CADDET energy efficiency
IEA
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RESULT 170
7807
Temperature control for residential buildings

Automatic control of electric heating saves energy

Summary

A Norwegian company has developed a control unit for time scheduled use of electric panel heaters and electric appliances. The microprocessor based unit saves energy by controlling the room temperature automatically in houses heated by electricity. Nobø Electro A.S. developed the unit which is called ORION 512.

The electronic controller can be connected to any electricity outlet. The regular electric wiring of the house is used for transmitting control signals to switch thermostat set-points of electric panel heaters from comfort to set-back temperature and vice versa. The unit can also turn electric appliances on and off.

Tests showed a reduction in heating demand of almost 20 % for an apartment using temperature set-back compared to an apartment with a constant temperature.

Highlights

- **Heating demand reduced by nearly 20 %**
- **No costly extra wiring necessary**
- **Very simple user interface**

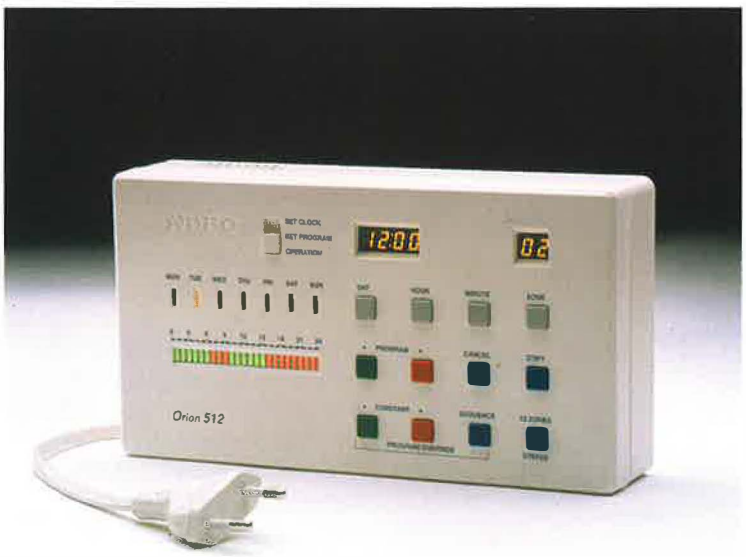

Figure 1: The ORION 512 electronic controller.

Aim of the Project

The Norwegian EMTEK-program promotes the introduction of energy efficient products. An important activity of the project is to verify the energy savings potential of the considered products. In order to verify achievable energy savings by using ORION 512, it was decided that the EMTEK-program should rent two identical apartments to monitor results.

The habits of the occupants of a house are a major factor influencing energy consumption. Past experiences show that comparing measurements of the energy consumption of occupied apartments often creates more "confusion than conclusions". The only way of verifying the benefits of time scheduled temperature set-back is to measure the temperature and energy consumption in two identical, unoccupied apartments.

The Principle

The electronic controller is a microprocessor based unit for time scheduled use of electric panel heaters and appliances (see Figure 1). The control sequence is programmed by pressing the buttons on the front panel of the unit. The green button is for set-back temperature or to turn an appliance off. Pressing on the red button raises the temperature to comfort level or turns an appliance on. When pressing the buttons, it is possible to see the program in the 24 segments, two-colour display. The red or green lights correspond to the buttons pressed.

Programs can be created for different hours of the day and for every day of the week. It is possible to have up to 12 different programs, for example one for the living room, one for the bedrooms etc. As most people do not live a completely regular life, the program can be overridden. When away on holiday set-back temperature can be programmed for 24 hours each day. The unit can also be externally controlled.

The control signals are low voltage, high frequency "telegrams" transmitted by the regular electric wiring in the house. They do not interfere with other appliances. Small "receivers" connected to electric panel heaters and other appliances to be controlled decode the signals. In this way the control unit switches thermostat set-points from comfort to set-back temperature and turns electric appliances on or off. It is possible to connect receivers to almost all kinds of electric panel heaters. Complete control of both comfort and set-back temperature is possible with panel heaters which have a thermostat with a so called "night set-back element" (resistor). Special receivers are available for electricity outlets for lamps, radios, televisions etc. (see Figure 2).

Figure 2: Receiver for use in electricity outlets.

The Situation

The EMTEK-program has monitored the energy consumption in two identical, unoccupied apartments. One of the apartments was heated using a time-scheduled temperature set-back strategy, and the other was kept at a constant temperature of 21 °C.

The house that was rented by the EMTEK-program is a vertically divided two-family housee located near Oslo (60°N), in Norway, where the dimensioning outdoor temperature is -20 °C. Each apartment has a living area of 134 m^2. The ground floor is partly below ground level and

consists of bedrooms, a bathroom and storage rooms. The entrance, kitchen, living room, bathroom and a bedroom are on the first floor. Above ground the house has a wooden frame construction with 15 cm of mineral wool insulation in the walls and 20 cm in the roof. The windows are double-glazed and sealed. Below ground the walls are made of lightweight concrete blocks. This construction is very common in Norway. The thermal insulation level is according to the present Norwegian Building Code.

