

Improving municipal energy management by motivational measures

Maarit HAAKANA
VTT Building Technology

Ulla SOITINAHO
Helsinki Energy Management Agency

1 - SYNOPSIS

The paper presents the development and testing of motivational measures for more energy efficient maintenance of pilot school buildings. Bonus wage system and non-material measures are described.

2 - ABSTRACT

Motivational measures for more energy efficient maintenance of buildings are piloted in the ongoing SAVE project 'Improving municipal energy management by motivational measures and knowledge transfer'. Different motivational measures are piloted in four school buildings in the City of Helsinki, the target group being the maintenance personnel.

According to a preliminary study carried out in the City of Helsinki one of the main problems in the energy management was that the energy saving did not motivate the personnel. The reason for the lack of motivation is mainly based on the complicated organisation and strict budgeting and wage systems.

The bonus wage system, developed in co-operation with the maintenance team of one pilot school was tested during October 1998 - March 1999. The bonus is based on achieving the target levels in energy and water consumption and performing certain maintenance work, for example checking the operation hours of ventilation and changing them whenever the need of ventilation is changed.

The maintenance teams of pilot schools are motivated also by non-material measures such as personal guidance, training and feedback related to the energy consumption. The municipal newsletter uses one pilot school as a good example in its energy saving articles. The detailed proposal for a new, more motivating energy cost budgeting system will also be produced in the project. The results of the pilot actions on motivation and energy consumption of the buildings will be available in spring 1999.

3 - INTRODUCTION

3.1. Background

Municipalities are among the largest groups of building owners and consequently building related energy consumers in Finland. For example, a major energy consumer group in the Helsinki area is comprised of the buildings owned by the City of Helsinki. The total energy end-use in buildings in the Helsinki area is about 9,5 TWh annually. Of this amount space and water heating account for about 2/3 and electricity about 1/3. The municipally owned buildings account for about 1 TWh of the heating energy and about 0,3 TWh of the electricity consumed annually, which means about 15 % of the heating energy and 10 % of the electricity consumption in the City area. Municipal buildings offer significant potential in energy efficiency improvement, from both the viewpoints of absolute energy consumption levels and replication of individual energy efficiency measures.

VTT Building Technology and the City of Helsinki have carried out common work during the past several years aiming at providing the City with methods and tools for the technical implementation of municipal energy management. This has included tools development for simple and fast determination of energy consumption targets for different types of buildings, development of energy audit schemes for municipal buildings, development of information packages etc. The technical tools have been put to practice successfully in several cases, and they have proven their value in practical energy management of individual buildings. However, even when the technical means of improving energy efficiency are available, there are still several obstacles for a successful energy management.

According to a preliminary study carried out in the City of Helsinki one of the main problems in the energy management was that the energy saving did not motivate the personnel. This has often ended at a lower improvement in energy efficiency than estimated, because the impact of motivation on the adoption/operation of the technical solutions (or vice versa) has to some extent counteracted the improvements. The reason for the lack of motivation was mainly based on the complicated organisation and strict budgeting and wage systems (Haakana et al.1996).

In an ongoing SAVE-project "Improving municipal energy management by motivational measures and knowledge transfer" (DGXVII-4.1031/Z/96-029) the motivational measures in the municipal public buildings are studied in one of the three work packages of the project. This work package is carried out by VTT Building Technology and Helsinki Energy Management Agency. VTT Building Technology is the leading impartial research institute in Finland in the field of energy efficiency in buildings. Helsinki Energy Management agency is one of the local energy agencies set up with the support of EC DGXVII under the framework of the "Regional and urban Energy Management" programme. The agency carries out information dissemination, technical advisory and consultancy services and project coordination in the field of energy efficiency within the Helsinki municipal area.

Other two work packages in the SAVE-project are carried out by TNO Building and Construction Research (Netherlands), which is the coordinator of the whole SAVE project, and by CSTB (France). Those work packages concentrate on motivating the occupants in residential buildings and facilitating the dissemination of best practices in energy management for energy managers of towns. The SAVE-project started in summer 1997 and it will be reported in June 1999.

3.2. Scope

In this presentation the work package carried out by VTT and Helsinki Energy Management Agency will be described.

The aim of the project was to demonstrate in pilot buildings a) the identification of organisational and motivational problems and possibilities for the introduction of incentives for management personnel, b) the definition of suitable organisational solutions to these bottlenecks and c) the actual impact of organisational and motivational changes on the energy performance of the target buildings. The energy performance includes here the heating energy consumption, electricity consumption and water consumption of the building.

