CADDET energy efficiency

IEA
OECD

AIVC 10978

Demand-sensitive-
lighting and ventilation

Energy-efficient lighting and ventilation in an office building

Summary

A publicly-owned office building in Eskilstuna, Sweden, has been retrofitted with high-frequency lighting, in combination with self-regulating controls for the lighting and ventilation systems. The building has a total floor area of 19,000 m^2 and contains more than 300 offices, a conference room, lunch rooms, and a recreation hall. Before retrofitting the total annual electricity consumption was 1,300 MWh and the district heat consumption was 950 MWh. The total annual energy consumption was reduced by 20% as a result of the new instal-lations.

Monitoring has shown a reduction in overall electrical energy consumption of approximately 30%. This saving comes from a 10% reduction in ventilation requirements, and a 40% reduction in electrical power demand.

Highlights

- **Self-regulating lighting and ventilation**
- **20% total energy savings**
- **Electric power demand reduced by 40%**

The retrofitted building in Eskilstuna.

Aim of the Project

The aim of the project was to demonstrate the energy savings that can be achieved by the installation of an integrated energy-efficient lighting and ventilation system when renovating a building.

The project also aimed to reduce the total energy consumption in the building and to lower the power demand for heat and electricity, compared to more conventional technologies.

The Principle

The conventional lighting in the building was replaced by high-frequency lighting. The lighting system was controlled by infrared occupancy sensors (Bosch-Wächter) situated in each office. These sensors detect movement in the room. The light is switched on when somebody is in the room and if lighting is required. The same sensors are also used to control the ventilation system. When the room is unoccupied, the lighting is switched off and the ventilation load is reduced to a set-back level.

As a result of this control system, the average temperature in the office is lowered during the heating season, and the cooling demand is therefore reduced throughout the rest of the year.

The building is connected to the local district heating system. Within the building itself, a heat pump is used for cooling and to preheat the inlet air. It is also possible to use the heat from the heat pump in the building's radiator system.

The Situation

The building was constructed at the beginning of the 20th century. It is owned by the community and is used as an office. The energy retrofitting measures installed were part of a more extensive building renovation programme. The municipality has a policy of making energy efficiency a priority when buying new office equipment, such as computers and photocopiers.

A typical office in the retrofitted building.

The building has a total floor area of 19,000 m^2 and consists of 330 offices, a conference room, lunch rooms and a recreation hall. The total electricity consumption in 1993 (before the energy-efficient installations were introduced) was 1,300 MWh. The district heat consumption was 950 MWh. These figures give a specific electricity consumption of 68 kWh/m^2, with a power demand of 16 W/m^2. The corresponding figures for heat demand were 50 kWh/m^2 and 45 W/m^2 respectively.

The new systems were installed in 1993. An energy audit was carried out before and after retrofitting (late 1992 and early 1994), but was limited to one section of the building. Monitoring was carried out for a period of five days. The section audited included 16 offices, a storage room, a pantry, a photocopy machine and 15 personal computers.

During the audit period the occupancy sensors reduced the electricity consumption by 24%, whilst the total energy consumption for ventilation decreased by around 8%.

The installation of high-frequency lighting instead of conventional lighting reduced the electricity consumption by an additional 9%.

Figure 1 shows the variation in hourly ventilation demand before and after the installation of the occupancy sensors. The demand for ventilation prior to the installation varied between 13 and 19.8 kW. After retrofitting, the demand decreased significantly, particularly at night when the building was

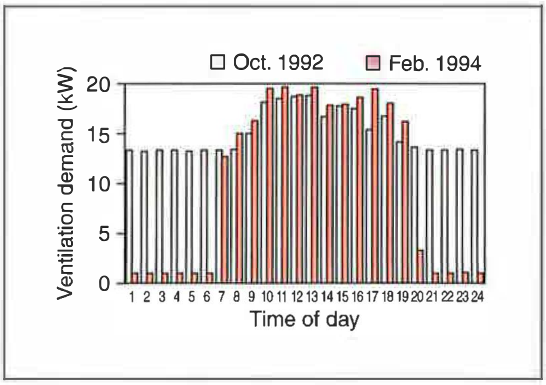

Figure 1: Ventilation demand before and after the installation of occupancy sensors.

