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Appendix F

Business Plans for Varna, Plovdiv and Stara Zagora Hospital Energy Efficiency Projects

ENERGY EFFICIENCY RETROFIT OF EXISTING HOSPITALS

PROJECT:
"ENERGY EFFICIENCY MEASURES
AT THE 'PROF. ST. KIRKOVICH' INTEGRATED DISTRICT HOSPITAL - STARA ZAGORA"

Business Plan

Sofia
December - 1997

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ENERGY EFFICIENCY RETROFIT OF EXISTING HOSPITALS PROJECT:
"ENERGY EFFICIENCY MEASURES AT THE 'PROF. ST. KIRKOVICH' INTEGRATED DISTRICT HOSPITAL - STARA ZAGORA"

0. INTRODUCTION

In Bulgaria there are 284 hospitals, 1189 city polyclinics and 1537 other health care establishments. A major portion of these are still housed in buildings erected in the years before World War II, using type-model designs and applying almost identical construction methods. The rest of the health care establishments are housed in existing old buildings, some of which have been constructed specially for medical purposes, while others have been adapted to fit that function. Observations show that the buildings in the health care sector are some of the most energy-intensive public (commercial) buildings, while on the other hand they offer a considerable potential for energy conservation. The majority of the health care buildings are municipal property and constitute a major financial burden for municipal budgets. This fact provides an impetus for local authorities to seek for opportunities to reduce energy costs and re-direct the anyway limited budgetary assets towards proper implementation of the principal function of the health care establishments - medical treatment of their patients.

In its effort to assist hospitals and municipalities to diminish their energy costs the Bulgarian Foundation for Energy Efficiency 'EnEffect' is working on a project for retrofitting of existing hospital buildings in Bulgaria. A pilot project for energy efficiency retrofit of the 'D-r Tota Venkova' Integrated Regional Hospital in Gabrovo has been realized as the first stage of this project. It helped 'EnEffect' accumulate sibstantial practical experience on the basis of the application of three major groups of measures to the boiler yard of the hospital, the building envelope and the in-house systems.

The second stage of the above-mentioned project envisages multiplication of the Gabrovo experience through its application to other hospitals in Bulgaria. The sub-project "Energy Efficiency Measures for 'Prof. St. Kirkovich' Integrated District Hospital - Stara Zagora" is part of it.

This proposal contains a detailed business plan and calculations related to the effect of the measures and their costs, as well as data about their positive impact on the environment as a result of the project implementation.

1. BORROWER OF RECORD

The recipient of the funding for the project for the Integrated District Hospital is the Municipality of Stara Zagora.

In compiance with the laws on local self-government and local finances, municipal budgets consist of municipality's own resources and budgetary subsidies. The municipality's own resources comprise tax revenues, fees and charges, revenue from business activities of

municipal enterprises and companies and from administration of business property. These assets are managed by the Municipal Council. The amount of state subsidy is determined annually on the basis of the real expenditure incurred during the preceding year.
The administration of municipal affairs is effected by elected bodies and appointed specialists. The members of the Municipal Council and the Mayor are elected directly by the population, while the Chairman of the Municipal Council is nominated and elected among its members. The deputy-mayors and the heads of departments within the municipal administration are appointed by the Mayor in consultation with the Municipal Council.
The main financial sources of the Municipality are the municipal budget, allocations under a variety of funds and other extrabudgetary means. The Municipality of Stara Zagora maintains active relations with the central authroties and with other neighbouring or more distant municipalities in Bulgaria. The Municipality has initiated a number of significant business activities or has participated actively in such activities. The principal Bulgarian banks operate branch offices in the city. The Municipality has well established relationships with a variety of financial institutions - banks, funds etc.

2. PROJECT INFORMATION

2.1. Site Description

The Integrated District Hospital "Prof. Stoyan Kirkovich", city of Stara Zagora, is a multi-profile health care establishment which is obliged to provide all kinds of medical services - emergency, urgent, hospital and pre-hospitalization treatment - to the inhabitants of both the Municipality of Stara Zagora and the region of the former Stara Zagora County with a population of a total of 416,000 inhabitants.
The hospital has 52 wards covering the major medical subject fields with a total of 1,130 beds and three polyclinics which provide medical services to the population of the city and that of the 49 villages of the municipality. The rate of utilization of the hospital beds is 75%.
The Integrated District Hospital is located in the North-Western part of the city on an area of 88 dca as part of the hospital estate which includes further the following; the Institutional Hospital at the Higher Medical Institute, featuring 460 beds; the Oncological Dispensary with 210 beds, a Dispensary Unit for pulmonary deseases with 60 beds, a Skin Deseases Dispensary with 42 beds and a Psychiatric Dispensary with 35 beds.
The total build-up area of the Integrated District Hospital is 14,500 m^2.
The hospital has a staff of a total of 1,936 employees, of which 393 are medical doctors.
The management of the hospital has undertaken the following initiatives for energy efficiency improvement:

1. Three proposals have been submitted under Project B 9307-02-02 of the PHARE Program, namely:
   - Replacement of an obsolete diesel-fuel burner
   - Hot water supply by means of solar collectors
   - Utilization of the exhaust heat from the hospital waste incincerator.

2. Initiatives put forward by the hospital proper
   - Rehabilitation of the space heating and water supply & sewerage systems
   - Completion of the steam condensing yard with "Armstrong" equipment
   - Use of own water source for technical applications.

3. New initiatives
   - Gasification of the energy yard
   - Installation of air conditioning in the main blocks and in the surgery theatres in the first place.
   - Energy conservation project

Energy consumption during 1996 is given in the table below:

Energy Consumption in 1996 by Fuel Type

Fuel Types	Consumption	Annual Expenditure (USD*)
Heavy oil	2,000 tons/year	628,000
Electrical power	3,000,000 kWh/year	151,000
TOTAL		779,000

* Exchange rate 1996 - 193.05 Levs/USD - Statistical Reference book - 1997

2.2. Technical description of the project

As a result of the preliminary energy audit a long list of energy conservation measures has been compiled for the hospital (Appendix 1). On the basis of the long list, a short list (Annex 2) of selected measures has been drawn up, making up the project. They have been chosen on the basis of criteria such as cost-effectiveness, urgency and contribution to upgrading of the comfort in the hospital building. Technology choice has been done after consultation with leading experts from Bulgaria and the U.S.A.

