PN-ACR-975

SERBIA EMERGENCY ENERGY EFFICIENCY PROGRAM

ENERGY CONSERVATION MEASURES IMPLEMENTED IN THE MUNICIPALITY OF KRUŠEVAC

EVALUATION REPORT

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Prepared by

Nexant

for

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Section 1 Introduction

Serbia's energy consumption, particularly for space heating, imposes serious challenges to the country's recovery. Households and Municipal Institutions are facing difficulties paying for energy/heat, while energy producers- particularly electricity- face supply shortages. Heavy subsidies to the prices of electricity and district heat had exacerbated the situation by encouraging high consumption levels. The budgets of cities and energy enterprises are strained to provide the subsidies, making it difficult to increase energy supplies. Energy efficiency is clearly one of the methods to relieve the supply shortages, while also providing social protection against the inevitable removal of subsidies.

USAID designed the Serbia Emergency Energy Efficiency Program (SEEEP) with the objective of promoting energy efficiency at national level. The key element of the program is the widespread demonstration of financially attractive energy saving technologies, which will attract both private and public investments toward the repetition of the demonstration projects. The anticipated large number of repetitions will in turn have a substantial impact in reducing energy consumption at national level, with a consequent reduction in government expenditures.

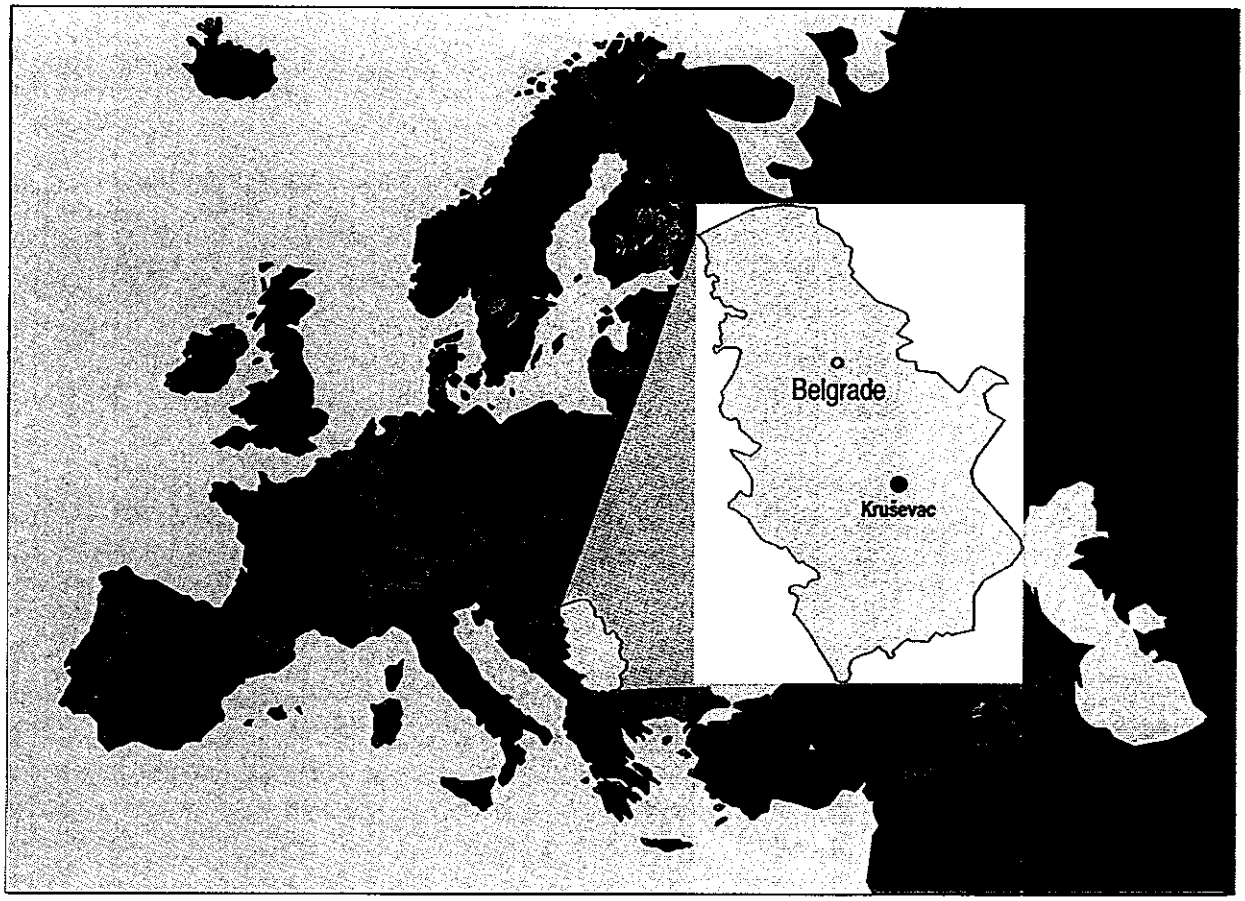
The practical implementation of SEEEP consisted in the installation of numerous energy efficiency demonstration projects. For the purpose of evaluating the energy savings achieved by each project, it was decided to use winter season 2000-2001 as the energy consumption baseline period, and winter season 2001-2002 for the measurement of energy consumption after the implementation of the projects.

As USAID contractor for SEEEP, in Spring 2001 Nexant performed a rapid assessment of the potential thermal and electric energy savings achievable in selected institutional buildings, to use as demonstration projects throughout Serbia. The assessment identified, in five Serbian Municipalities, approximately forty potential energy efficiency measures, offering various degrees of financial feasibility, and submitted them to USAID for approval. USAID reviewed them and approved 16 for immediate implementation.

One of the Municipalities in which several approved measures had been implemented is the Municipality of Krusevac.

Kruševac is located 210 km Southeast of Belgrade. The town dates back to the Middle Ages and at one time was one of the cultural centers of Serbia. The town covers 854 km^2, with over 100 settlements. The majority of the land, approximately 57% of the total area, is rural and the rest is considered urban. Kruševac has a total population of 138,000 people, of which 29,000 are in working age. The most important industries are Chemical, Food (beverages), and Agriculture.

This Post-Implementation Evaluation Report illustrates the energy efficiency measures implemented in the Municipality of Krusevac, and the resulting savings.


