ENERGY MANAGEMENT IN BUILDINGS

Summarised Results of THERMIE Demonstration Projects

Basics

The technology of building management systems & controls includes a variety of systems, over a wide range of complexity, designed for the control, monitoring and optimisation of various functions and services provided in a building, including heating and cooling, ventilation, lighting and often the management of electrical appliances.

These systems have a direct communication interface and may be remote controlled and monitored.

The basic control technologies have been in existence for some time. Systems available range in complexity from the extreme case of a timer-controlled water heater or thermostatic radiator values to so-called 'intelligent houses' which manage everything from the security and safety systems to the air conditioning, lighting and ventilation system, to telematic services and most appliances of a house according to efficiency criteria.

The use of these technologies allows the optimisation of various services often with large energy savings. There are numerous methods by which building services within buildings can be controlled. Most systems seek to control either

- **time**: when a service such as heating or lighting is provided and when it should not be provided;
- **a parameter** representative of the service such as temperature for room heating or illuminance for lighting. This can also vary with time.

Time Control Methods (for heating)

Time switches turn on and off the heating (or water heating) system at preselected periods (of day, of week.).

Optimisers: these controls start the heating system in a building at a variable time to ensure that whatever the conditions, the building reaches the desired temperature when occupancy starts.

Temperature control methods

Frost protection generally involves running heating system pumps and boilers when the outside temperature reaches a set level (0° C) or less to protect against freezing.

Compensated systems: which control flow temperature in the heating circuit relative to outside temperature thus raising the circuit flow temperature when the outside temperature drops.

Thermostatic radiator valves: these units sense the air temperature in a room and throttle the flow accordingly through the emitter (radiator and convector) on which they are fitted.

Modulating control can be applied to most types of heat emitters and is used to restrict the flow depending on the load demand and thus control the temperature.

Other methods are thermostats, occupancy sensing and user interactive control..

Lighting control methods

Zoning: lights are switched on in zones corresponding to the use and layout of the illuminated areas, to avoid lighting a large area if only a small part of it requires light..

Timer control: to switch on and off automatically in each zone to match a prerequisite schedule for light use.

Occupancy sensing: in areas, which are occupied intermittently, occupancy senses can be used to indicate whether or not anybody is present and switch the light on or off accordingly. Detection systems are based on ultrasonic movement or infrared sensing.

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Light level control: this consists of switching or dimming artificial lighting to maintain a light level measured by a photocell. It is particularly necessary to make best use of daylight..

Building Energy Management Systems

These technologies consist of both hardware and software.

The hardware is typically represented by one (or more) control and processing unit and by a number of other peripheral devices (which control the operation of e.g. heating or cooling systems, artificial light sources or other appliances and which can also be represented by sensors, thermostats, etc.,) connected to the former. The control unit, based on the information supplied by some of the peripherals or based on pre-set instructions, runs the system. The control unit can be as simple as a relay or timer switching an electric water heater on or off or as sophisticated as a microprocessor operating on 'fuzzy logic'. Commands can be sent from the central unit to the peripheral units through ethernet cable, power-lines or telephone lines, optic-fiber cables.

The software is the program and the instructions that allow the control unit to manage the operations of the peripheral devices and the appliances.

Working Schema

Building Energy Management Systems (BEMS) are electronic mechanisms to control the proper operation of the home lights, appliances and other elements..

BEMS need some type of control wiring that connect all the equipment and some sensors to serve as a reference. With this simple installation, one or several electronic cards (either packed isolated or connected to a PC) take over the operation by switching on and off all the elements connected, according to a sequence previously planned..

In many occasions, this type of systems is connected to a modem and may be activated by phone at distance. Also it has been a standard practice to include some user's information. In this way the BEMS is not only controlling the energy consumption but also providing data to the building user of when and how much energy, water, gas etc has been spent.

Where?

Following are simple examples of buildings using

1. At Aix en Provence, FR, the BEMS automatically chooses the cooling strategy appropriate to prevailing conditions
2. In the case of Athens, the installation is programmed and operated through a Building Management System, which also controls and operates lighting, solar shading and night cooling. In this case, whilst the BEMS is capable of limiting cooling loads through operation of the solar shading and night ventilation, occupants are also expected to co-operate in the strategy by opening windows and using the ceiling fans or air-conditioning units when required.

The most common use of BEMS is the heating control, as in the following cases:

1. At Waterford, a data term central heating controller with optimiser, time and temperature controls and weather compensator is installed. The system provides separate zones for the first and ground floor. Radiators are fitted with thermostatically controlled valves. Lobbies to front and back doors eliminate draughts. Manually controlled trickle vents are installed in all "habitable" rooms with local extractor fans installed in the bathrooms and the kitchen. A "pressurised and spill" air filtered supply and extract system, with electrical preheating facility, achieves one air change per hour. Fresh air supply to the fireplace reduces heat loss from the living room.
2. The houses of Dublin have a flexible heating control. A programmable digital time controller is provided in each house with a facility for seven-day programming. Radiators are fitted with adjustable thermostatic radiator valves. Here the houses have installed "pay as you use" heat meters. The system uses a unique “pay-as-you-use” card in the heat meter which residents buy in their local shop. Each card costs £5.00 and delivers 125 kWh of heat. The meters have an emergency button, which will automatically credit the system with 100 units if a replacement card is not conveniently available.
3. At Rocklngham a data acquisition system was installed so that the buildings' thermal performance can be monitored over time. The outside temperature and temperatures inside each dwelling are recorded continuously, as well as the heating (room and hot water) energy each dwelling consumes. Boiler performance, solar radiation and wind speed data are also recorded.