This business plan deals only with the " Energy efficient air-conditioning using SEMCO Heat Recovery Unit (SHRU)" which is hereby proposed for funding by the USAID. In view of the fact that no such unit has been used by the hospital so far, the calculations of the estimated savings have been done against a normalized baseline, determined on the basis of the figures for provision of the micro-climate parameters by means of equpment available on the Bulgarian market. The rest of the short list measures will be submitted to other funding institutions in two separate business plans.

The following equipment will be included in the measure "Energy efficient air-conditioning using SEMCO Heat Recovery Unit (SHRU)"

SEMCO Heat Recovery Unit, size 18, el. heater, water heater, sound ATT, curb,
Carrier air-cooled condensing unit and parts
Humidifier
Control system - hardware
Air filters 30%

Air filters 95%
Air HEPA filters 99.97% and parts
Duct works and parts
Hot water parts
Electrical parts cables
Ceiling and ceiling lighting fixtures
Miscelenious materials
Audit, design, planning, project managemeng\t, M&E

The service of the equipment will be carried out by the technicians of the hospital and a specialized municipal company responsible for the heating system of the hospital. The required staff skills will be acquired through specialized training. The operating staff will pass a training course organized within the period of project implementation.

2.3. Technical and Economical Evaluation of the Project

Both innovative and practically tested technologies with high energy efficiency will be used to ensure project viability. The project has potential to achieve high energy savings of 564310 kWh electricity per year and 68792,17 Nm^3 natural gas per year. Upon completion of the project, the annual energy costs will be cut down by USD 46 470 and this accounts for 6 % of the current energy expenditure or 10% after shift from diesel fuel to natural gas .

Expected Annual Energy Savings

Groups of Measures	Fuel Type	Fuel Savings	Project Costs	Savings Value
SEMCO - 18	Natural gas	68792,17 Nm^3/year		USD 10,670
	electricity	564,310 kWh/year		USD 35,880
TOTAL			USD 170,000	USD 46,470

Simple Payback Period: 3,7 years

2.4. Profitability Forecast

Because of the relatively long service life of the greater portion of the envisaged technical equipment (20 years), the project guarantees long-term profitability.
The expected local benefits from the hospital retrofit are:

- reduced electricity consumption
- marked reduction of the local environmental pollution
- improvement of the comfort in the operative theatres of the hospital
- reaching the standards for micro-climate in some special premises of the hospital
- diminishing of the post-operative stay of patients thanks to surgical interventions held in lower than acceptable particles limit operative theatres enviroment.

3. ENVIRONMENTAL IMPACT

Like most of the energy conservation projects, the energy retrofit of the Stara Zagora Hospital is estimated to produce substantial benefits to the environment Fuels used in Bulgaria feature high SO_2 content, and the coefficient of CO_2 emissions as a result of applied burning technologies in the country, is high. This makes energy saving projects even more environmentally beneficial than usual.

Energy and emissions savings

El. consumption kWh/year		CO_2 Emissions in t		SO_2 Emissions in t		NOx Emissions in t		CO Emissions in t		CH_4 Emissions in t	
Before Measures	After Measures	Per Year	Project Lifetime	Per Year	Project Lifetime	Per Year	Project Lifetime	Per Year	Project Lifetime	Per Year	Project Lifetime
705010	140700	482,6	9652,5	12,3	246,0	0,9	17,8	0,08	1,5	0,03	0,5
Natural gas consumption Nm^3/year		CO_2 Emissions in t		SO_2 Emissions in t		NOx Emissions in t		CO Emissions in t		CH_4 Emissions in t	
Before Measures	After Measures	Per Year	Project Lifetime	Per Year	Project Lifetime	Per Year	Project Lifetime	Per Year	Project Lifetime	Per Year	Project Lifetime
94253	17857	137,2	2744,3	0	0	0,25	5,02	3,0	60,0	0,01	0,2

4. PROJECT IMPLEMENTATION

4.1. Time schedule

The start of the project implementation is scheduled for the end of 1997 and it should cover a period of 6 months. After the implementation of the measures, monitoring of results and impact on hospital budget will be carried out.

Time schedule for the implementation of the project

Activity	Starting Date	Closing Date
Preliminary Energy Scanning	01.09.1997	30.11.1997
Preliminary Business Plan	30.11.1997	30.12.1997
Detailed Energy Audit & Design	01.12.97	15.02.1998
Final Business Plan	01.02.1998	30.02.1998
Tenders for Implementation of Energy Conservation Measures	15.02.1998	15.03.1998

Contracting	25.03.1998	10.04.1998
Deinstallation & Frame construction	01.04.1998	15.04.1998
Equipment delivery	01.02.1998	15.04.1998
Control of Delivery	01.02.1998	01.05.1998
Installation	01.05.1998	30.06.1998
Training of Personnel	15.04.1998	15.07.1998
Start up: Operation and Maintenance	01.07.1998	

4.2. Project Implementation Unit

The Bulgarian Foundation for Energy Efficiency EnEffect serves as a Project Implementation Unit (PIU) for the project in Stara Zagora. A Project Co-Manager from the US AID is Electrotek Concept Inc., acting for the implementation of the project. The PIU works closely with the management staff of the hospital and the municipal authorities in Stara Zagora. The PIU is composed of highly skilled experts, who have the required administrative, technical, economic and legal knowledge and experience.

4.3. Contracting procedures

The subcontractors for installation works will be chosen on a competitive basis. The tenders are advertised in the central daily newspapers. Request for Proposal documents are distributed among the bidders. The offers presented are overviewed by a special jury and the best offers are granted a fixed price contract.

The supplies of technical equipment are procured from Bulgarian and foreign companies and installation works are assigned to local companies.

4.4. Commissioning and guarantees

The responsibilities for implementation of the project will be distributed between the municipality, the hospital and EnEffect. in the latter's capacity of PIU. The distribution of responsibilities among these three parties will be regulated by a three-partite Memorandum of Understanding. The Municipality commits itself to ensure the construction-related coordination and permits for the project, transportation of the equipment, financing any additional works become necessary in the course of implementation, as well as to participate in the selection of subcontractors and acceptance control of their work. The Municipality will provide service and maintenance of the space heating system of the hospital through its specialized Division for Business Activities.

The hospital becomes the owner of the newly installed equipment and will enlist it in its material assets. It commits itself to create favourable conditions for implementation of the project, to establish a system and appropriate conditions for safeguarding and correct

operation of the applied measures, as well as to provide support for the follow-up survey. The technical staff of the hospital shall maintain the installed equipment.