Belgrade
Kruševac

The methodology applied for the calculation of savings achieved by the energy efficiency measures implemented by Nexant within the framework of the Serbian Emergency Energy Efficiency Program is based on the guidelines established by the International Performance Measurement & Verification Protocol (IPMVP, Ref. 1), issued by the U.S. Department of Energy in October 1997.

The methodology is discussed in detail in Nexant report entitled "Measurement and Verification Plan". The specific steps used for the collection of the necessary energy consumption data, and the calculation of savings, achieved by the various measures, are described in this report. The methodology has been applied consistently to all the measures. The data collected and the results of the analyses are presented in a latter section of this report.

2.1 CALCULATION PROCEDURE

The energy saving due to an Energy Conservation Measures (ECM) implemented in a facility is determined by comparing the quantity of energy consumed in the facility, or part thereof, during a specified baseline period (in this case winter season 2000-2001), before the installation of the ECM, and the quantity of energy consumed during a corresponding period of the same characteristics, i.e. length, weather conditions, etc..., after the installation of the ECM (in this case winter season 2001-2002). By subtracting 'actual energy consumption after ECM installation' from 'adjusted energy consumption before ECM installation' we obtain:

Energy Saving = Adjusted energy consumption before ECM installation -
-Actual energy consumption after ECM installation

2.2 ADJUSTED ENERGY CONSUMPTION BEFORE ECM INSTALLATION

Energy consumption before ECM installation is estimated either from direct measurement of various parameters or from historical data obtained from the utilities, municipalities, or other relevant sources.

In most situations, energy consumption pattern or parameters affecting the energy consumption change for various reasons after installation. These changes typically include change in operating hours, change in operating or ambient temperature, change in energy requirement, change in level of comfort, etc. To estimate energy saving, it is necessary that the measurements, before and after, reflect energy usage under similar conditions. Two important parameters that changed from the baseline period to the after ECM installation period have been addressed already in Nexant's Rapid Assessment Report, precisely:

- All facilities complained that during the baseline period, i.e. winter season 2000-2001, the quantity of heating fuel available was not sufficient to create an adequate level of comfort for the occupants of the facility. Use of supplementary portable electric heaters improved somewhat the situation, but not to satisfactory levels. To equalize the conditions before and after the ECM installation, the before energy consumption was adjusted to reflect an

adequate level of comfort (i.e. approximately 18-20 °C indoor temperature). The adjustment was obtained by multiplying the effective consumption, estimated from the information received, by the following factor:

Comfort Level factor = $(T_c - T_{w1}) / (T_a - T_{w1})$

Where: T_c= Indoor comfort temperature (approx 20°C)

T_a= Indoor temperature actually experienced in Winter 2000-2001, as estimated from verbal information obtained during site visits

T_{w1}= Monthly average outdoor temperature in Winter 2000-2001, as obtained from the Serbian National Weather Institute

- The prices charged for heating fuels and electricity were heavily subsidized during the baseline period, and did not reflect the realistic international market levels toward which prices are now inevitably moving, as government subsidies are being reduced or abolished. To reflect a realistic estimate, the calculation of energy costs has been based on the following realistic prices:

Electricity	$ 0.05 per kWh
Light Oil	$ 0.23 per Litre
Heavy Oil	$ 0.18 per Litre
Natural Gas	$ 0.10 per m^3
Coal	$ 33.5 per ton (this reflects price of locally produced coal, not an international price)

Other important parameters considered for the adjustment include:

- The baseline winter season 2000-2001 has been an exceptionally mild one, while winter season 2001-2002, during which the measures have been implemented, and the after ECM installation measurements taken, is the harshest winter on record in Serbia for the last 30 years. The adjustment was obtained by multiplying the effective consumption, estimated from the information received, by the following factor:

Winter Rigidity factor = $(T_c - T_{w2}) / (T_c - T_{w1})$

Where: T_c= Indoor comfort temperature (approx 20°C)

T_{w1} = Monthly average outdoor temperature in Winter 2000-2001, as obtained from the Serbian National Weather Institute

T_{w2} = Monthly average outdoor temperature in Winter 2001-2002, as obtained from the Serbian National Weather Institute

- In case of applications where new high efficiency lighting technology is used, the wattage of the old lamps has to be adjusted to reflect the illumination level (Lux) provided by the new system. This is obtained by multiplying the Wattage of the old lamps by a factor equal to the ratio of the new illumination level to the old illumination level.

These adjustments made the winter season 2000-2001 energy consumption data comparable to the winter season 2001-2002 energy consumption data.

2.3 ACTUAL ENERGY CONSUMPTION AFTER ECM INSTALLATION

The usual method for deriving energy consumption data after ECM installation is to use direct measurements or recording of various parameters. However, since the ECM installations were completed in February 2002, the only measured data available refer to March and April 2002. These data were used as a basis to extrapolate the data to cover the months of October 2001 through February 2002, when the ECMs were still being installed.

The extrapolation of the actual consumption data measured in March-April 2002 was done under the basic assumption that *the rate at which thermal energy is consumed is linearly proportional to the indoor-outdoor temperature differential.*

To extrapolate the March-April 2002 consumption data to the months of October 2001 through February 2002, we must derive the equation of the line representing the consumption on the Cartesian plane defined by axis X (temperature differential) and axis Y (hourly thermal consumption). The line contains the two known points:

$$P_1 (X_1, Y_1) \quad \text{and} \quad P_2 (X_2, Y_2)$$

Where:

X_1= hourly consumption in March 2002
Y_1= indoor-outdoor temperature differential in March 2002

X_2= hourly consumption in April 2002
Y_2= indoor-outdoor temperature differential in April 2002

The equation of the line is then derived as:

$$\boxed{aX + bY + c = 0}$$

Where:

$a = Y_1 - Y_2$
$b = X_2 - X_1$
$c = X_1 Y_2 - X_2 Y_1$

The extrapolated consumption data for the months of October 2001 through February 2002 are then obtained by entering the known indoor-outdoor temperature differentials in the equation, calculating the hourly consumptions, and multiplying it by the known number of hours of operation per month.

2.4 ENERGY SAVING, COST SAVING, AND SIMPLE PAYBACK PERIOD

Annual energy saving was calculated by subtracting the post-installation energy consumption from the adjusted pre-installation energy consumption, over the entire winter season, i.e. from October 1st through April 15th.