In order to check that both apartments had equal thermal properties in addition to being geometrically identical, two days were initially spent fine tuning the thermostats of all the panel heaters. This stabilised the temperature in all rooms, in both apartments, at 21 °C +/- 0.5 °C. Both apartments were equipped with electric panel heaters with high quality electronic thermostats, making it possible to accurately control the temperature. Before the experiment started one of the apartments had its existing panel heaters replaced by panel heaters from Nobø Electro A.S.

During the initialising period the energy consumption per day for each apartment was 88 and 91 kWh respectively. For all practical purposes, these measurements are equal (the highest value was for the apartment that later used temperature set-back). The outdoor temperature was nearly constant at -0.5 °C during the initialising period.

Having established that the apartments had equal thermal properties, one of the apartments started time scheduled temperature set-back. The time scheduling was made according to the habits of a typical family of four, with both parents working away from home and the children at primary school. Without any reduction in thermal comfort such a family can have temperature set-back during the night, and during the day, before the children come home from school and the parents come home from work.

The thermostat was set at 15 °C during the set-back period and the apartment was divided into three zones. The zones and periods with comfort and set-back thermostat set-points were as shown in Table 1.

Zone 1: Kitchen/living room, first floor.					
Week days		Saturdays		Sundays	
00.00-05.00 hrs	15 °C	00.00-07.00 hrs	15°C	00.00-07.00 hrs	15 °C
05.00-08.00 "	21 °C	07.00-24.00 "	21°C	07.00-23.00 "	21 °C
08.00-15.00 "	15 °C			23.00-24.00 "	15 °C
15.00-23.00 "	21 °C				
23.00-24.00 "	15 °C				
Zone 2: Bedroom, first floor.					
Week days		Saturdays		Sundays	
00.00-15.00 hrs	15 °C	00.00-17.00 hrs	15 °C	00.00-17.00 hrs	15 °C
15.00-23.00 "	21 °C	17.00-24.00 "	21 °C	17.00-23.00 "	21 °C
23.00-24.00 "	15 °C			23.00-24.00 "	15 °C
Zone 3: All rooms on the ground floor.					
Week days		Saturdays		Sundays	
00.00-14.00 hrs	15 °C	00.00-07.00 hrs	15°C	00.00-07.00 hrs	15 °C
14.00-21.00 "	21 °C	07.00-22.00 "	21°C	07.00-21.00 "	21 °C
21.00-24.00 "	15 °C	22.00-24.00 "	15°C	21.00-24.00 "	15 °C

Table 1: Apartment zones with set-back and comfort temperature periods.

The energy consumption of both apartments was monitored by reading the kWh-meter regularly. In the beginning of the experiment the kWh-meter was read once every day, later it was read every two or three days. The temperatures in all rooms, in both apartments, were measured by means of microthermistors placed 1.6 m above the floor. The thermistors were connected to data loggers, one in each apartment. The average of the temperature readings made every few seconds was stored in the data loggers every five minutes. Each week the readings were transferred from the data loggers to a personal computer for analysis.

The mean outdoor temperature during the experiment was

-0.5 °C which is the same as the average temperature taken over 30 years for March in this area. The average energy consumption for heating a house of this size in this area is 16,000-17,000 kWh/year.

The Organisation

The VEKST Foundation is a small, independent, private foundation mainly working with research and development projects. Most of the projects are related to energy efficiency and indoor climate in buildings. The majority of the projects are financed by the Ministry of Industry and Energy through the Norwegian Water Resources and Energy Administration. This is also the case for the EMTEK-program which is a joint project between the VEKST Foundation and the National Institute of Technology.

Economics

On a yearly basis the saving amounts to approximately 3,300 kWh, or NOK 1,500 with the average price of electricity at approximately 0.50 NOK/kWh. The cost of the control unit is approximately NOK 3,000 and eight receivers cost about NOK 3,000 in total, giving a payback period of about four years. Larger houses, houses with lower insulation levels, or a higher electricity price, will reduce the payback period.

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* IEA: International Energy Agency
OECD: Organisation for Economic Co-operation and Development

IEA

The IEA was established in 1974 within the framework of the OECD to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among the 23 IEA Participating Countries to increase energy security through energy conservation, development of alternative energy sources, new energy technology, and research and development (R&D).

This is achieved, in part, through a programme of energy technology and R&D collaboration currently within the framework of 35 Implementing Agreements, containing a total of more than 60 separate collaboration projects.

The Scheme

CADDET functions as the IEA Centre for Analysis and Dissemination Demonstrated Energy Technologies for all IEA CADDET member countries.

This project can now be repeated in CADDET member countries. Parties interested in adopting this process can contact their National Team or CADDET.

Demonstrations are a vital link between R&D or pilot studies and the end-use market. Projects are published as a CADDET 'Demo' or 'Result' respectively, for on-going and finalised projects.

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