In addition to the general management of the project, EnEffect will have the obligation to negotiate with the subcontractors and to ensure control on implementation and commissioning approval of their work. The technical quality of workmanship under the project will be guaranteed through specific requirements and penalties in the contracts, as well as by means of the envisaged commissioning approval expertise.

The Municipality, in its capacity of owner of the project site, will be the recipient of all contributions in terms of operating costs to complement the available project funding. The municipal top management intends to take further action to ensure financial stability of its activities.

a) The Stara Zagora Municipal Council is studying the possibilities to make use of means acquired from privatisation deals with municipal property.

b) The Stara Zagora Municipal Council is negotiating with the Ministry of Finance to ensure guaranteed level of the annual contributions to the municipal budget from the state budget subsidy.

c) A proposal for decision of the Stara Zagora Municipal Council is being drafted on the issues of ensuring the level of income to the municipal budget from municipality's own sources of revenue.

d) The Stara Zagora Municipal Council is working out a mechanism to ensure the right to use the savings realized as a result of the project for payment back of project-related credits.

5. PROJECT MANAGEMENT

5.1. Management Team

The current manager of the hospital assets is the hospital administrative manager. The installed equipment as property of the hospital will be accounted like any other assets. It will not be an autonomous cost center The management will be organized in the same manner as that of the existing heating system.

5.2. Risks for Changes in Boundary Conditions

No dramatic negative changes in the legal and regulatory framework, which can affect the operation of the completed project, are expected. The situation in Bulgaria has improved and stabilized recently as a result of the Currency Board regime and following a number of legislative amendments, mainly with respect to foreign investments and the banking system. The price of energy is state regulated with tendency of increase to reach the level of production costs, and this will have a positive impact upon any energy conservation project. To date fuel and energy prices have reached the level agreed with the World Bank and the International Monetary Fund..

6. PROJECT COSTS

The total cost of the project is estimated to be USD 170 000. Equipment and instalation costs amount to USD 153 000. Auditing, design & planning, Project Management Coordination, Monitoring & Evaluation costs are USD 17 000

The attached table shows the detailed project equipment costs.

Detailed cost table

AC System and Components	Costs in USD
SEMCO Heat Recovery Unit, size 18, el. heater, water heater, sound ATT, curb,	69 325
Carrier air-cooled condensing unit and parts	12 007
Humidifier	5 995
Control system - hardware	901
Air filters 30%	240
Air filters 95%	300
Air HEPA filters 99.97% and parts	15 555
Duct works and parts	25 500
Hot water parts	1 637
Electrical parts cables	4 663
Ceiling and ceiling lighting fixtures	15 280
Miscelenious materials	455
Audit, design, planning, project managemeng\t, M&E	18 000
TOTAL	**169 858**

7. FINANCING PLAN

The energy retrofit project of the Stara Zagora Hospital will be financed by 2 types of sources: equity capital, grants. The grants pay for the greater part of activities under the project. The hospital/municipality itself will participate in the funding of activities other than the delivery of the SEMCO UNIT.

Sources of Financing	Investment
Grant from USAID	USD 131 000
Hospital/Municipality	USD 40 000

8. FINANCIAL PROJECTIONS

ECONOMIC ASSUMPTIONS:

- ⇒ Interest Rate 12%
- ⇒ Inflation 3%
- ⇒ Project Life Time 20 years
- ⇒ Fuel Prices incl. V.A.T.:
  - Natural Gas USD 142 - 159 USD/1000 Nm^3
  - Electricity USD 0.063 - 0.067/kWh

SIMPLE PAYBACK 3.7 years

8.1.Cash flow analysis results

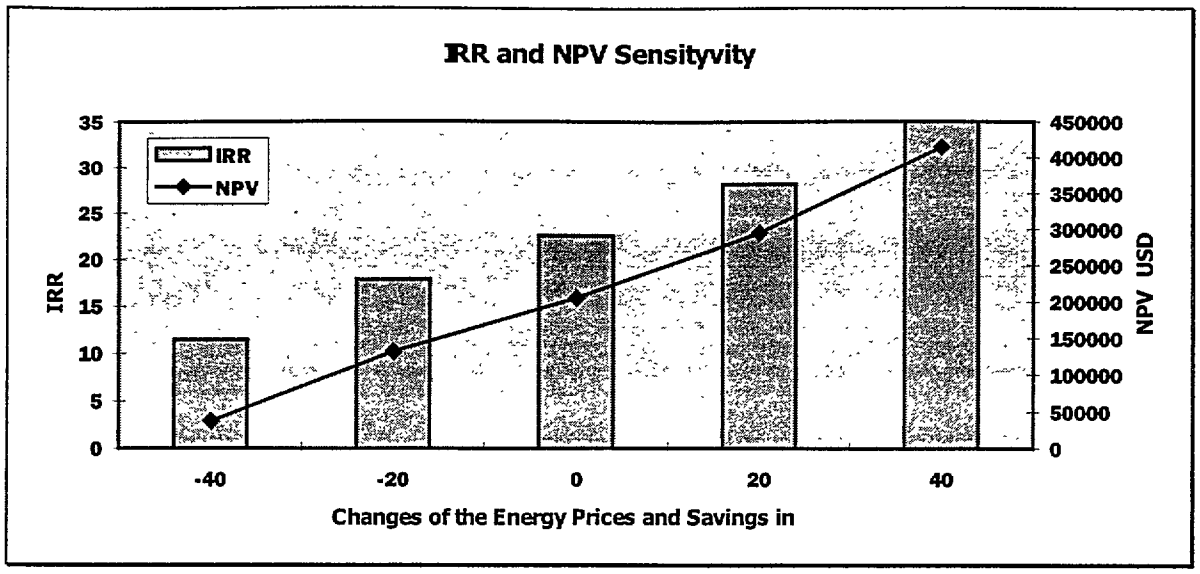
Net Present Value	USD 203 000
NPVQ	1.2
IRR	22 %

8.2. Income by energy savings by year

46 470 USD/year

8.3. Sensitivity analysis

As the factor of main concern of the project are the energy savings, the factor of greatest importance for the sensitivity analysis is the level of energy prices. The project benefits and indicators for profitability highly depend on this level. There is a tendency for increase in energy prices in Bulgaria towards the world level which is a result of the dependence of Bulgarian energy sector on imports of primary energy. That's why the level of energy prices has been used as the basis for a sensitivity analysis of the project.