Annual cost saving was calculated by multiplying the annual energy saving by the realistic price of fuel and/or electricity.

Simple Payback period was calculated by dividing the capital cost of the implementation by the annual cost saving.

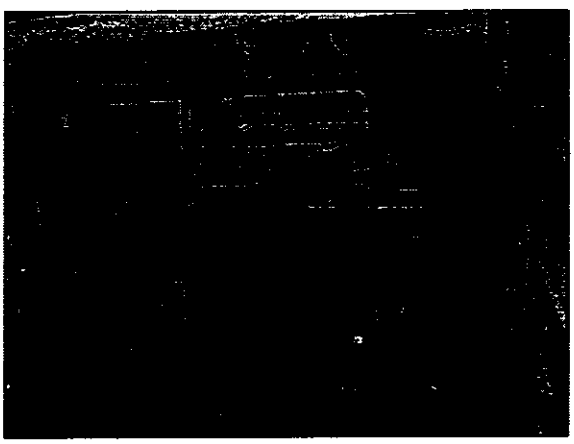
All calculations were performed using Excel spreadsheet programs.

The health center is a two-story building located in the city center, with a total floor area of approximately 2,600 m^2. The center provides maternity care services to the surrounding community, consisting of approximately 140,000 residents.

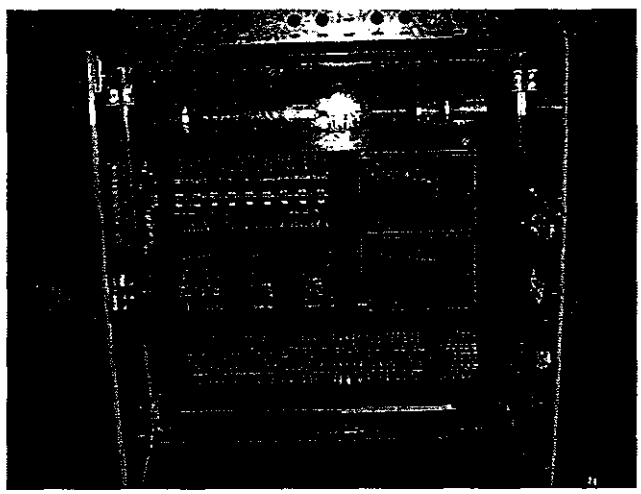
3.1 HEATING SYSTEM UPGRADE AND WINDOW REPLACEMENT – PROJECT DESCRIPTION

Heating System Upgrade - Two new 750 kW boilers, complete with light oil burners, related ancillary equipment, and control system were installed to replace the two existing obsolete boilers. In addition, all the radiators in the Center were cleaned internally, and thermostatic valves were installed on all of them. Also, thermal shields were installed behind each radiator facing a cold surface (outside walls or windows).

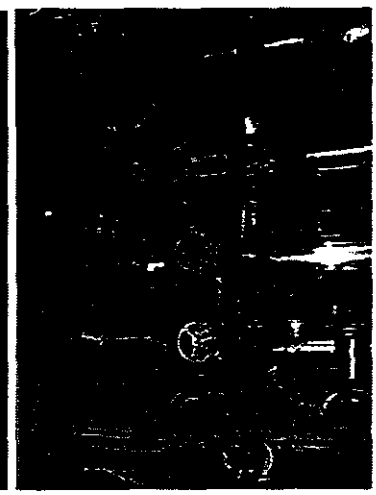
Old boilers



New installed boilers

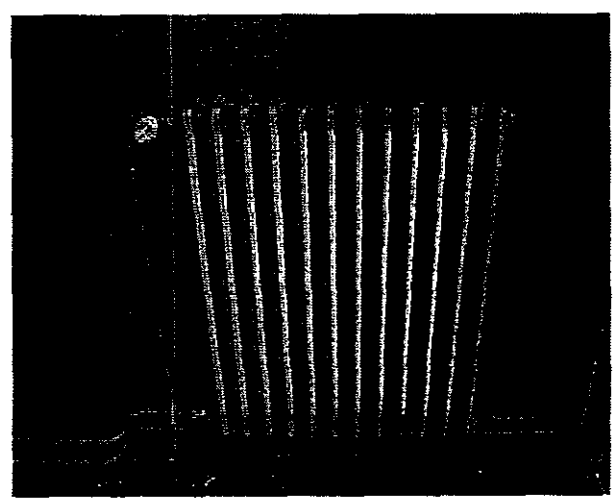


New electronic controls



New pipes and valves

Cleaning radiator



Finished and remounted radiator

Window Replacement – All the 315 old wood frame windows, for a total area of approximately 1090 m^2, were replaced with locally manufactured double glass pane windows with PVC frames. Also, all single pane glass panels, forming 650 m^2 of the building envelope, were replaced with double glass pane panels.

Windows installation

Windows installation being completed

3.2 BASELINE ENERGY USE

Thermal Energy Consumption - Historical thermal energy consumption data for every month during the winter season of year 2000-2001 was obtained from the Municipality.

Electrical Energy Consumption - Historical electrical energy consumption data for every month during the winter season of year 2000-2001 was obtained from the Municipality in the form of utility bills for each month. Since the electricity consumption for heating and lighting are not metered separately, the utility bills include combined consumption for both heating and lighting. To separate the two components, the monthly consumptions for the entire year was examined. The consumption during non-winter months essentially consists of lighting. This consumption was extrapolated for the winter months using approximations and subtracted from the respective monthly total electricity consumption during the winter season. This process gives the approximate monthly electricity consumption for heating.

Operating Hours – The facility operating hours during the heating season was recorded, based on the Health Center's daily hours of operation.

Average Outdoor Ambient Temperature – This information was obtained, for each winter month, from the National Weather Institute.

Adjusted pre-installation energy consumption. The historical energy consumption, obtained from the Municipality was adjusted as described at paragraph 2.1.1 above

Average Indoor Ambient Temperature – the estimate of average indoor ambient temperature was obtained from the Health Center.

