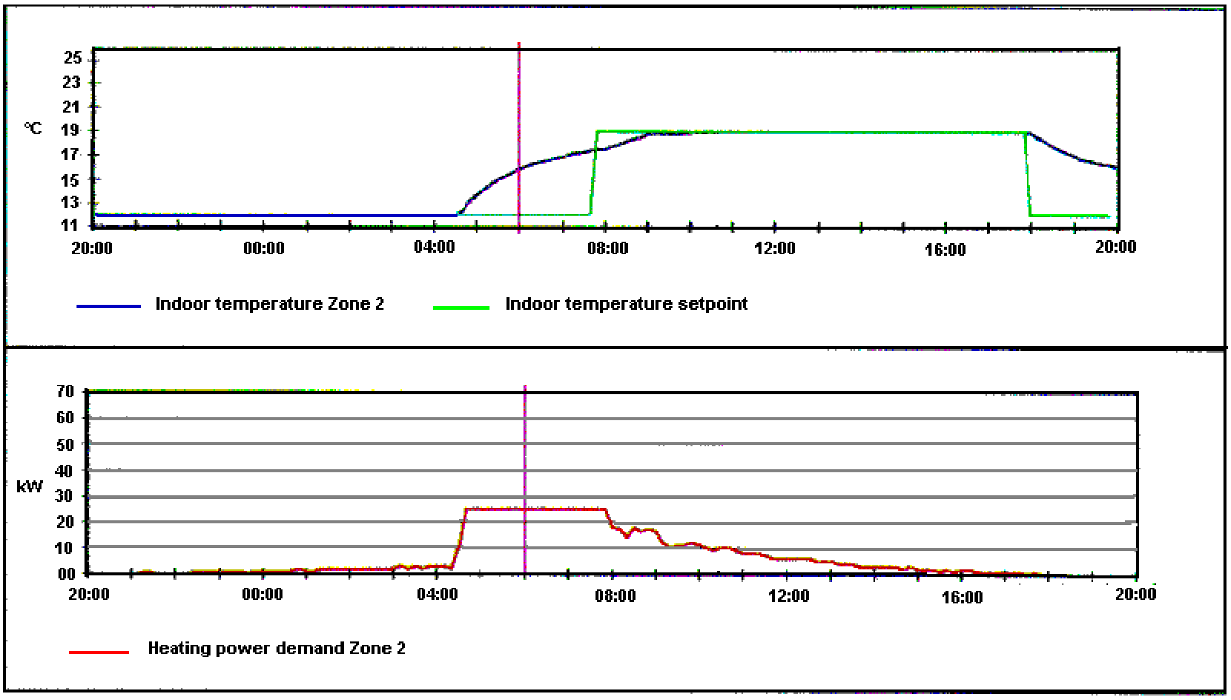

Figure 8: Results obtained in energy optimisation

The boost begins too late and precludes obtaining comfort at the beginning of occupancy.

The tariff structure can also be taken into account to reduce the costs of the energy consumed. In this case, the purpose is to obtain comfort at the end of the low occupancy hours. The boost is initiated in this way while the electric power is least expensive [1].

The following curve shows the boost on a weekday. Comfort is obtained beginning at 6 a.m. The boost is halted and the system goes over to normal mode.