8.4. Risk analysis

- ***Sponsor Risk*** - The hospital and the municipality have a very serious attitude to the project. They are very interested in implementing of SEMCO UNIT into the hospital and will support the project with money and in-kind.
- ***Completion Risk*** - The contractors are serious institutions. There is not risk the equipment not to be putted into operation - this is the second project which will be implemented by the same partners.
- ***Technology Risk*** - The technology has a satisfactory track-record and the efficiency level can be easily achieved
- ***Input and Supply Risk*** - There is not risk with the power supply.
- ***Operation Risk*** - There is not risk to the forecasted results, because the project team is skilled in the employment of the relevant technology and O&M requirements are in accordance with the potential of the hospital.

Appendix 1

LONG LIST OF ENERGY SAVING MEASURES

1. Energy efficient air-conditioning using SEMCO Heat Recovery Unit (SHRU)
2. Heat source
    2.1. Shift from heavy oil to gas
        2.1.1. Installing gas burners to the existing boilers
        2.1.2. Installing a gas motor (turbine) and electricity generator - combined heat and power generation (CHP)
    2.2. Shift from steam to water
        2.2.1. Reconstruction of boilers from steam to water heat carrier
        2.2.2. Construction of a central heat exchanger station steam-to-water at the existing boilers
    2.3. Automatic control system (CAP) as a function of the outdoor temperature and the operative duty cycle of the individual buildings (programme control)
    2.4. Metering system to record the energy supplied to the various consumers.
3. Technological waste incinerator station with heat recovery
4. Rehabilitation of the heat distribution network by means of pre-isolated pipes and fittings (ABB I.C.Moeller System) with grooves-free layout of the pipelines.
5. Rehabilitation of the sub-stations
    5.1. CAP with programme control
    5.2. Local measurement of heat supply
    5.3. Rehabilitation of hot water boilers. Dismounting of heat exchangers for space heating
    5.4. Replacement of the circulation pumps with energy efficient flange pumps (GRUNDFOS, WILO, etc.)
6. Rehabilitation of the in-house heating systems
    6.1. Introduction of a zoning system for temperature control (by facade orientation, by sub-sites etc.)
    6.2. Local control of the heating units
    6.3. Thermal insulation of heating pipework
7. Rehabilitation of the in-house hot water systems
    7.1. Energy- and water-saving fixtures
    7.2. Thermal insulation of the pipework
8. Rehabilitation of the in-house lighting systems
    8.1. Replacement of luminaires and lighting fixtures
    8.2. Duty-bound/programme control
    8.3. Separation and metering of the individual electricity consumers (high-precision ABB electric meters with possibilities for distance reading)
9. Architectural and engineering energy conservation upgrading of the hospital building
    9.1. Energy efficient interior reconstruction of unoccupied free spaces
    9.2. Elimination of the stack effect
    9.3. Energy efficient reconstruction of the entrance spaces (special doors, heated air curtains, etc.)
    9.4. Solar heat shades and engineering solutions of the glazing in the surgery unit.

9.5. Sealing of building joints to reduce thermal losses due to infiltration.

9.6. Replacement of glazing or fitting additional glazing to poor quality joinery.

9.7. Fitting additional wind-resistant glazing to windy facades or rooms

9.8. Application of additional external insulation on flat roofs

9.9. Application of specific light-reflecting coatings on the walls and ceilings to reduce the need of artificial lighting.

10. Auxilliary yard

10.1. Replacement of obsolete and energy intensive equipment

10.2. Replacement of certain unefficient technological activities by hiring external services.

Appendix 2

SHORT LIST OF ENERGY SAVING MEASURES

1. Energy efficient air-conditioning using SEMCO Heat Recovery Unit (SHRU)
2. Heat source
    2.1. Shift from heavy oil to gas
        2.1.1. Installing gas burners to the existing boilers
    2.2. Shift from steam to water
        2.2.1. Reconstruction of boilers from steam to water heat carrier
    2.3. Automatic control system (CAP) as a function of the outdoor temperature and the operative duty cycle of the individual buildings (programme control)
3. Technological waste incinerator station with heat recovery
4. Rehabilitation of the heat distribution network by means of pre-isolated pipes and fittings (ABB I.C.Moeller System) with grooves-free layout of the pipelines.
5. Rehabilitation of the sub-stations
    5.1. CAP with programme control
    5.2. Local measurement of heat supply
    5.3. Rehabilitation of hot water boilers. Dismounting of heat exchangers for space heating
    5.4. Replacement of the circulation pumps with energy efficient flange pumps (GRUNDFOS, WILO, etc.)
6. Rehabilitation of the in-house heating systems
    6.1. Introduction of a zoning system for temperature control (by facade orientation, by sub-sites etc.)
7. Rehabilitation of the in-house hot water systems
    7.1. Energy- and water-saving fixtures
8. Rehabilitation of the in-house lighting systems
    8.1. Replacement of luminaires and lighting fixtures
9. Architectural and engineering energy conservation upgrading of the hospital building
    9.1. Energy efficient interior reconstruction of unoccupied free spaces
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    9.3. Energy efficient reconstruction of the entrance spaces (special doors, heated air curtains, etc.)
    9.4. Solar heat shades and engineering solutions of the glazing in the surgery unit.
10. Auxilliary yard
    10.1. Replacement of obsolete and energy intensive equipment

ENERGY REPORT

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Plovdiv, Bulgaria

December 2, 1997

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1A. SUMMARY

This Energy Report presents some of the most attractive Energy Efficiency Measures (EEMs) resulting from the AEE/Plovdiv energy analysis of the Plovdiv University Hospital. The proposed EEMs are packaged in two Energy Efficiency Projects (EEPs): EEP #1 of total installed cost estimated at $97,000 and EEP #2 of total installed cost estimated at $101,800. USAID/Electrotek will be in a position to select one EEP. After selecting a EEP USAID/Electrotec Inc. is expected to pay an incentive/buy the energy efficiency equipment required.

The Proposed EEPs Economic Summary provides an overview of our estimates of the EEP costs, annual savings, USAID/Electrotek Inc. incentive payment, and simple payback for a standard package of proposed EEMs. A summary of the EEM packages is presented in the EEP Summary Table. Descriptions of each proposed EEM are presented in Section 5. Detailed cash flow analysis, detailed financial schedule, detailed project implementation schedule/financial disbursement schedule and a copy of the performance contract between Plovdiv University Hospital and AEE/Plovdiv will be presented when this energy report and proposed EEP has been approved by USAID/Electrotec and an official letter from USAID/Electrotek confirming the disbursement of incentive payment is received by AEE/Plovdiv and the Plovdiv University Hospital.