Pre-Installation (Baseline) Data								
		2000			2001			
	Annualized Average/Total	October	November	December	January	February	March	April
Thermal Energy Consumption, kWh	1,370,200	40,178	116,415	245,192	286,404	314,732	343,066	24,211
Electrical Energy Consumption, kWh	145,989	17,353	18,453	36,055	32,146	22,351	14,631	5,000
Adjusted Thermal Energy Consumption, kWh	3,243,172	105,733	533,571	573,535	583,718	426,001	986,314	34,299
Adjusted Electrical Energy Consumption, kWh	359,496	45,666	84,576	84,337	65,517	30,253	42,064	7,083
Hours of Operation	1,100	100	200	200	100	200	200	100
Average Outdoor Ambient Temperature, °C	—	10	11	4	4	4	11	11
Average Indoor Ambient Temperature, °C	—	15	14	14	14	14	15	16
Average Differential Ambient Temperature, °C		5	3	10	11	10	4	5
Average Wall Temperature °C - Outside Surface	—	12	6	2	-	3	9	12
Average Wall Temperature °C - Inside Surface	—	20	22	23	24	21	21	21
Average Differential Wall Temperature, °C	—	9	16	22	24	19	13	9
Average Wall Thickness, m	—	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total Shield Surface Area, m^2	—	168	168	168	168	168	168	168
Average Wall Thermal Conductivity, W/m^2-°C/m	—	2	2	2	2	2	2	2
Total Heat Loss, kWh	25,172	1,199	4,513	6,064	3,384	5,218	3,525	1,269
Adjusted Total Heat Loss, kWh	91,373	4,509	29,568	20,277	9,861	10,096	14,490	2,570

3.3 POST-INSTALLATION ENERGY USE

Thermal Energy Consumption – Was estimated on the basis of periodic measurements of the level in the boilers' fuel oil tank.

Electrical Energy Consumption – Was obtained from the Center's monthly bills. It has to be noted that the total energy consumption for Winter season 2001-2002 is larger than the one for Winter season 2000-2001: this is due to the fact that the heating system was out of operation for two months during the installation of the new boilers, and the only source of heat available during this period were portable electric heaters.

Average Outdoor Ambient Temperature – Was obtained from the National Weather Institute.

Average Indoor Ambient Temperature – Was recorded several times a day over a 24-hour period, at three typical different locations in the Center, on the first day, last day, and two intermediate days of the month. The average indoor ambient temperature was then derived averaging these data.

Post-Installation Data								
		2001			2002			
		Adjusted Monthly Data						
	Annualized Average/Total	October	November	December	January	February	March	April
Thermal Energy Consumption, kWh	496,886	39,547	89,920	124,316	58,718	80,748	77,903	25,734
Electrical Energy Consumption, kWh	172,150	17,480	26,050	39,030	37,080	24,480	20,020	8,010
Total Energy Consumption, kWh	669,036	57,027	115,970	163,346	95,798	105,228	97,923	33,744
	-	-	-	-	-	-	-	-
Hours of Operation	1,100	100	200	200	100	200	200	100
		-						
Average Outdoor Ambient Temperature, °C	—	7	5	(3)	(1)	7	9	15
Average Indoor Ambient Temperature, °C	—	20	20	20	20	20	22	22
Average Ambient Temperature Difference, °C	—	13	15	23	21	13	13	7
		-						
Average Wall Temperature °C - Outside Surface	—	9	7	-	1	9	16	17
Average Wall Temperature °C - Inside Surface	—	15	12	6	7	14	22	21
Average Wall Temperature Difference, °C	—	6	5	6	6	5	6	4
		-						
Average Wall Thickness, m	—	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total Shield Surface Area, m^2	—	240	240	240	240	240	240	240
Average Wall Thermal Conductivity, W/m^2-°C/m	—	2	2	2	2	2	2	2
Average Heat Loss, kWh	11,999	1,210	2,016	2,419	1,210	2,016	2,298	831

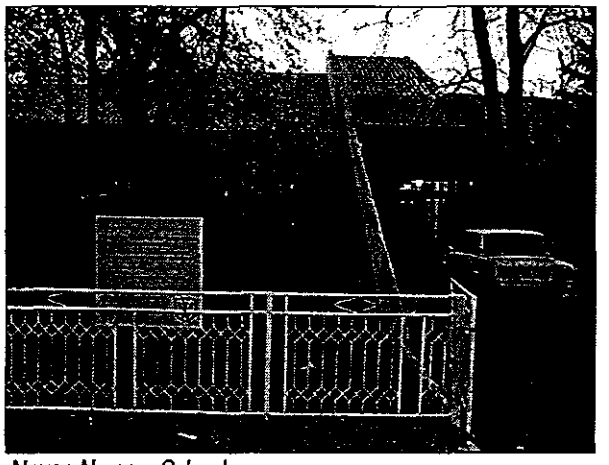
3.4 ENERGY SAVINGS

As mentioned, the energy savings were calculated as the difference between the adjusted pre-installation consumption , and the post-installation consumption. The result is summarized in the following tables, the first of which refers to the savings achieved by the new heating system, and the second to the savings achieved by the radiators thermal shields.

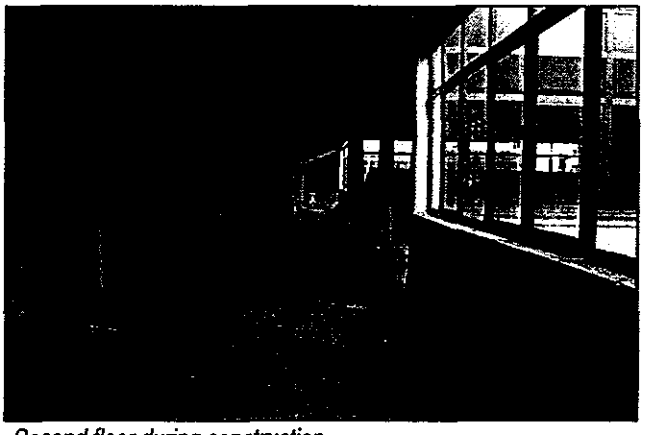
Annual Energy and Cost Saving		
	For Facility	
	Estimated	**Actual**
Thermal Energy Saving, kWh/Yr	2,552,089	2,746,286
Electric Energy Saving, kWh/Yr	117,763	187,346
Thermal Cost Saving, $/Yr	$67,959	$62,574
Electric Cost Saving, $/Yr	$5,888	$9,367
Total Cost Saving, $/Yr	$73,389	$71,941
Implementation Cost, $	$223,347	$168,470
Simple Payback Period, Yrs	3.0	2.3