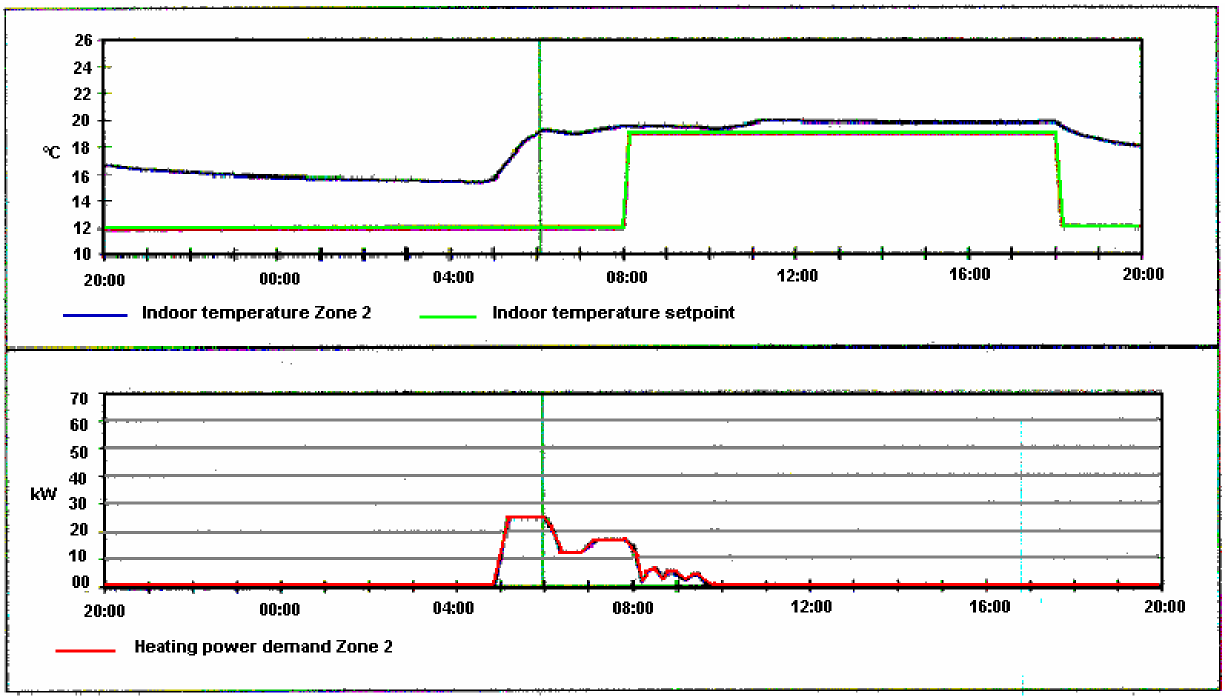

Figure 9: Results obtained in tariff optimisation

It is observed that the system has re-started the heating in order to obtain comfort from 6 a.m. on, that is, at the end of the low occupancy period, when the price per kWh is most attractive. Once the comfort is obtained, the system goes over to normal limitation mode. Once occupancy begins, the arrival of the people and the start-up of the equipment considerably limit the heating needs during occupancy.

LOAD SHEDDING

The purpose of load shedding is to make sure that the system is capable of managing the electric loads while respecting the power levels subscribed to in each tariff section for the electric power subscription.

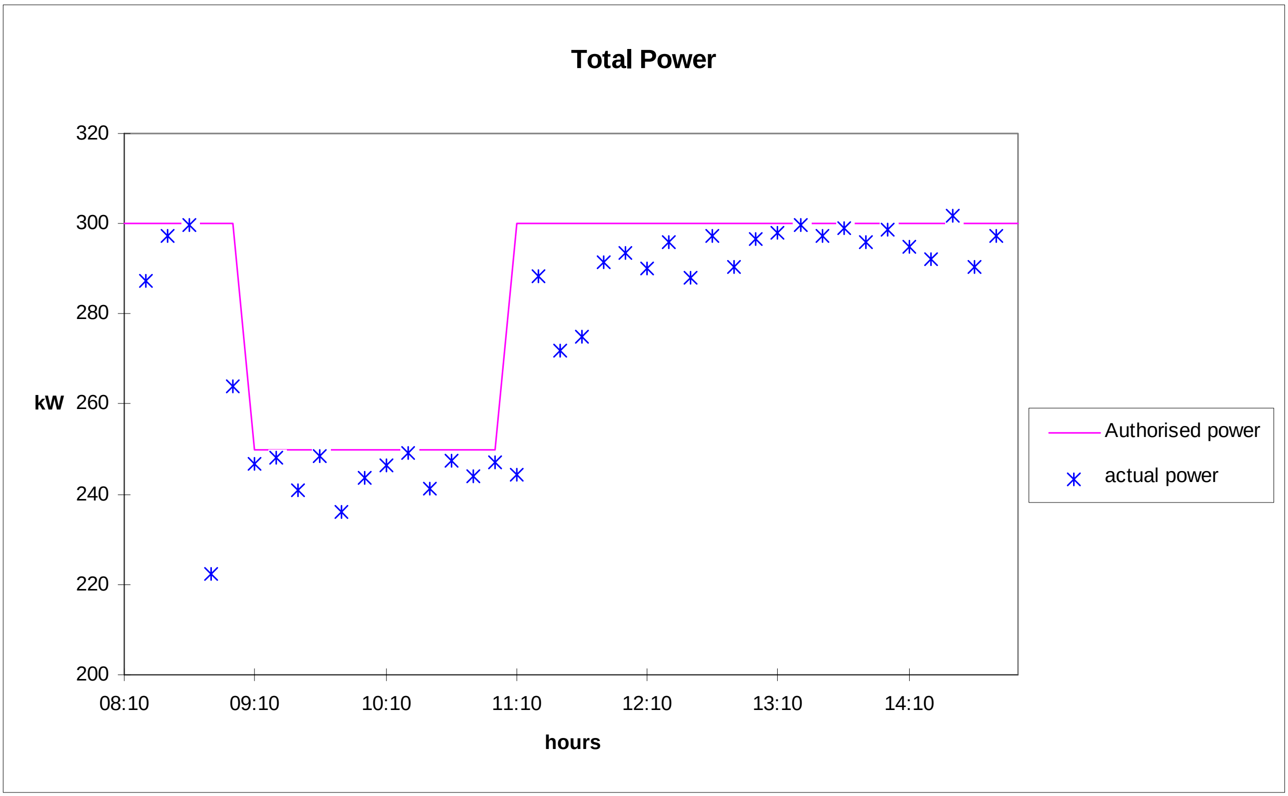

Figure 10 : Results obtained in the load shedding of the electricity load.

It is observed that the system has made it possible, while shedding a part of the electricity loads (heating and domestic hot water), to avoid exceeding the powers authorised in each tariff section. Two other properties were checked for this function, i.e. the possibility of setting priorities between the various loads which can be shed and the management of the impact of load shedding on the comfort of the various heating zones.

7. CONCLUSIONS.

The test on the first two systems made it possible to validate the two electricity installations of the buildings managed, located on the simulator, and to improve and simplify the test procedure

This assessment mode can be applied to other products such as zone controllers and automatic building control systems.

Parts of the procedure can be transferred to the European Standardisation Committee. The procedure for assessing the terminal regulation function is now being transferred to the WG2 TC247. Other parts may be able to be used.

The assessment procedure is still in its early stages. Nevertheless, such a procedure may become an objective decision making tool for contracting authorities. The assessment report for the manufacturers in this way would become a major marketing leverage factor.

However, the implementation of the assessment procedure implies the installation of the BEMS system on the test apparatus. It would be interesting to be able to apply all or part of the procedure directly on the sites managed by BEMS systems.

8. RÉFÉRENCES

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