1B. THE NEXT STEP

Upon receiving a letter from USAID/Electrotec Inc. confirming that the Plovdiv University Hospital becomes eligible to receive the incentive/grant, we will be in a position to provide more detailed information as requested by Electrotek Inc. Then we would like to proceed to implementation of the recommended in this report energy efficiency measures. To proceed with the program, Plovdiv University Hospital will execute a Performance Contracting Agreement with AEE/Plovdiv, concurred by USAID/Electrotec and Plovdiv Muncipality. The letter of Confirmation will become part of the performance contract. Thus the Hospital will officially accept the offered incentive. At this time the Hospital will choose to implement only the recommended EEP approved by USAID/Electrotec. The Plovdiv University Hospital is committed to maximize its own savings by installing other recommended EEMs by securing financing from other sources and by investing the savings realized from the USAID/Electrotec incentive program.

TABLE 1: PLOVDIV UNIVERSITY HOSPITAL PROJECT ECONOMIC SUMMARY

1.	ANNUAL ENERGY COSTS (exchange rate: $1 = BGL 1800)	
	Present Annual Electric Costs	$233,900
	Present Annual Fuel Costs	$586,860
	Total Annual Energy Costs	$820,760
2.	PROJECTED ANNUAL ENERGY SAVINGS RESULTING FROM IMPLEMENTATION OF EEPs RECOMMENDED IN THIS REPORT:	
	EEP #1:	
	Projected Annual Electric Savings	$ 32,850
	Projected Annual Fuel Savings	$ 25,650
	Total Annual Projected Savings	$ 58,500
	EEP #2:	
	Projected Annual Electric Savings	$ 3,372
	Projected Annual Fuel Savings	$ 38,650
	Total Annual Projected Savings	$ 42,022
3.	PROJECT COSTS:	
	EEP #1:	
	Total Installed Cost of EEMs*	$97,000
	EEP #2:	
	Total Installed Cost of EEMs*	$101,805
4.	INCENTIVE PAYMENTS:	
	EEP # 1	
	Incentive (equipment cost)	$48,912
	EEP # 2	
	Incentive (equipment cost)	$68,030
5.	NET COST TO CUSTOMER:	
	EEP #1	
	Project Cost after Incentives	$48,088
	EEP #2	
	Project Cost after Incentives	$33,775
6.	POST-INCENTIVE ECONOMICS:	
	EEP #1:	
	Net Simple Payback:	1.65 years
	EEP #2:	
	Net Simple Payback:	2.42 years

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1C. RECOMMENDED ENERGY EFFICIENCY MEASURES

The EEM Summary lists the proposed EEPs recommended by AEE/Plovdiv, their associated costs and savings, their expected useful lives, and simple paybacks for each EEMs and the entire package. The baseline energy consumption for all savings calculations was determined from data received from Plovdiv University Hospital's equipment name plates, facilities operations personnel and from taking measurements. All savings calculations in this report are based on the Plovdiv University Hospital's current electric and fuel rates.

1D. FINANCING OPTIONS

AEE/Plovdiv will assist the Plovdiv University Hospital to evaluate its financing options by preparing a detailed analysis of several financing methods and their impact on cash flow.

1E. THE IMPLEMENTATION PHASE

Should the USAID/Elecrotek and Plovdiv University Hospital choose to proceed with implementation of the recommended EEMs, they will select AEE as the engineering/installation contractor. AEE is uniquely qualified to perform this work, having a proven track record by providing "turn-key" installations on over $2 million of energy Efficiency projects for our clients in Bulgaria. AEE will provide comprehensive engineering design, equipment selection and purchasing services, installation, and commissioning services for the selected EEMs. Our design professionals and skilled tradesmen will work with the Plovdiv University Hospital's administration and staff to assure a smooth installation with minimal disruptions to hospital operations.

After receiving the Letter of Confirmation from USAID/Electrotec, the Plovdiv Uiversity Hospital is prepared to enter into the Performance Contracting Agreement. Then AEE will assist in developing an implementation plan. This plan will include the project start date, completion date, incentive and payment dates, EEMs to be installed, and significant milestones. It is our plan to allow the Hospital one year to implement the recommended EEMs and three to five years performance guarantees. The milestones are a mechanism for the AEE/Plovdiv to receive payments during the installation and performance guarantee phases. These milestones must be clearly defined in the implementation plan and must be completely installed and operating to be eligible for payment.

EEPs SUMMARY TABLE

Energy Efficiency Package # 1:

1. Install occupancy sensors and EMS for the lighting system.
2. Connect the EMS to the heat-exchange stations, install energy efficient plate heat-exchangers and replace actuators.

Energy Efficiency Package # 2:

1. Retrofit fluorescent lighting with T-8 lamp and electronic ballasts.
2. Replace inefficient fuel oil # 6 burners.
3. Building envelope improvements

A. THE ENERGY REPORT

AEE/Plovdiv, a professional engineering and energy management organization, is the energy Efficiency consultant selected by the Plovdiv University Hospital to be the Contractor/Arranger (C/A) for the USAID/Electrotek Energy Efficiency Program (EEP). As the C/A, it is AEE/Plovdiv's responsibility to conduct an Energy Analysis Survey (EAS) to identify cost effective electrical energy Efficiency measures (EEMs), determine which of them might qualify for incentive payments under the EEP program criteria, calculate their energy savings and the amount of the incentive payment to the customer, and facilitate implementation of the qualified EEMs. This Report contains the relevant results of AEE/Plovdiv engineering analysis of energy consumption at the Plovdiv University Hospital, including recommendations for a number of cost-effective energy Efficiency measures (EEMs) packaged in two packages. One is expected to get approval by USAID/Electrotec for equipment incentive payment.

The Executive Summary contains an EEM Summary Table, which lists all of the recommended EEMs, their total energy savings, estimated costs, USAID/Electrotek incentive payment, and simple payback. Descriptions of all of the EEMs are presented in Section 5.