In a short summary: the aim was to find out, what are the motivational problems among operational personnel, what could be done to improve the situation and what kind of motivational measures are the most attractive? If those motivational measures were implemented, would they have any impact on the energy consumption of the buildings? In that order, it was decided to test different motivational measures in 4 - 5 pilot buildings. The motivational measures were planned to be both material and non-material: money, personal guidance, training and feedback related to the energy consumption, and energy saving articles using pilot schools as good examples.

The project has not been completed yet. In this presentation the experiences gathered so far (March 1999) have been summarised.

4 - METHODOLOGY

4.1. Selection and analysis of pilot cases

Previous analyses of the municipal energy management structure was reviewed and refined in order to identify pilot cases with the best potential. School buildings were chosen as the main general target group. The maintenance organisation of school buildings in Helsinki, Services Centre of Educational Department (later SCED), has been interested in energy saving issues and has actively developed energy management procedures in schools during the past several years. Nevertheless, a number of motivational problems among the maintenance personnel at grassroots level could still be observed.

Maintenance personnel in the schools are employed and paid by SCED. The energy and water bills are paid by the school master, who commissions the maintenance work from SCED. If energy is saved, the school master can use the saved money for acquiring educational material, such as computers etc. However, even though the maintenance team often contributes significantly to the energy efficiency, SCED does not receive its share of the saved energy costs. Consequently the saved energy costs can be used to improve the working conditions of teachers and pupils but not the working conditions of the maintenance team. This drawback in the municipal budgeting system has been identified as one of the main problems in motivating the maintenance personnel.

There are over 160 schools in Helsinki area owned by the municipality. A questionnaire was sent to the technical maintenance persons of 120 schools concerning the importance of the energy saving work, the possibilities of the maintenance persons to have an influence on the energy use, and many other questions connected to the energy saving and the maintenance and school organisation. The response rate was very high (74 %) and it was noticed that the maintenance persons were more interested in saving energy than assumed. That assumption was based on interviews on a smaller group of maintenance personnel, which was done a few years before this questionnaire. Some part of this growth in energy saving interest is probably based on the development work done by SCED and the Helsinki Energy Management Agency.

Several discussions were carried out also with the director and personnel of SCED in order to outline the problems and possible solutions and in order to choose the pilot cases.

It was decided to focus on four case study schools. One of them had already been a pilot school in testing the bonus wage system of SCED, which was carried out during 1997 in seven schools in Helsinki. The bonus in that previous pilot study was based on economical results, customer satisfaction and the undertaking of development projects. Energy issues were not included. The three other schools selected as pilot cases in this project had no experience in bonus wages. The wage system of maintenance personnel is normally based on fixed monthly salary.

All the technical maintenance persons of the pilot schools were interviewed in the beginning of the year 1998. The questions were made about motivation and related problems. The maintenance persons also gave marks on different motivational measures which were offered by the interviewer. There were 16 different motivational measures and the maintenance persons gave them school grades from 4 to 10, where 4 is the worst grade and 10 is the best. Personal bonus wage was the most attractive motivational measure. Table 1 lists the five best motivational measures based on the opinions of the maintenance persons.

Table 1. The best measures to motivate the maintenance personnel to save energy.

<i>Motivational measure</i>	<i>Grade</i>
• personal bonus wage will be paid on the basis of energy saving work	9
• the money saved in energy consumption will be used for the work of maintenance team	8.6
• monthly meetings in energy saving issues will be arranged for a group consisting of the school master, maintenance person and his foreman.	8.4
• competition, where the maintenance person who has saved energy will be awarded	8.2
• visits to the similar buildings abroad	8

4.2. Motivational measures, planning

Different motivational measures were discussed and proposed for the approval of SCED already during autumn 1997. There were four pilot schools allowing four different motivational measures to be tested. SCED made some restrictions, e.g. the technical maintenance person could not have a personal reward of saving energy. The bonus or reward had to be given always to the whole maintenance team of the school. The maintenance team in schools includes the technical maintenance person, the cleaners and the kitchen personnel.

Changing the budgeting system is one of the motivational measures, which was proposed by the project group. All the measures with structural or organisational changes take always quite a long period to put into effect. This means that the project will only start discussions of changing the budgeting system in one of the pilot schools (school 1) and will produce a detailed proposal for a new, more motivating energy cost budgeting system.

The previous bonus wage system of SCED was expanded into 16 schools in the beginning of 1998. The system had not included energy issues and the SCED wanted to include some small parts of energy issues in their expanding bonus wage system. The project group developed in autumn 1997 a simple performance evaluation method for energy efficient maintenance, which SCED used in developing their standard bonus wage system. The energy efficiency evaluation scheme proposed by the project group was going to be tested in school number 2 as a part of SCED's standard bonus wage system.