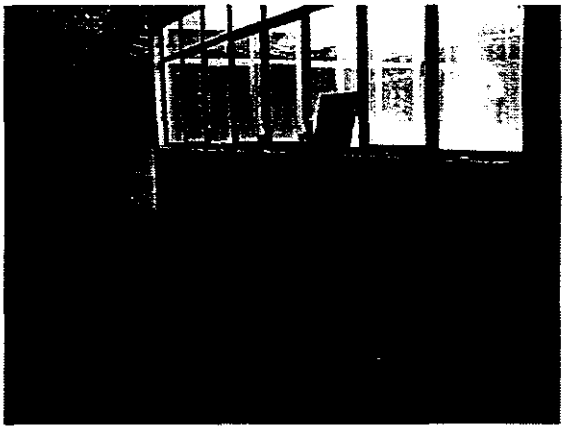
Annual Energy and Cost Saving		
	For Radiator Shield	
	Estimated	
Thermal Energy Saving, kWh/Yr	458	79,373
Electric Energy Saving, kWh/Yr	--	--
Thermal Cost Saving, $/Yr	$458	$1,809
Electric Cost Saving, $/Yr	--	--
Total Cost Saving, $/Yr	$458	$1,809
Implementation Cost, $	$2,506	$2,506
Simple Payback Period, Yrs	5.5	1.4

The school originally consisted of a one story building, with a total floor area of approximately 1,112 m^2, and two internal atriums, enclosed in glass panels, and open to the outdoor. Recently, a second story has been added, with an additional floor area of 650 m2. The school has 17 classrooms and can accommodate approximately 430 children.



Neven Nursery School

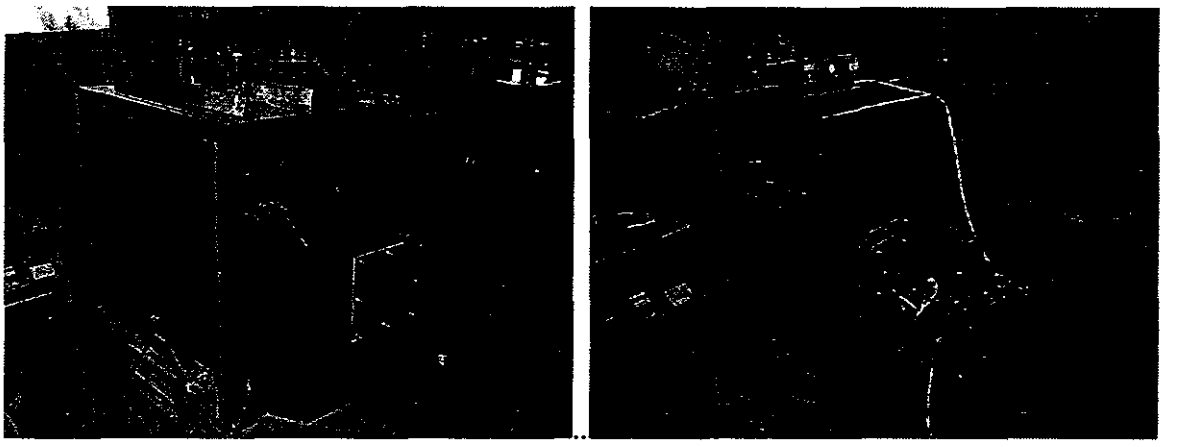




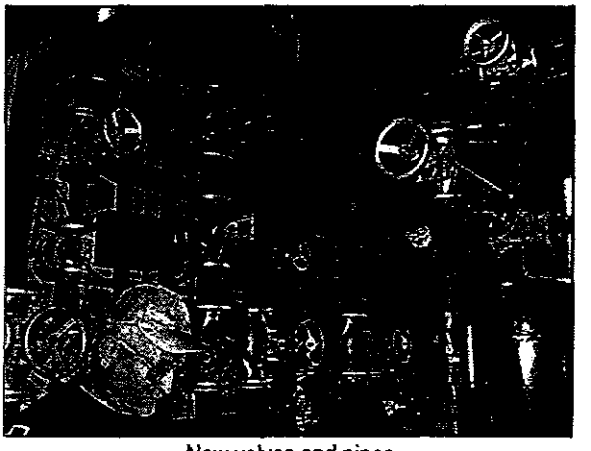
Second floor during construction

4.1 HEATING SYSTEM UPGRADE – PROJECT DESCRIPTION

Two new 300 kW boilers, complete with burners and related ancillary equipment had been installed to replace the two obsolete boilers in use at the school. The heating system has been extended to the newly added second floor, by extending the distribution lines to the new floor, and by installing new radiators, as needed.

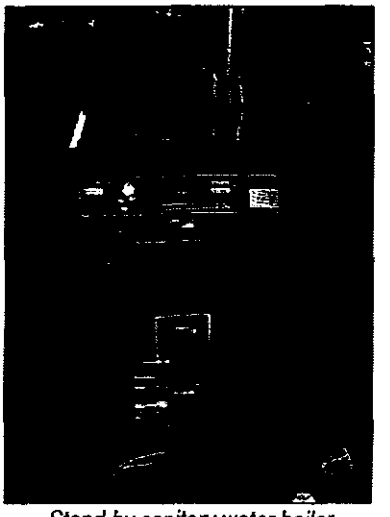


New boilers and burners



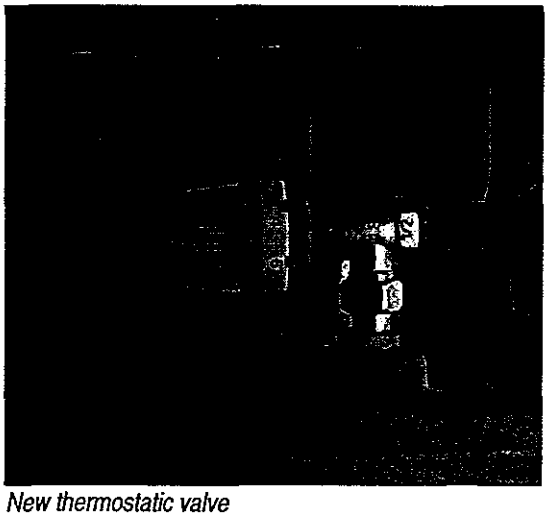
New valves and pipes

An additional 60 kW stand-by boiler has been installed to satisfy hot water needs in the summer, when the heating system is not in operation. A new hot water distribution system to the classrooms, lavatories, and kitchen has also been installed. This new installation replaced electric heaters in use during the winter.