Upon presentation of this report, the USAID/Electrotek will be asked to sign a letter of confirmation one package of proposed EEMs. This letter will enable AEE/Plovdiv to enter into performance contracting arrangements with the hospital. Equipment manufacturer's five years guarantees, drawings, installation guidebooks and O&M procedures should be furnished by USAID/Electrotek.

B. THE ENERGY EFFICIENCY PROGRAM

The Energy Efficiency Program (EEP) is developed and funded by USAID/Electrotek. The EEP was established to encourage Bulgarian hospitals to use energy more efficiently. Under the EEP, USAID/Electrotek provide monetary incentives to eligible hospitals for the installation of energy Efficiency measures (EEMs) through performance contracting approach which meet the program criteria.

C. ENERGY EFFICIENCY MEASURES

In this report AEE/Plovdiv identifies some of the potential EEMs which were analyzed for both technical and commercial feasibility in the EEP.

D. THE EEP PROCESS

There are four major steps in the Energy Efficiency Program:

1) the Preliminary Facility Evaluation, a walk-through audit to identify potential EEMs

2) the Energy Analysis Survey, which expands the results of the walk through by an in-depth engineering analysis of the facility's energy utilization, identification of qualified EEMs and their costs, calculations of energy savings, and calculation of the USAID/Electrotek incentive payments

3) the Packaging/Financial Plan, which includes presentation of this report

4) implementation of the qualified EEMs.

The presentation of this report completes the third step of the EEP process. The report contains recommendations for an energy Efficiency program. The next step for the Hospital is to enter into a performance contract with AEE/Plovdiv and implement the approved EEMs to realize the savings estimated in this report and to receive the incentive payment from USAID/Electrotek.

AEE/Plovdiv's background and experience in delivering energy Efficiency services to clients like the Plovdiv University Hospital provides the assurance that your project will be completed in a timely and efficient manner. AEE/Plovdiv has a comprehensive in-house engineering and project management capabilities. We will provide the Hospital with the following professional services: a complete engineering design, equipment selection and purchasing, installation, and commissioning for the selected EEMs.

Prior to installing the qualified EEMs, AEE/Plovdiv and the Plovdiv University Hospital will create a project implementation schedule. This schedule will identify milestones for partial payments to AEE/Plovdiv. These milestones must be equal to at least 40% of the total project cost.

Upon completion of the implementation/installation phase, USAID/Electrotek provides an on-site inspection of the installations. This inspection is to verify that the installed EEMs satisfy the intent of this program. Upon acceptance of the final inspection report, the Hospital will pay AEE/Plovdiv the final payment for the engineering services.

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E. KEY PERSONNEL

AEE's Project Managers for the EEP at Plovdiv University Hospital are:

Mr. Ilko Petkov
Mr. Evgeni Genchev
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Plovdiv, 4002
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The Plovdiv University Hospital EAP contact is:

Ivan Piskov
Director of Engineering
Plovdiv University Hospital

AEE/Plovdiv would like to express sincere thanks to Mr. Ivan Piskov and the hospital's facility personnel for their valuable assistance.

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A. BUILDING TYPE

Plovdiv University Hospital is over 100,000 square meter acute care facility located in Plovdiv. The facility was constructed in 1970, and currently consists of the Main Building, the HEI Building, the Critical Care Center (CCC), and the Service Building. Services provided at Plovdiv University Hospital include over 460 patient care beds, emergency care, intensive care, radiology, physical and occupational therapy, pediatrics, urology and laboratory services.

B. CONSTRUCTION

Plovdiv University Hospital has concrete block exterior walls with insulation and exterior face brick, with an estimated insulation R-value of 10. The Main building windows are poorly maintained. They are good candidates for energy efficiency improvements. The roof is a flat built up membrane roof, with an estimated insulation R-value of 9.

C. SPACE INVENTORY

AEE/PLOVDIV has identified the usage and sizes of all major spaces at the Plovdiv University Hospital. The Space Inventory Table has been prepared. The corridors lighting has been identified as a good candidate for improvement.

D. MECHANICAL SYSTEMS

Chilled water is produced for the hospital by a series of air cooled chillers located in an outdoor "chiller farm" behind the hospital. There are four chillers with total electric consumption of 68kW. Presently, only three chillers are operational, and the facility experiences frequent operational problems with these units. Conrols need improvement.

High pressure steam and hot water are produced in the central boiler plant by three boilers with firing rate of 350l mazut/hour and four boilers with firing rate of 1000 mazut/hour. Steam is used in the building for laundry and cooking; hot water for domestic hot water and heating. Some of the steam and hot water are sold to neighboring buildings.

The majority of the original facility is heated and cooled by radiators without thermostat or control valves.

Domestic water (including that used for fire protection) is provided by the local Water Company. The hospital has a well on site as well.

E. CONTROLS

Most HVAC equipment in hospital is equipped with temperature controls not maintained well. Any equipment shutdown during unoccupied periods is done manually. There is no energy

management control system installed. The hospital has an on-going project of rehabilitation of heat-exchange station and boilers.

F. LIGHTING

Interior lighting at the Plovdiv University Hospital consists of a variety of fluorescent and incandescent fixtures. Fluorescent lighting fixtures are two 40W low energy efficiency lamps.

Exterior lighting at the hospital is primarily 150 and 200 Watt mercury fixtures.

A. OVERALL

The Plovdiv University Hospital currently purchases electricity from the National Electric Company under Industrial Rate. The total electrical energy costs at this site during the 12 month period from July 1996 to July 1997 was $233,900.

Mazut is purchased from a wide range of suppliers for use in the boilers. The total fuel costs for the 12 month period from July 1996 to July 1997 was $586,860.

B. EXISTING ENERGY-PRODUCING AND ENERGY-SAVING SYSTEMS

Rehabilitation of controls for heat-exchanger stations is in progress.

C. ELECTRICITY AND FUEL END-USE SUMMARY

Over 50% percent of the current electrical consumption of the hospital is used for lighting. Over 70% of the fuel consumption (i.e., fuel oil #6 - mazut) at the hospital is used for heating, heating domestic water and laundry use, with the remainder primarily sold to neighboring buildings.

This section describes energy Efficiency measures (EEMs) that were considered by AEE/PLOVDIV and the Plovdiv University Hospital for this Energy Report.

