PN-ACH-468
104597

Csolnoky Ferenc Kórház és Rendelõintézet County Hospital, Veszprem, Hungary Energy Efficiency Demonstration Project Evaluation

Final Report

PREPARED BY:

Jennifer Fagan

IN ASSOCIATION WITH:

EGI – Contracting Engineering Company, Ltd.
Budapest, Hungary

PREPARED FOR:

United States Agency for International Development
Budapest, Hungary and Washington, DC
Regional Energy Efficiency Project (180-0030)
Contract No. DHR-C-00-95-00064-00

and

Csolnoky Ferenc Kórház és Rendelõintézet County Hospital
Veszprem, Hungary

30 April, 1999

1

1. PROJECT BACKGROUND

The proposed project was selected based on three considerations:

1. The site selected (a municipally-owned hospital) is one of the type of facilities identified in the Hungary Project Work Plan as being seriously in need of energy efficiency improvements;
2. The technologies involved in the demonstration project appear to be very cost-effective, and are also very replicable throughout Hungary;
3. The municipality and hospital involved are financially stable and highly motivated to reduce energy consumption and related costs.

This project was the outcome of the Energy Managers Contest conducted by EGI Contracting Engineering Co., Ltd. and the Hungarian Chamber of Engineers under Electrotek Concepts Inc.'s USAID contract. Mr. Sandor Nagy, Energy Manager at Veszprem County Hospital, submitted a proposed energy savings plan that included many of the measures that were ultimately installed in the hospital buildings. His rationale and calculations of proposed energy and cost savings appeared to be very sound. It was on this basis that EGI and Electrotek selected Veszprem to participate in the hospital energy efficiency demonstration project activity.

Veszprem County Hospital is an 840-bed hospital complex. The complex consists of several buildings, including a separate school and museum. The total energy use and cost for the hospital complex before project implementation was as follows:

Electricity:	Usage - 4,450 MWh/year
	Cost – 51.1 million Ft. ($243,000)
Natural Gas:	Usage – 1.93 million meters^3 /year, 65,620 GJ/year
	Cost – 65.6 million Ft. ($312,000)
Water:	Usage – 155,800 meters^3 /year
	Cost – 22.6 million Ft. ($108,000)

2. DESCRIPTION OF PROJECT

There were five energy efficiency measures that were installed:

- Steam traps and condensate system upgrade for the laundry;
- Heating system controls for Building A;
- Water saving equipment in the outpatient building;
- New boiler for the outpatient building; and,
- Refurbishing the indoor lighting system with efficient fluorescent fixtures and bulbs.

The energy efficiency measures are described briefly below.

Laundry Improvements

Twenty-five steam traps, a new condensate tank, two electric condensate pumps and level switches, and new piping were installed in the laundry. All of these measures were intended to lower condensate/steam losses in the laundry, which were considerable.

Heating System Controls

Previously, Building A of the hospital had two heating circuits that had manually-controlled steam/water exchangers. The new heating controls provide computerized, automated control of these circuits and are connected to the building management system for the hospital.

Water Saving Equipment

Automatic faucets and toilet flushers were installed in the outpatient building. Much water was being lost due to open faucets and running toilets. Before these measures were installed, Mr. Nagy needed to have one of his staff members go to all the bathrooms regularly to turn everything off, so with the new measures, there are both water and labor savings.

New Boiler

A new boiler was installed in a detached, specialized out-patient building, and the building was then disconnected from the central heating system. A large component of the energy savings from this measure is the distribution losses associated with 105 meters of distribution piping that are now avoided. This section of distribution piping is now removed. Also, steam losses from the steam traps located in the substation serving the building are avoided.

Energy Efficient Lighting

In building A, three different types of fluorescent fixtures were installed to replace existing incandescent fixtures:

- 36 watt single bulb fixtures to replace 60 watt incandescent fixtures
- 36-watt 2-bulb fixtures to replace incandescent fixtures with two 100 watt bulbs
- Single 15-watt tube lights to replace a n incandescent fixture with a single 25 watt bulb

3. INSTALLATION OF PROPOSED MEASURES

The hospital was responsible for the installation of all of these measures. A large portion of their contribution to the project was the installation cost and labor. Therefore, the priorities and resources of the hospital dictated the timing of the equipment installation. Because of this, the installation of some of the measures (particularly the energy-efficient lights) took place very late in the project.