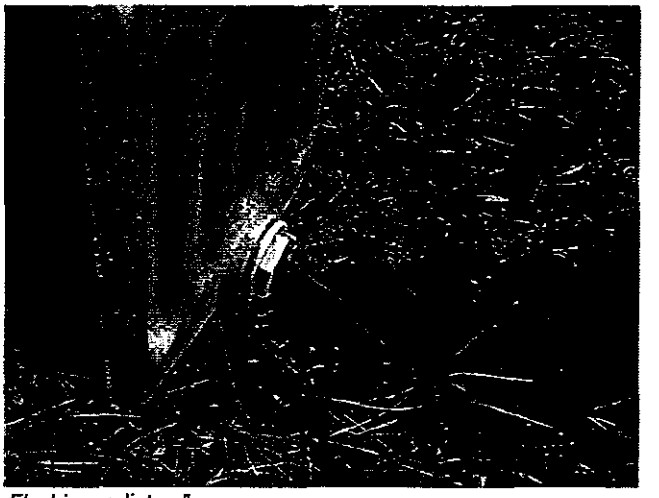


Stand-by sanitary water boiler

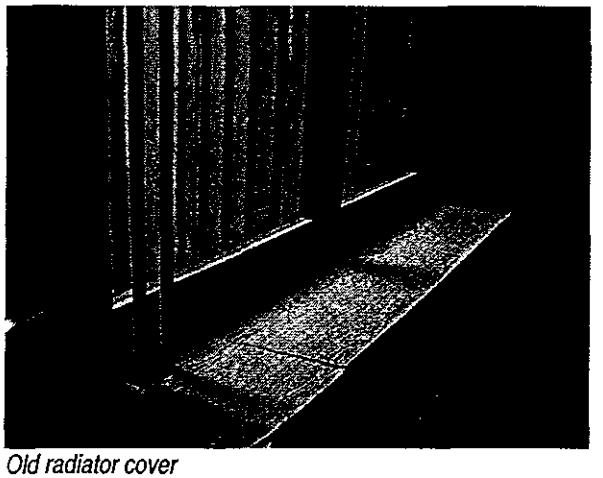
All radiators had been cleaned internally, and provided with thermal control valves. Those facing cold surfaces (walls or windows exposed to the outdoor atmosphere) had been provided with thermal insulators installed between the radiator and the cold surface. In addition, the old radiator wooden enclosures were replaced with new one which allow better thermal convection.



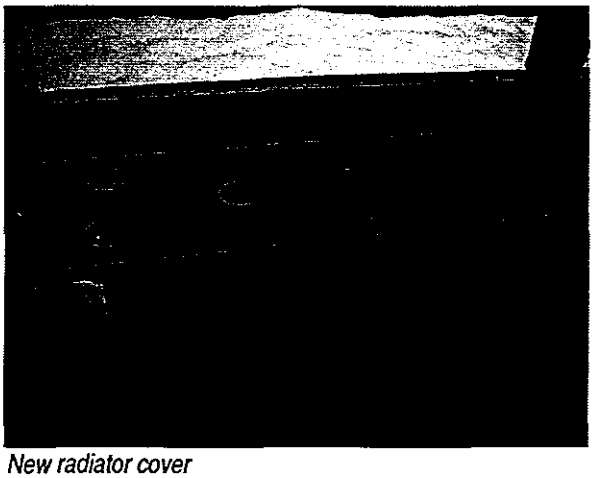
New thermostatic valve



Flushing radiators"



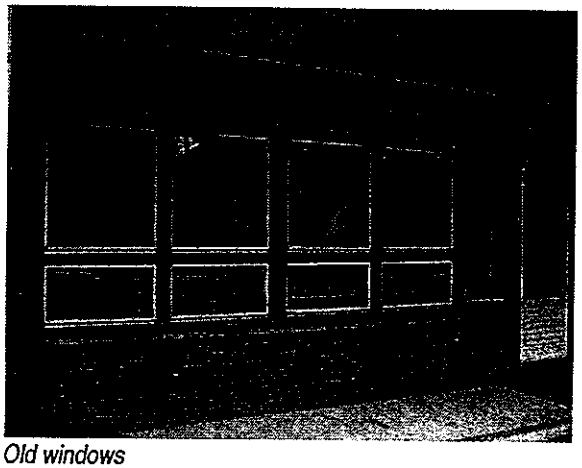
Old radiator cover



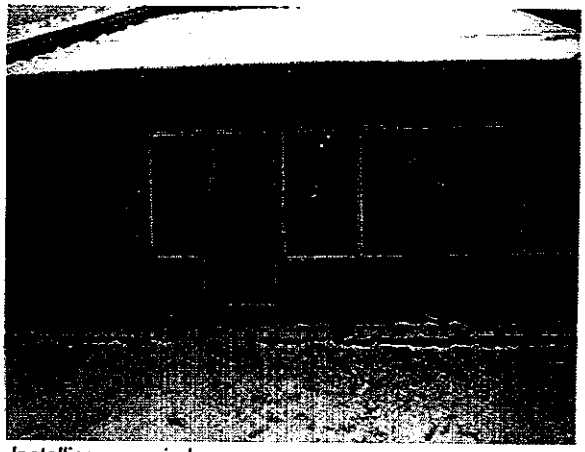
New radiator cover

4.2 BUILDING ENVELOPE UPGRADE – PROJECT DESCRIPTION

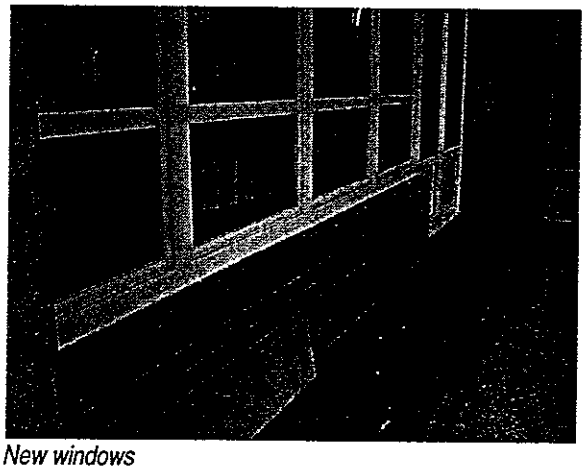
Windows Replacement – All the old wood frame windows, exposed to the outside atmosphere, for a total area of 155 m2, had been replaced with new double glass pane, PVC frame windows of local manufacture. In addition, all single pane glass panels previously forming the walls of the two atriums on the ground floor of the school, were replaced with double pane glass panels.