4. В Drogheda, програматор ТЕС с девет канала At Drogheda a nine-channel TEC programmer controls space heating and water heating. Steel panel radiators are fitted with thermostatically controlled valves. Here, the BEMS also controls the ventilation. Draught lobbies are provided to front and back doors. Manually controlled trickle vents are fitted to window sashes. The open fire is fitted with an underfloor air supply system.

5. At Aalborg the "Black box"' registers energy and water use. Each house is equipped with a digital energy and water monitoring system that allows the users to read the actual, dally, weekly, monthly or quarterly use of energy and water as well as the cost of any operation requiring energy or water. There is a digital meter in the kitchen to show the above-mentioned values. The meter can also show both humidity and indoor temperature..

Summarised results of Phare Demonstration Project in Bulgaria

"Installation of a Centralised System for Monitoring and Control of Heat in 13 Schools and Kindergartens in the Town of Veliko Tarnovo"

The material presents the results of a demonstration project for installation of a centralised system for monitoring and control of heat consumption in 13 schools and kindergartens in the town of Veliko Tarnovo. The existing substations have indirect heat consumption measuring but are oversized and there is no automatic control.

I. Technical solutions

The system consists of 13 local systems for automatic control and information collection supplied to a central dispatching station comprising of a PC with the respective software. The control and information exchange between the two levels is done by means of a modem connection through existing direct telephone lines. The systems has the following functions:

1. Control of internal heating system loop in accordance with the outside temperature by means of monitoring and correction of the return water temperature. The control device is programmable with the possibility to correct and change the heat curve as well as to set economical (reduced) heating schedule for the week-end and nights.
2. Periodical writing and accumulating of data on registered and pre-set temperatures in substations within certain periods of time.
3. Collection and accumulation in communication module memory of heat meters data. The data are stored in the energy independent memory of the communication module (controller) and upon request are transferred to the Central Dispatching Station (CDS) at the higher level.
4. Possibility to review and change the parameter of the control device when connection between the main PC and the respective local system is available.
5. The software in the central PC at the CDS provides the communication with substation control devices, data accumulation and storage. The software also supports graphic presentation of data, and alert generation in case of eventual parameter deviation from the pre-set limits

The system is based on Brunata Thermix 03 04 control device at the substations. The communication module has been programmed for work with standard modems. The systems has been tested with heat meters Multical 3. The mechanics brand is Controli, Italy.

II. Description of the system for automatic control at the substations

A system for automatic control of feed water to the inside heating installation has been mounted in each substation. The system is based on a programmable microprocessor control device, sensors for respective temperature measuring and regulating motor-valve mounted on the internal heating installation (IHI) loop. The system perform automatic control and the data collection and the communication with the central PC is don by additional communication controller and a modem described above. Fig.1 shows the scheme for automatic regulation. схемата за автоматично регулиране.

The control device has the following functions:

1. Regulation of IHI loop according to a pre-set

curve where the target (temperature of the feed water to the installation) is being calculated in accordance to the outside temperature.

2. The regulation is done on proportion-integral PI – rule with possibility to change the constant values..
3. Corrections in the pre-set values for the feed water to the installation depending on the t ° C of the return water, by means of maintaining a constant temperature difference between the feed and return water for the current working pint of the pre-set curve.
4. Availability of a timer in the control device for setting of optimum operating regimes for certain periods of time.

III. Short description of the communication part

The communication part consists of :

1. Communication microprocessor module compatible with interface MULTICAL-III for reading of heat meter data;
2. Standard external modem for connection with the central computer.
3. Software functions:
   - Reading and accumulating of data from the control device and the current settings.
   - Reading and accumulating of heat meter data.
   - Determined by the operator period for data recording.
   - On-line review of control settings.

IV. Summarised Results

	Indicators	Unit	Preliminary results	Final results
1	Heat savings	Gcal/year	606,25	879,84
2	Savings	%	15,00	21,8
3	Heavy fuel oil savings	t/year	83,34	120,95
4	Price of heavy fuel oil	Euro/ton	101,15	101,15
5	Heavy fuel oil cost savings	Euro/year	8429,84	12234,00
6	Investment	Euro	31955	31955
7	Pay-back period	Year	3,79	2,61

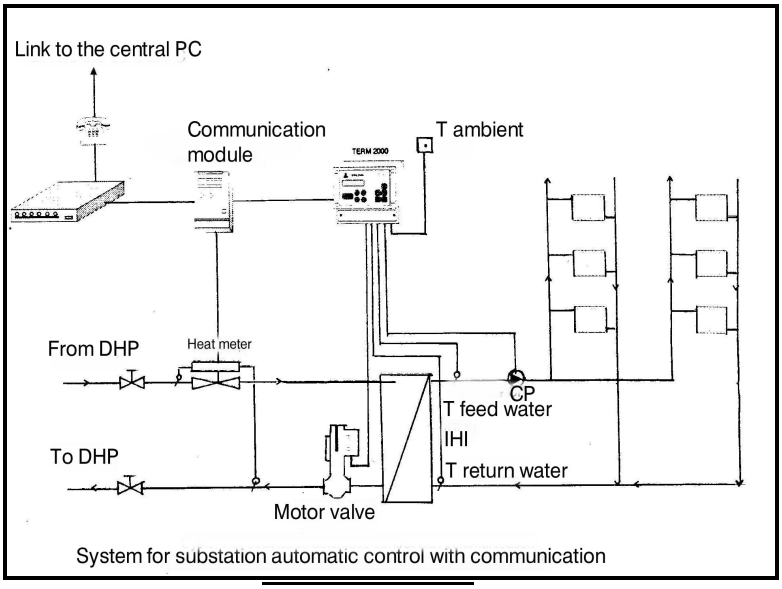

Fig. 1

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