Most of the energy savings measures were installed during the spring and summer of 1998. The steam measures for the laundry were purchased and installed first, in April-May 1998. These measures were desperately needed by the hospital because existing equipment had corroded and failed, and there was a serious problem with steam build-up in the laundry. The heating system measures and water saving equipment were installed during the summer and early fall of 1998, before the start of the heating season.

Originally, the schedule for installation of the lighting measures was tied to planned renovations for Building B that were to take place during the summer of 1998. However, these renovations were delayed and subsequently, cancelled due to lack of funds. Therefore, it was necessary for Veszprem to (1) find another location to install these fixtures; and (2) secure sufficient budget to install these fixtures. In the fall of 1998, Veszprem decided to install the fixtures in Building A rather than Building B. And finally, in November 1998, the fixtures were installed in Building A.

4. QUANTITATIVE EVALUATION OF ENERGY SAVINGS AND PROJECT PAYBACK

Methodology Used to Compute Energy Savings

To compute the energy savings for this project, both whole-building metered data and direct observations (using data collected through spot metering) were used. The following describes the method used to estimate the energy savings for the various installed measures.

Steam traps for the laundry

The steam traps were inspected by an ULTRAPROBE 500 type steam trap tester before the intervention. This device converts the ultrasonic sound generated by the steam flow, whose intensity is proportionate to the velocity, to an audible frequency. The actual flow can be identified as a function of the intensity and sensitivity readings of the instrument with the help of a calibration chart. Based on the measurements carried out, the total steam loss was identified at 250 kg/h. The majority of the losses were caused by poor technical condition of the steam traps. Also, the thermostatic type traps were not compatible with the equipment they served, resulting in further inefficiency.

Through the project, reliable, inverted-bucket type steam traps were installed. The working principle of this type of steam trap is better suited to the equipment of the laundry and the probability of steam trap failure is much lower than with the previously installed equipment. When the new steam traps operate properly, the total loss can be avoided; i.e. all the 250 kg/h steam could be saved. Based on this, the main monitoring method used was the random checking of the steam traps by the UTRAPROBE tester. As long as the steam traps were found to be in good working order, the 250 kg/h savings were assumed to have been achieved.

The steam traps were inspected twice, in October 1998 and in March 1999. In both cases, all of the steam traps were found to be in good working condition and no sound of blow-though steam was detected. Thus it is reasonable to assume that all of the 250 g/h savings have been achieved. The hospital's technical staff also agreed with this assessment.

The savings were also confirmed by the experience of the boiler operators, who observed that often one boiler was enough to meet the demand whereas before, two boilers were needed under similar conditions.

The available monthly readings of the gas meter, however, did not confirm the savings because, according to the hospital staff, there have been significant changes in the load and operating times of the laundry, resulting in increased gas use. Therefore, gas meter readings could not be used to confirm the energy savings from the steam traps or other installed measures.

Therefore the annual savings, calculated based on engineering assumptions, are as follows:

Avoided losses	250	kg/h
Operation time (hours/day) of the laundry	7.5	h/day
No. of working days a year	250	days

Annual savings = (250 day * 7.5 h/day * 250 kg/h) = 470 tons of steam

Heating system controls for building A

To monitor heat savings from the new heating controls, the following parameters were metered and logged before and after the installation of the new system:

- Supply and return heating water temperature,
- Outdoor temperature, and
- Indoor temperature in selected, typical rooms.

This data provided information on how the new controls were working. It also documented the extent of overheating of the building (if any).