Because the importance of energy issues was very low in the SCED's standard bonus wage system, the project group wanted to test a special bonus wage system, which would concentrate only on energy use and actions which have an effect on energy saving of the school. School number 3 was going to be a test case for a bonus wage system, which will give more weight to energy issues than the standard bonus system. It was decided that the project group and the maintenance team of the pilot school 3 would together develop the bonus wage system.

School number 4 was chosen to be a target of non-material motivational measures. Unlike the maintenance teams in the other pilot schools, personnel in this pilot school would receive personal guidance, training and feedback related to the energy consumption. They would also be used as a positive example in the articles of the municipal facilities management newsletter.

The final version of the motivational measures that would be demonstrated and tested are presented in table 2.

Table 2. Motivational measures to be tested in pilot schools

<i>Pilot school</i>	<i>Motivational measure</i>
<i>School 1</i>	<ul style="list-style-type: none"> • Proposal for changing the budgeting procedure so that the savings in energy costs can be shared between the school and SCED
<i>School 2</i>	<ul style="list-style-type: none"> • Payment of bonus wages with the proposed energy efficiency evaluation included in SCED's standard bonus system
<i>School 3</i>	<ul style="list-style-type: none"> • Special reward which is more dependent on energy issues than the normal bonus system
<i>School 4</i>	<ul style="list-style-type: none"> • Non-material motivation measures according to the wishes and needs of the maintenance person

The budgeting proposal and the standard bonus system of SCED will not be described further on in this presentation.

4.3. Motivational measures, implementation

After the interviews in pilot schools were completed in spring 1998, the decision could be made in choosing which of the schools would be school 1 and which ones would act as schools 2, 3 and 4. The pilot school and the motivational measure to be tested just in that particular school could be brought together, when the opinions of the technical maintenance persons were available. Although money was the most important measure to motivate the maintenance personnel to save energy, the maintenance persons differed in their other opinions in grading motivational measures. This was very valuable for the project. For example, the maintenance person in one school was very interested in publicity and using his school as an example in energy saving articles. It was easy to choose this school as the target for the non-material motivational measures, thereby it was chosen to act as school number 4.

The analysis of the technical systems of all the pilot schools was done in the spring 1998. The possibilities of the maintenance persons to save energy and their knowledge on using the technical equipment were observed. At the same time the indoor temperatures and CO₂- concentrations in chosen classrooms were measured in order to find out the current level of indoor climate. The energy saving measures in buildings must not worsen the indoor climate. The indoor climate measurement was carried out in all the schools twice more during the project.

The maintenance persons of the pilot schools will be interviewed in the end of the project (spring 1999). The questions will be quite similar to those in the beginning of the project, in order to reveal the changes in the work motivation. Also the energy consumption of the pilot schools will be analysed.

4.3.1. Bonus wage system

The bonus wage system for school 3 was developed in co-operation with the maintenance team of the school. The project group made proposals of the evaluation method and its content to be approved by the maintenance group. Several meetings were arranged during the spring and the summer of 1998, where drafts of the bonus wage system and its evaluation method were developed further. Final version of the method was completed in September 1998 and the system was tested during October 1998 - March 1999.

The bonus is based on achieving the target levels in energy and water consumption and performing certain maintenance work, for example checking the operation hours of ventilation and changing them whenever the need of ventilation is changed. The evaluation method consists of earning "points" by doing 18 different maintenance work actions and reaching the electricity, heating energy and water consumption target levels. The maintenance work included in the evaluation method has an influence on the energy use. For example ventilation has a very significant role in the energy consumption of the school, thus it is very important to use it in an energy efficient way.

Every single task gives “points” from 1 to 5, where 3 is the common level and does not justify any bonus. To get a bonus the maintenance team has to perform better than an average team and score more than 3 “points”. For example, if the maintenance person checks the operation hours of ventilation twice a year, which is the common way of doing it in schools, he gets 3 “points”. If he does it once a month, he gets 4 “points” and if he does it once a week, he gets 5 “points”.

In the same way, if the electricity consumption during the test-period will stay at the same level as the average consumption of the three previous years ($\pm 1.5\%$), the maintenance team receives 3 “points”. If the consumption decreases by 2.5 % or 5 %, they receive 4 or 5 “points”, respectively. Same kind of target levels were set for the heating energy consumption as well as for water consumption. Because the maintenance team can influence on the heating energy consumption of the school more than on the electricity consumption, it was decided to use weighting factors when counting the final points. The points connected to the heating energy targets have a weighting factor of 1.5 and the points connected to the electricity targets have a weighting factor of 1. In the similar fashion some maintenance work actions have weighting factors ranging from 0.5 to 2.0.