The following describes all those Energy Efficiency Measures (EEMs) that we propose for USAID/Electrotek incentive payments:

EEM #	DESCRIPTION
1.	Install occupancy sensors and EMS for the lighting system.
2.	Connect the EMS to the heat-exchange stations, install energy efficient plate heat-exchangers and replace solenoid valves
3.	Retrofit fluorescent lighting with T-8 lamp and electronic ballasts.
4.	Replace inefficient fuel oil # 6 burners.
5.	Building envelope improvements

Energy Efficiency Package # 1:

Total cost: US$ 97,000

INSTALL OCCUPANCY SENSORS AND EMS FOR THE LIGHTING SYSTEM

EEM Description

Plovdiv University Hospital has fourteen floors with spacious corridors illuminated 24 hours a day. There are 125 flourescent fixtures with two 40 W lamps each. Currently, there is no control or monitoring on the lighting system.

Implementation Outline

Install an integrated EMS to monitor and control the lighting of fourteen floors for the purpose of this project. This will optimize the time of use of the lighting. It will be designed in a way that allows to expand integration to include HVAC, access control and lifts.

Other benefits

Demonstrate the benefits of EMS which is new to Bulgarian energy managers. Allow hospital management to expand the EMS in the future. It will help to build up a long term relationship between the Hospital and the AEE/Plovdiv.

Equipment specification (based on Andover Control EMS budget prices)

Equipment		Price in US$
1.	PIR Detectors (80 pieces)	3,888
2.	Lighting Controllers with 8 PR7 relays no feedback (10 pieces)	24,960
3.	IBM PC	2,000
4.	Master Controller	8,640
5.	Arcnet cables and accessories	1,000
6.	OS/2 standard	324
7.	Single user software	2,880

TOTAL: $43,692

Other Costs covered by the Hospital:

Services provided by AEE/Plovdiv		Price in US$
1.	Detailed design	8,695
2.	Installation, programming and start-up	17,360
3.	Maintenance and operation (three years)	9,500
4.	Monitoring and Verification (three yrs)	8,640

TOTAL: $44,195

TOTAL PROJECT COST: $87,887

Cost and Savings Summary

Savings:	(10kW x 10 floors x 365 days x 24 hours) - (10kW x 10 floors x 365 x 12 hours) = 438,000 kWh 438,000 kWh x 0.07 c = US$ 32,850
Life years	10
Cost	US$ 87,887
Payback (yrs)	2.67 years

INSTALL ENERGY EFFICIENT PLATE HEAT-EXCHANGERS, REPLACE FAULTY THREE WAY VALVES AND CONNECT TO THE EMS

EEM Description

Plovdiv University Hospital has twenty heat-exchange stations with old, poorly maintained, inefficient heat-exchangers and controls. Currently the Hospital has replaced old, none-operational controls in six heat-exchange stations.

Implementation Outline

Rehabilitate one heat-exchange station: Hei Building. Integrate this station in the EMS.

Other benefits
Demonstrate the benefits of EMS which is new to Bulgarian energy managers.

Equipment specification (based on APV, Johnson Controls and Andover Control EMS budget prices)

Equipment		Price in US$
1.	Plate heat-exchanger	1,350
2.	Three-way valve (2 pieces)	860
3.	Flow meter	1,400
4.	Stand alone controller	640
5.	Cables, accessories and sensors	970

TOTAL: $5,220

Other Costs covered by the Hospital:

Services provided by AEE/Plovdiv		Price in US$
1.	Detailed design	1,465
2.	Installation, programming and start-up	1,670
3.	Maintenance and operation (three years)	900
4.	Monitoring and Verification (three yrs)	660

TOTAL: $4,695

TOTAL PROJECT COST: $9,915

Cost and Savings Summary

Savings:	(1400kW x 150 days x 18 hours) -	
	(1150kW x 150 days x 12 hours)	= 1,710,000 kWh
	1,710,000 kWh x 0.015 c	=
	US$ 25,650	
Life years	10	
Cost	US$ 9,915	
Payback (yrs)	0.4years	

Energy Efficiency Package # 2:
Total cost: US$ 101,805

INSTALL OCCUPANCY SENSORS AND EMS FOR THE LIGHTING SYSTEM

EEM Description

Plovdiv University Hospital has four boilers with firing rate of 1000 l mazut/hour and three boilers with firing rate of 350 l mazut/hour. The burners are old and inefficient. Some of the mazout consumed to fuel boilers for steam generation in the boiler house. Of seven boilers installed in the plant two are operating with a capacity of 4.5 t/h and 12 t/h of saturated steam. The boilers are in good condition. The burners are operated manually and inefficiently. Air-to-fuel ratios are adjusted visually by the experience of the operators; no stack measurements are performed. Boiler efficiencies are generally low due to 2 main reasons: 1/high stack temperatures; high air-to-fuel ratios. The measured boiler combustion efficiencies ranged from 70 to 72%. The audit team found that the boiler operators rarely change the boiler firing rate. If burners are replaced, expected efficiencies are around 80 to 84 %.

Implementation Outline

Replace the existing low efficient mazut burners with new modern automated efficient burners.

Other benefits

Mitigate environmental imact.

Equipment specification (based on Iron Firemen budget prices)

Equipment		Price in US$
1.	Mazut burner 1000l/hour + controls and accessories (2 pieces)	42,470
2.	Mazut burner 350l/hour hour + controls and accessories (1 piece)	16,160

TOTAL: $58,630

Other Costs covered by the Hospital:

Services provided by AEE/Plovdiv		Price in US$
1.	Detailed design	1,695
2.	Installation, programming and start-up	6,360
3.	Maintenance and operation (three years)	1,800
4.	Monitoring and Verification (three yrs)	1,500

TOTAL: $11,355

TOTAL PROJECT COST: $69,985

Cost and Savings Summary

Savings:	2000 t mazut x 10 %	= 200 t mazut
	200 t x $ 145	=
	US$ 29,000	
Life years	10	
Cost	US$ 69,985	
Payback (yrs)	2.41 years	

RETROFIT FLUORECENT LIGHTING WITH T-8 LAMPS AND ELECTRONIC BALLASTS

EEM Description

Plovdiv University Hospital has fourteen floors with spacious corridors illuminated 24 hours a day. There are 125 flourescent fixtures with two 40 W low efficient lamps with magnetic ballasts.

Implementation Outline

Install energy efficient lamps T-8 with electronic ballasts on one floor. Expected savings around 55 % according to vendors.

Other benefits
Demonstrate the benefits of energy efficient lighting.