The energy used for space heating is not metered separately in building A. The design heat demand of the building for -15°C ambient temperature is 780 kW. Based on the 3050 degree-day value applicable to Veszprém, the average space heating demand is 430 kW. The length of the heating season in an average year is 4500 h/year, thus the total heat use in design state is:

430 x 4500 = 1935 MWh = 6950 GJ

The difference between the actual heat use and the design heat demand before the project was confirmed through a walk through audit, spot checks of indoor temperature readings and collection of temperature data in different rooms of the hospital over a two month period. It was found that the actual heat consumption exceeded the design value by 18%.

Based on these findings, the baseline heat use of the building before the controls were installed was estimated to be 8500 GJ/year. In the Monitoring and Verification Plan, it was decided that heating energy use and energy savings after installation of the controls would be confirmed through:

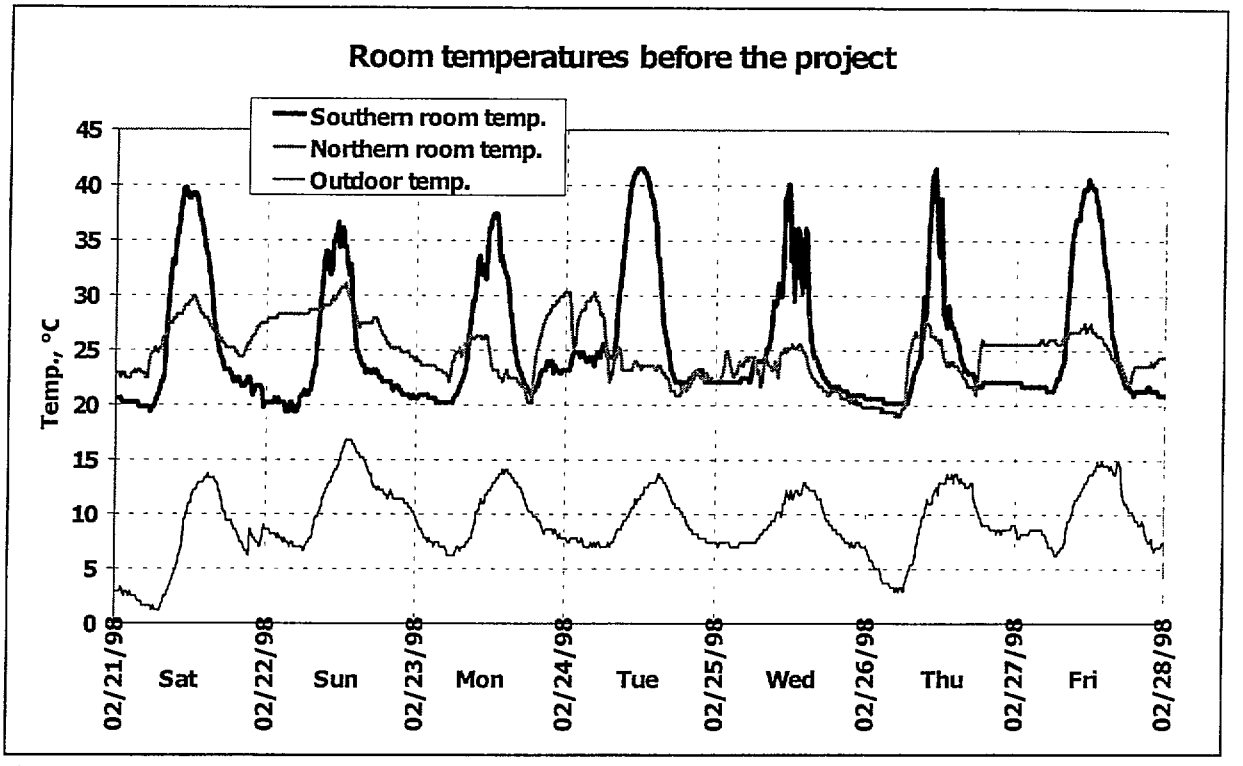
- Long-term temperature logging in the same rooms where baseline temperature data was collected.
- Performing walk-through audits, spot checking indoor temperatures in selected rooms and counting the number of open windows.