The possibilities to save electricity or water by carrying out maintenance work or technical actions were very limited in the test school. That is why the maintenance team receives points in those areas by bringing out ideas on how to save electricity or water in their own work. If they write down new ideas once a month they receive 4 points and if they do that twice a month they receive 5 points.

Usually the point levels are connected with the frequency of doing the maintenance actions. The maintenance team has received the forms in which they fill up the dates after doing the tasks. In one task they have to measure temperatures in class rooms once a month, then they also write down the temperatures in the form. The forms are sent monthly to Helsinki Energy Management Agency, which has been collecting the monthly consumption figures of all the schools of Helsinki since 1994.

The headmaster of the school gives his evaluation of the quality level of the maintenance work during the pilot period. His evaluation gives also points from 1 to 5. The aim of this evaluation is to ensure that the energy saving will not be achieved at the expense of other maintenance tasks.

The points will be summarised in order to find out the amount of earned bonus wage in the beginning of April 1999. If the team has done almost everything at the level of 5 points, the total sum of points is 100 points (weighting factors included). If so, everyone in the maintenance team gets a bonus of 2000 FIM (333 Euro). That sum is about one quarter of their monthly salary. If on the average they have done everything at the level of 3 points, (sum 66 points) they do not receive bonus money. Between 66 and 100 points, they receive a percentual part of the maximum bonus.

4.3.2. Non-material measures

The technical maintenance person of pilot school number 4 is motivated by non-material measures such as personal guidance, training and feedback related to the energy consumption. He is used also as a positive example in the articles of the municipal facilities management newsletter, “Kiinteistövinkki”, published by Helsinki Energy Management Agency. That newsletter was founded with the purpose of giving general and regular information of energy saving goals and methods to the operating personnel of the municipal building stock of Helsinki (over 3000 buildings). The newsletter is published twice or three times a year.

The maintenance person of the school number 4 was presented in the newsletter published in the beginning of 1999. An article in the newsletter dealt with his interest in measuring voluntarily the indoor climate conditions of the school. In the article it was also told about finding out the defects in the building constructions which had increased the heating energy consumption of the school. The article was carefully written in such a way that it showed that his work was appreciated.

Personal guidance was provided to the maintenance person of the school twice in the autumn of 1998. The guidance was given especially in the use of the control systems of heating and ventilation. The guidance has to be done in a very discreet way, when guiding a person who has been working in his own way for over 13

years. The guidance was arranged so, that the maintenance person acted as a host when the control system expert gave guidance to a student.

5 - RESULTS

At the end of March 1999 the final results of the project were not yet available. Intermediate results can however be presented.

At school 3, where the bonus wage system was tested, the heating energy, electricity and water consumption in October and November were over 5 % smaller than the average consumption in the same months during the previous three years. The maintenance personnel had done every maintenance action on 5-point level and they were on their way to the full-scale bonus wage. The cleaners and the kitchen personnel had noticed many very practical ideas about how to save electricity and water. For example they had decided to check all the toilets after every break in order to close the water tabs and turn off the lights. The headmaster of the school will later be interviewed in order to find out the quality level of the maintenance work during the pilot period.

At school 4 (non-material measures) no changes in energy consumption can be found so far. The maintenance person turned out to be very interested in energy matters once someone showed interest in his work. He checked the ventilation system and after the guidance, he voluntarily measured the indoor temperatures, surface temperatures and CO₂-concentrations in the classrooms. His measurements showed that there were some faults in the wall construction of an extension of the school. In order to have a proper temperature in that extension, the rest of the school had to be overheated. Now he has proposed extra heaters to be installed into the classrooms of the extension.

6 - CONCLUSIONS

The results gathered so far give an impression that maintenance personnel can be motivated to save energy by bonus wage systems and also by noticing their work and giving them guidance. It might, however, be more honest to say that they already are motivated to save energy but that they just need some kind of an extra push to get them started.

In some estimates it is expected that motivational measures leading to better operation and maintenance of buildings will account for a saving potential of 10 - 20 % in individual buildings, and around 10 % when multiplied across a heterogeneous building stock. If this amount of energy could be saved for example in the buildings owned by the City of Helsinki, it would mean 0,13 TWh annually.

The results of these pilot cases are synthesised in order to provide experience and guidelines for planning and implementing general energy efficiency measures within public buildings. The results will be reported in June 1999.

7 - REFERENCES

HAAKANA et al. 1996. *"The organisational and administrative problems in energy management of the City of Helsinki."* Internal report for the use of Helsinki Energy Management Agency (only in Finnish)

L.L SOETHOUT et al. 1998. *"Improving municipal energy management by motivational measures and knowledge transfer."* Progress report. TNO-report 98-BBI-R0390.