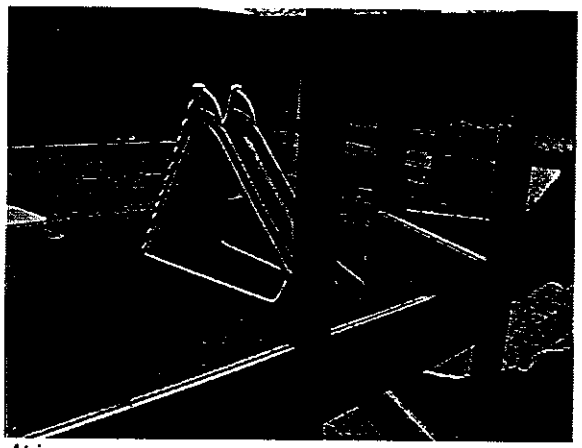
Old windows



Installing new windows



New windows



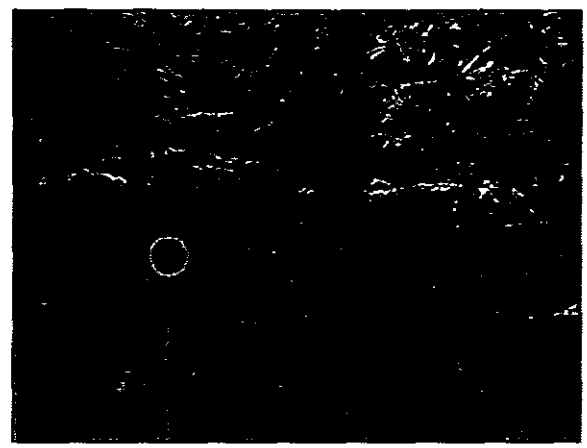
Atrium

Old panels in atrium

New panels in atrium

Roof Insulation – Thermal insulation has been installed on the new roof of the newly added second floor

Roof without insulation



Roof with insulation

4.3 BASELINE ENERGY USE

Thermal Energy Consumption - Historical thermal energy consumption data for every month during the winter season of year 2000-2001 was obtained from the Municipality.

Electrical Energy Consumption - Historical electrical energy consumption data for every month during the winter season of year 2000-2001 was obtained from the Municipality in the form of utility bills for each month. Since the electricity consumption for heating and lighting are not metered separately, the utility bills include combined consumption for both heating and lighting. To separate the two components, the monthly consumptions for the entire year was examined. The consumption during non-winter months essentially consists of lighting. This consumption was extrapolated for the winter months using approximations and subtracted from the respective monthly total electricity consumption during the winter season. This process gives the approximate monthly electricity consumption for heating.

Operating Hours – The facility operating hours during the heating season was recorded, based on the School's daily hours of operation.

Average Outdoor Ambient Temperature – This information was obtained, for each winter month, from the National Weather Institute.

Adjusted pre-installation energy consumption. The historical energy consumption, obtained from the Municipality was adjusted as described at paragraph 2.1.1 above

Average Indoor Ambient Temperature – the estimate of average indoor ambient temperature was obtained from the School.

Pre-Installation (Baseline) Data								
		2000			2001			
	Annualized Average/Total	October	November	December	January	February	March	April
Thermal Energy Consumption, kWh	455,500	33,000	67,000	111,000	78,500	89,000	44,000	33,000
Electrical Energy Consumption, kWh	178,980	19,270	24,000	20,100	34,800	31,930	34,680	14,200
Adjusted Thermal Energy Consumption, kWh	1,269,403	170,322	200,215	333,771	194,931	170,728	128,050	71,386
Adjusted Electrical Energy Consumption, kWh	510,927	99,458	71,719	60,440	86,415	61,251	100,927	30,718
Heated floor area Pre-Installation (m^2)	1,112	-	-	-	-	-	-	-
Hours of Operation	—	100	200	200	100	200	200	100
Average Outdoor Ambient Temperature, °C	—	11	5	1	(0)	2	8	11
Average Indoor Ambient Temperature, °C	—	15	14	14	14	14	15	16
Average Differential Ambient Temperature, °C		4	9	13	14	12	7	5
Average Wall Temperature °C - Outside Surface	—	12	6	2	-	3	9	12
Average Wall Temperature °C - Inside Surface	—	20	22	23	24	21	21	21
Average Differential Wall Temperature, °C	—	9	16	22	24	19	13	9
		-	-	-	-	-	-	-
Average Wall Thickness, m	—	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total Shield Surface Area, m^2	—	56	56	56	56	56	56	56
Average Wall Thermal Conductivity, W/m^2-°C/m	—	2	2	2	2	2	2	2
Total Heat Loss thru Wall Across Radiators, kWh	8,337	397	1,495	2,008	1,121	1,728	1,168	420
Adjusted Total Heat Loss Across Radiators, kWh	25,788	2,301	5,016	6,783	3,126	3,723	3,817	1,021

4.4 POST-INSTALLATION ENERGY USE

Thermal Energy Consumption – Was estimated on the basis of periodic measurements of the level in the boilers' fuel oil tank.

Electrical Energy Consumption – Was obtained from the School's monthly bills.

Average Outdoor Ambient Temperature – Was obtained from the National Weather Institute.

Average Indoor Ambient Temperature – Was recorded several times a day over a 24-hour period, at three typical different locations in the School, on the first day, last day, and two intermediate days of the month. The average indoor ambient temperature was then derived averaging these data.