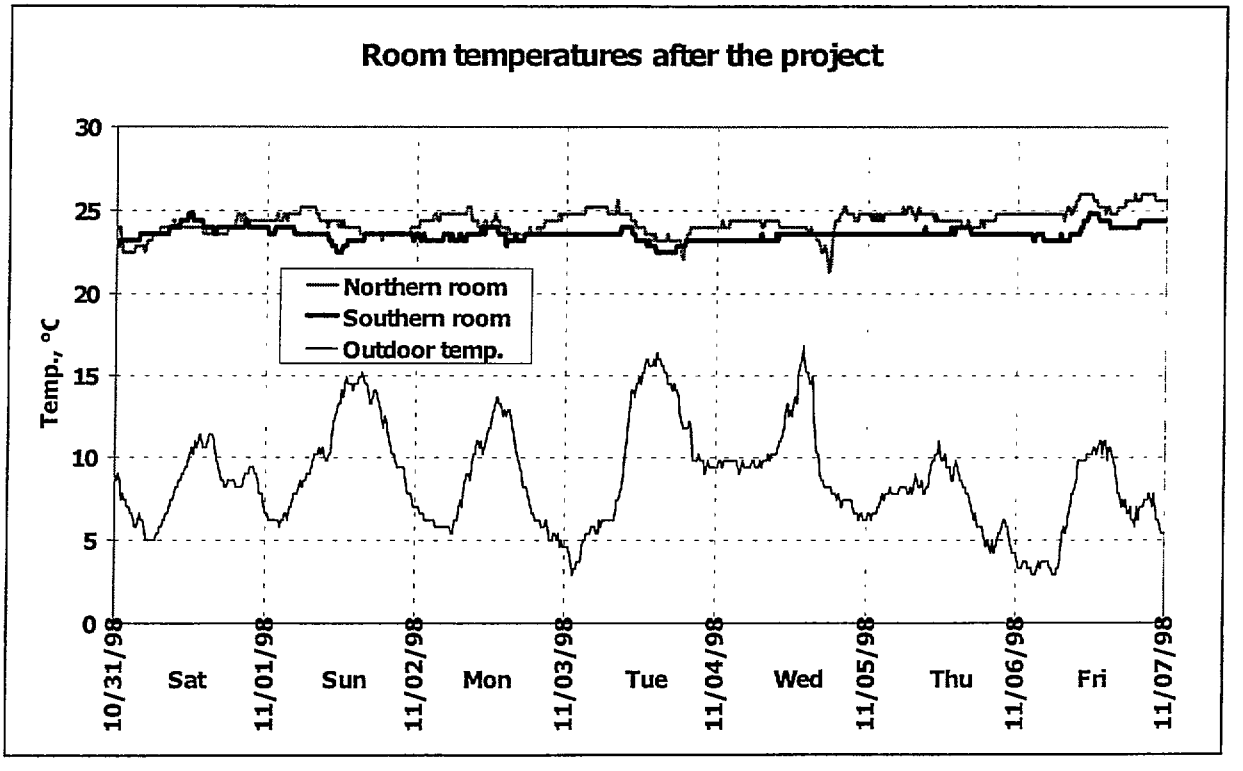
Based on the above, the difference between the actual heat use and the design status was found to be similar to the baseline situation, and annual heat use was then calculated.

The second investigation, after measures were installed, took place between 10/29/98-11/25/98. The results are presented in the charts of the two temperature logging sessions (before/after the project) shown on the following pages. The charts present two representative weeks, where the outdoor temperatures were similar. The following differences, which document the impacts of the new heating controls, are apparent from the charts:

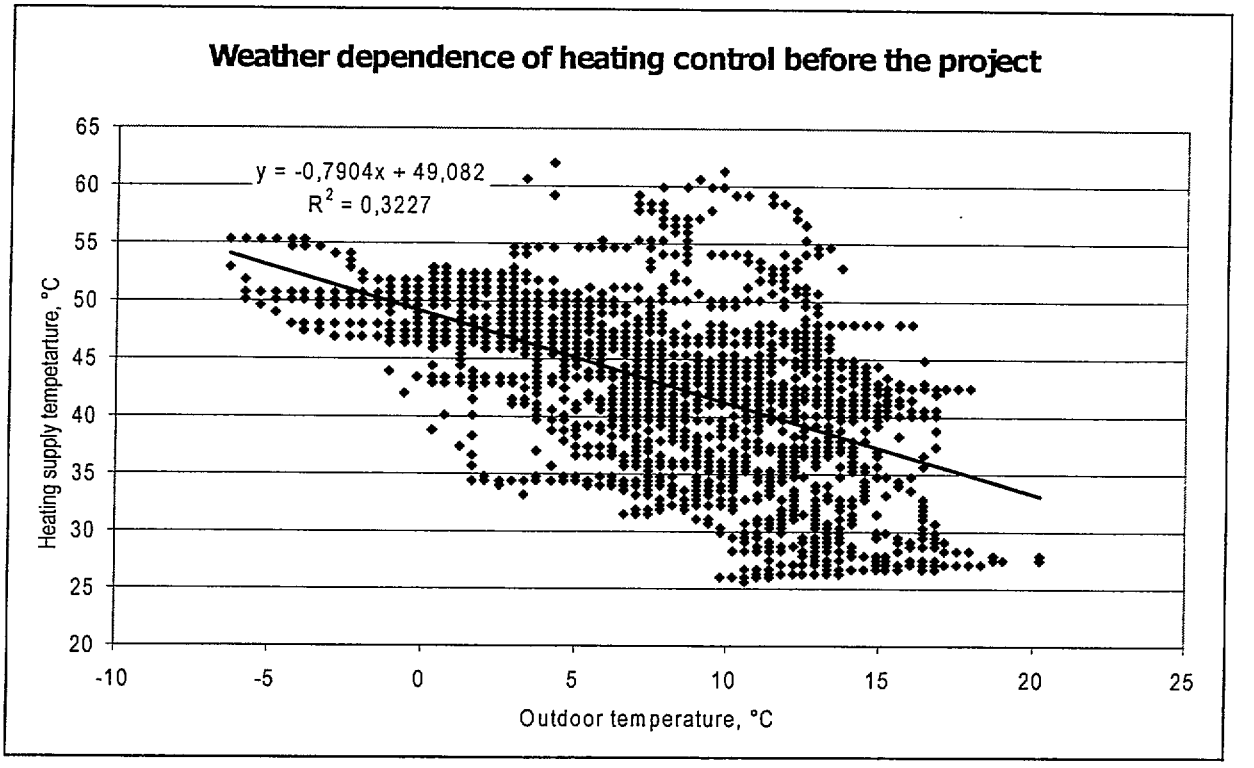
- The large variations in room temperature disappeared due to properly working controls.
- The differences between the southern and northern facing room temperatures, which were apparent in the "before" state even during nights, when no solar irradiation occurred, were significantly reduced. This shows that the individual heating circuits are adequately adjusted.
- The average room temperature of the southern room was reduced from 25.8°C to 23.6°C, (reduction 2.2°, the periods of solar irradiation were excluded); while that of the northern room was reduced from 26.7°C to 24.1°C (reduction 2.6°)