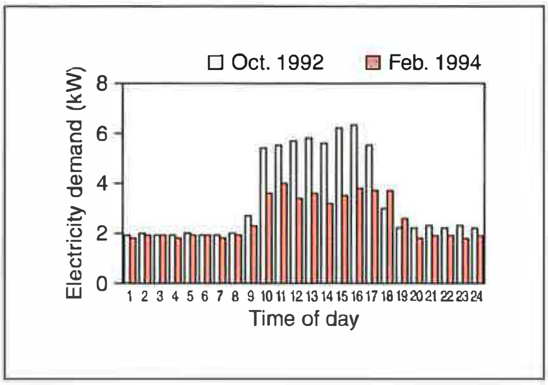

Figure 2: Electricity demand before and after the installation of occupancy sensors.

unoccupied, to a minimum of only 1.5 kW.

Similarly, Figure 2 shows how the demand for electricity varied before and after the sensors were installed. Prior to installation, the electrical power demand varied between 2 and 6.8 kW. After retrofitting, the demand decreased to between 2 and 4 kW. This represents a reduction of approximately 40% in the peak demand.

Other energy conservation measures were also installed, including screen-saving personal computer displays, timer controls on photocopiers, etc. However, these additional measures did not result in any significant savings.

The installations have worked well but some experiences from this project are worth mentioning. The sensing device in the occupancy sensors detects movement in a room, and will switch the lighting on when someone enters. However, experience has shown that infra-red sensors would probably have been more suitable. With the current situation, it is possible that the lighting could be switched off if a person in the room were to sit still for a long period of time. This might occur, for example, with someone working at a computer terminal. It is also questionable whether the same sensor should be used to control both the lighting and ventilation systems. Having the sensors set up in this way means that the lights must be switched on, even on sunny days, in order to obtain sufficient ventilation.

The Company

Eskilstuna Energy & Miljö AB is the local utility supplier of district heat, electricity, water and sewage in Eskilstuna, a town some 100 km west of Stockholm, Sweden. The company is owned by the municipality and has an annual turnover of approximately SEK 600 million. It currently employs around 300 people. The annual supply of district heat is 709 GWh, with a maximum demand of 370 MW. The annual supply of electricity is 660 GWh, of which 100 GWh is used for heating purposes.

Economics

The additional investment costs required for the installation of occupancy sensors and high-frequency lighting was approximately SEK 2.3 million. Of this figure, around SEK 750,000 was contributed as a grant by the Swedish Energy Development Corporation.

Assuming an annual energy saving of 20% for both electricity and heat, i.e. an electricity saving of 260 MWh, and a 180 MWh thermal energy saving from the district heating network, the annual cost savings amount to SEK 150,000. These savings are based on an electricity price of SEK 450/MWh, a thermal energy price of SEK 300/MWh, and assume an increase in maintenance costs of SEK 23,000 per year. The resulting simple payback period is thus 15 years, though this period is reduced to around 10 years if the grant from the Swedish Energy Development Corporation is taken into account.

Host & Contracting Organisation

Eskilstuna Energi
& Miljö AB
Marknadsavdelningen
S-631 86 Eskilstuna
Sweden
Tel.: +46-16-102000
Fax: +46-16-148805
Contact: Mr Kari Potkonen

Host Organisation

Eskilstuna Kommun
Fastighetskontoret
S-631 86 Eskilstuna
Sweden
Tel.: +46-16-101000
Fax: +46-16-139641
Contact:
Mr Lennart Larsson

Subsidising Organisation

Swedish Energy
Development Corporation
Elforsk AB
S-101 53 Stockholm
Sweden
Tel.: +46-8-6772530
Fax: +46-8-6772535
Contact:
Ms Görel Ardelius

Please write to the address below if you require more information.

CADDET energy efficiency IEA * OECD

Swentiboldstraat 21,
6137 AE Sittard,
PO Box 17, 6130 AA Sittard,
The Netherlands,
Telephone: +31-46-4202224,
Telefax: +31-46-4510389,
E-mail: caddet@caddet-ee.org
Internet: http://www.caddet-ee.org

* 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 24 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 40 Implementing Agreements, containing a total of over 70 separate collaboration projects.

The Scheme

CADDET functions as the IEA Centre for Analysis and Dissemination of Demonstrated Energy Technologies. Currently, the Energy Efficiency programme is active in 15 member countries.

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

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

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