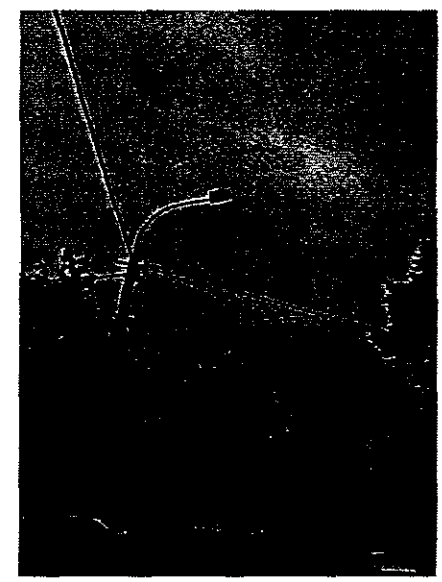
Post-Installation Data								
		2001			2002			
		Adjusted Monthly Data						
	Annualized Average/Total	October	November	December	January	February	March	April
Thermal Energy Consumption, kWh	671,199	52,625	124,608	185,104	86,502	108,476	91,354	22,530
Electrical Energy Consumption, kWh	50,542	6,363	8,217	6,724	10,449	9,663	7,006	2,120
Total Energy Consumption, kWh	721,741	58,988	132,825	191,828	96,951	118,139	98,360	24,650
Heated floor area Post-Installation (m^2)	1,763	-	-	-	-	-	-	-
Hours of Operation	—	100	200	200	100	200	200	100
Average Outdoor Ambient Temperature, °C	—	7	5	(3)	(1)	7	9	14
Average Indoor Ambient Temperature, °C	—	21	21	21	21	21	22	20
Average Ambient Temperature Difference, °C	—	14	16	24	22	14	12	7
Average Wall Temperature °C - Outside Surface	—	9	7	-	2	9	11	16
Average Wall Temperature °C - Inside Surface	—	19	17	10	14	19	21	21
Average Wall Temperature Difference, °C	—	10	10	10	12	10	10	5
Average Wall Thickness, m	—	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total Shield Surface Area, m^2	—	99	99	99	99	99	99	99
Average Wall Thermal Conductivity, W/m2-°C/m	—	2	2	2	2	2	2	2
Total Heat Loss Across Radiators, kWh	8,890	832	1,663	1,663	998	1,663	1,663	407

4.5 ENERGY SAVINGS

As mentioned, the energy savings were calculated as the difference between the adjusted pre-installation consumption , and the post-installation consumption. The result is summarized in the following tables, the first of which refers to the savings achieved by the new heating system, and the second to the savings achieved by the radiators thermal shields.

Annual Energy and Cost Saving		
	For Facility	
	Estimated	**Actual**
Thermal Energy Saving, kWh/Yr	198,741	598,204
Electric Energy Saving, kWh/Yr	67,104	460,385
Thermal Cost Saving, $/Yr	$9,592	$13,630
Electric Cost Saving, $/Yr	$3,355	$23,019
Total Cost Saving, $/Yr	$12,947	$36,649
Implementation Cost, $	$71,493	$88,289
Simple Payback Period, Yrs	5.5	2.4

Annual Energy and Cost Saving		
	For Radiator Shield	
	Estimated	**Actual**
Thermal Energy Saving, kWh/Yr	5,996	16,898
Electric Energy Saving, kWh/Yr	--	--
Thermal Cost Saving, $/Yr	$152	$385
Electric Cost Saving, $/Yr	--	--
Total Cost Saving, $/Yr	$152	$385
Implementation Cost, $	$830	$830
Simple Payback Period, Yrs	5.5	2.2

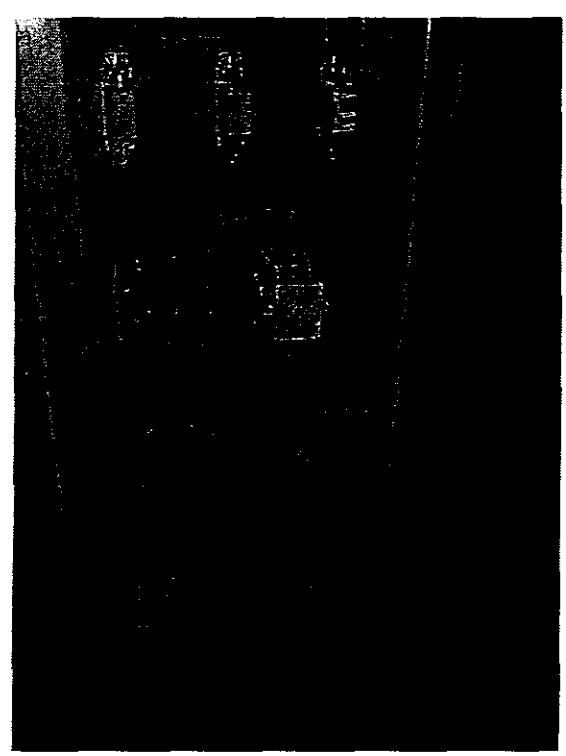


The street lighting system in the City of Krusevac includes a large number of high wattage lamps, both Mercury vapor and High Pressure Sodium types. From a meeting with the Municipality's Technical Department in charge of street lighting, it became apparent that considerable energy savings could be obtained by switching off, after midnight, every other light bulb of the street lighting system in selected areas of the city, where this application is technically feasible.

5.1 STREET LIGHTING PARTIAL-TIME DELAMPING - DESCRIPTION

Implementation of this measure is feasible only when the lighting system is three phase wired, and requires the installation of inexpensive radio-controlled, or timer switches.

The required radio controlled relays have been installed, and now 50% of the upgraded street lighting system is being switched off after midnight. It has to be noted that after switch off, the level of light in the affected streets is still at an acceptable level, and poses no hazard to the limited volume of circulation at that time of the day.



Radio controlled relay installed in one of the street lighting system cabinets"

5.2 ENERGY SAVINGS

The amount of savings is derived with a straightforward calculation based on the total wattage switched off, and the number of hours it remains switched off during the year:

Annual Energy and Cost Saving	
Total yearly consumption before ECM implementation, kWh/y	2,242,080
Electric Energy Saving, kWh/y	467,100
Total Cost Saving, $/y	$23,355
Cost of ECM Implementation:	$4,541.00
Payback Period, Yrs	0.2