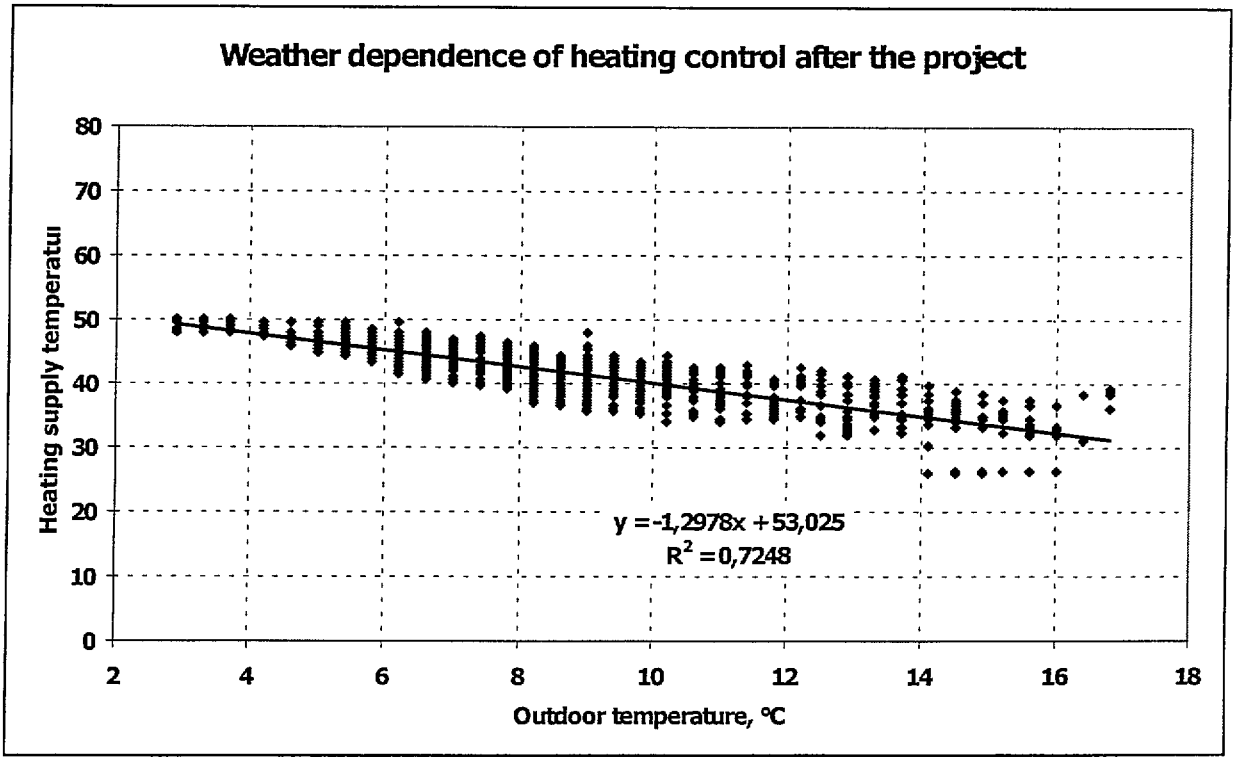
These values are rather close to the originally estimated 3°C-degree reduction. Obviously, the reduction of the room temperatures varies in the different rooms within the building, based on the outdoor temperature conditions and other factors. The spot checks in the building and the temperature logger data indicate a reduction of between 1.3-4.1°C. It is difficult to calculate an average temperature reduction, but these values suggest that the originally estimated savings are fairly close to the actual savings achieved, i.e. the 1550 GJ/year.





The following charts also demonstrate how effective the installation of automatic controls was. Both charts show the relationship between the outdoor temperature and the supply temperature of the heating system. It is apparent that manual control could hardly follow the changes of weather, while with the automatic controls the correlation between the two values is rather strong.





Water saving equipment

The water use of the outpatient building is metered by a water gauge. The practically constant monthly water use increased to 2000 m^3/month in 1995. Much of the reason for the high water use was the fact that the faucets and toilet flushers in the building were often left open. As a temporary solution, in February 1996, the boiler house operators were instructed to inspect the building regularly (3 times a day) and turn off the taps. This manual intervention resulted in considerable savings. The monthly water consumption data for the beginning of 1996 are as follows:

Month	Water use, m^3
January	2000
February	1695
March	1002
April	683

The post-January 1996 data reflects the impact of the manual inspections and intervention that were started in February 1996 and intended to be temporary (until water saving devices could be installed). Therefore, post-January 1996 data is not an appropriate baseline for evaluating the savings from the water saving devices. Instead, the 1995 average and the January 1996 data (i.e. 2000 m^3/month) were used as baseline data for calculating savings.

It was agreed that the basis for identifying the savings would be the regular reading of the water gauge of the building. The monthly reading is compared to the readings before the intervention. This approach assumes that the occupancy of the building did not change as a consequence of the project. It is also assumed that no seasonality of water use occurs, therefore any significant change in the monthly water consumption figures is due to the project.

The readings from the period after the project were the following:

Period	Number of days	Water gauge reading, m^3	Normalized consumption m^3/day
11/17/98-12/14/98	27	505	18.7
12/14/98-01/23/99	40	446	10.9
01/23/99-02/15/99	23	250	11.2
02/15/99-03/15/99	28	423	15.1

If the above values are averaged over the entire period examined, then the average water consumption after the project is 13.8 m^3/day or 414 m^3/month. Thus, the savings are 1,586 m^3/month, or approximately 19,000 m^3/year. This is more than the double the estimated savings of 8400 m^3/year.

New boiler in the out patient building

There were no meters installed for the building, therefore the (avoided) distribution losses could only be calculated. The steam trap losses were computed on the same basis as for the laundry improvements, using ULTRAPROBE measurements. The following was the agreed-upon calculation methodology:

The heat transfer for poor, often flooded insulation is calculated based on a coefficient of 4 W/m²K. Thus, the total heat loss over the pipeline and through the steam traps was calculated as follows:

Pipeline heat loss (avoided):

Heat transfer coeff:	4	W/m²/K
Heat transfer surface:	26	m²
Average steam temp:	100	°C
Average ambient temp:	10	°C
Heat loss:	9,38	kW (4 * 26 * [100-90])
Annual operation hours:	4500	h
Annual heat loss:	42,2	MWh = 152 GJ

Steam losses through the steam traps (avoided):

The loss of steam trap 1:	18	kg/h
The loss of steam trap 2:	22	kg/h
The loss of steam trap 3:	15	kg/h
Total steam loss:	55	kg/h
Annual operation (hours):	4500	hours
Annual steam loss (4500 * 55):	248	tons

After the new, autonomous boiler was installed, both the substation and the pipeline were removed. Therefore, both types of losses are entirely avoided. Although there is a further saving due to the improved efficiency of the new boiler, it is very difficult to calculate the energy saved, since the efficiency of the existing boiler is now somewhat lower due to the reduced load. Therefore, in the calculation of the savings only the avoided losses of the pipeline and the substation have been taken into account.

Energy Efficient Lighting

The energy and cost savings from the energy efficient lighting were straightforward to monitor and evaluate. The electricity savings in kWhs was simply the number of watts saved times the run time for the lights. The watts saved were computed based on the difference in the total wattage of fixtures and bulbs before and after installation of the new fixtures and bulbs.

The input data for the calculation of watts saved are as follows:

Type	Power demand, W	Type	Power demand, incl. ballast, W	Unit power saving	Number of such lights	Total power saving, W
60 W bulb	60	1x36 W tube	40	20	37	740
2x100 bulb	200	2x36 W tube	80	120	154	18,480
25 W bulb	25	1x15 W tube	17	8	100	800
TOTAL					291	20,020

The run time for the lights was monitored using run-time data loggers. The run time was found to be 3500 hours/year, based on the data logger readings.

Based on the power demand savings of 20.02 kW and the annual run time of 3,500 hours/year, the annual energy savings are 70,070 kWh.

Summary of Energy Savings and Simple Payback for Each of the Installed Measures

No.	Measure	Energy or Water Savings/yr.	Energy Bill Savings in KFt./yr.	Measure Cost in KFt.	Simple Payback (years)
1	Laundry improvements	470 tons (steam)	1034 KFt.	2083 KFt.	2.0
2	Heating system controls (bldg. A)	1550 GJ	1366 KFt.	3475 KFt.	2.5
3	Water saving equipment	19000 m^3/yr.	4028 KFt.	1372 KFt.	.3
4	New boiler for outpatient building	152 GJ 248 tons (steam)	680 KFt.	2081 KFt.	3.1
5	Energy Efficient Lighting	70,070 kWh	1013 KFt.	2081 KFt.	2.0