Equipment specification (based on Grainger budget prices)

Equipment		Price in US$
1.	Energy Saving electronic ballast fixtures (100 pieces)	7,800
2.	TL 80 Fluorecent lamps 25W (200 pieces)	1,600

TOTAL: $9,400

Other Costs covered by the Hospital:

Services provided by AEE/Plovdiv		Price in US$
1.	Detailed design	600
2.	Installation, programming and start-up	860
3.	Maintenance and operation (three years)	400
4.	Monitoring and Verification (three yrs)	400

TOTAL: $2,260

TOTAL PROJECT COST: $11,660

Cost and Savings Summary

Savings:	10kW x 1 floor x 365 days x 24 hours = 87,600 kWh 87,600 kWh x 0.07 c x .55 = US$ 3,372
Life years	5
Cost	US$ 11,660
Payback (yrs)	3.44 years

BUILDING ENVELOP IMPROVEMENTS - WETHERIZATION

EEM Description

Plovdiv University Hospital has very poor building envelope. There is a need to weather strip all window frames.

Implementation Outline

Weather strip window frames, replace broken windows and repair window frames.

All Costs covered by the Hospital:

Services provided by AEE/Plovdiv		Price in US$
1.	Materials	7,465
2.	Detailed design	465
3.	Installation, programming and start-up	10,670
4.	Maintenance and operation (three years)	900
5.	Monitoring and Verification (three yrs)	660

TOTAL: $20,160

TOTAL PROJECT COST: $20,160

Cost and Savings Summary

Savings:	Estimated at: US$ 9,650
Life years	10
Cost	US$ 20,160
Payback (yrs)	2.08 years

Business Plan

Varna Hospital Shared Savings Project

Prepared for:
Electrotek Concepts Inc.

Prepared by:
Association of Energy Engineers -
Bulgarian Chapter

Sofia, Bulgaria

October 1997

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I. Project Summary

The Hospital Shared Savings Project is developed in accordance with the Memorandum of Understanding between Municipality of Varna, United Regional Clinic Hospital - Varna, Association of Energy Engineers - Bulgaria and Electrotek Concepts, Inc., signed in August 19, 1997.

The Regional Hospital is a typical hospital facility of medium-to large sized Bulgarian cities. Its structure consists of 12 buildings.

Total building area - 58,000 m^2;
Number of hospital beds - 932;
Personnel -1,164.

According to the signed MOU in the common sharing of the participation and responsibilities:

- The Municipality partially finances the project and implementation activities;
- The Hospital directly participates with its specialists and provides the required working conditions;
- AEE - Bulgaria performs the energy audit, the project and installation works, monitoring and evaluation of the results and partially finances these activities;
- Electrotek Concepts, Inc. provides limited technical assistance in all of the project stages, procurement and shipping of a part of the specified energy saving equipment donated by USAID.

All team members are members of the Association of Energy Engineers and Certified Energy Managers. They have an experience in development, implementation, monitoring and evaluation of the Demonstration Energy Efficiency Project in the Regional Hospital "Dr. T. Venkova", Gabrovo.

A shared savings agreement will be signed after the acceptance of the Business plan and the selection of the projects to be implemented. A possible sharing of the savings between Hospital, Municipality and AEE during a period of 3 years is: 50:30:20.

During the Energy Audit energy consumption data has been collected and analyzed. ECO measures has been identified and evaluated. The first priority list is proposed for consideration in the Business Plan:

Summary of ECO's Selected for First Priority Installation

ECO Nr.	Name	Invest-ment Total $	Savings from total building t/y	%	kWh	%	$	Pay-back years
B-1	Replacement of Ventilation and AC System in Surgery Room							
	Total:	38,850			72000	87	4,392	8.84
B-2	Installation of Solar Collectors							
	Total:	25,600	5.3 t/y				3,763	6.8
B-3	Boiler House Efficiency Improvement							
	Total:	26,140	80 t/y	3.5			16,605	1.56
B-4	Steam Distribution System Improvement							
	Total:	4,079	105.8 t/y	5.2			22,206	0.23
B-5	Laundry Energy Efficiency Improvement							
	Total:	600	14.2 t/y	0.7			2,987	0.77
B-6	Substations Energy Efficiency Improvement							
	Total:	1,930	1,370 t/y	5			1,370	0.4
E-1	Installation of three tariff electric meters							
	Total:	3,750				20	12,890	0.29
E -2	Replacement of incandescent lamps							
	Total:	5,600				83	3,803	1.47
E-3	Shifting Loads							
	Total:	2,500				16	5,841	0.43
E-4	Occupancy Lighting Control							
	Total:	2,750				60	2,232	1.25
	Total for Selected ECO's:	96,849					76,062	1.27

- The total cost savings from the proposed measures are 76,062 USD;
- The sum of the required investments is 98,849;

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- The payback of the investments after the implementation of all measures is 1.27 years

Non energy impact on the Hospital:
- improved climate in the surgery rooms according to the standard requirements;
- reduction of the pollution from the boiler house as a result of improved efficiency.

The schedule for implementation is as follows:

- installation and implementation of the measured selected to be supported by USAID - by the end of 1997;
- monitoring, maintenance and support of the measures with assistance of AEE chapter - January-June 1998;
- evaluation of the real savings and savings sharing - 1998;
- formation of Municipality fund for energy efficiency projects - 1998-1999;
- implementation of the second list of measures - 1998-1999

The results of the risk analysis and estimations are incorporated in the accepted value of the discount rate.

The level of the risk of the project, having in mind Bulgarian common and specific project conditions (using the method of accumulated risk) consists on three components:

- return of no risk investment in Bulgaria - 8%;
- branch risk (no stabile legal frame, prices, institutions) - 8%;
- project risk (problems with Municipality budget, radical changes in the Hospital) - 4%.

Total discount rate: 0.20

The proposed Business Plan is a base for decision making from the Municipality, Hospital and USAID for selection of the first priority list of measures to be implemented.

II. Business plan

2.1. Introduction

The Hospital Shared Savings Project is developed in accordance with the Memorandum of Understanding between Municipality of Varna, United Regional Clinic Hospital - Varna, Association of Energy Engineers - Bulgaria and Electrotek Concepts, Inc., signed in August 19, 1997. The first step of the Project is the Energy Audit and the Business Plan, developed in accordance with the contract between the Municipality, the Hospital and the Association.

The purpose of the Business Plan is to analyze the technical, financial, management and organization aspects of the proposed energy saving measures of first priority, identified in the energy Audit. The criteria used for measures selection are:

- measures proposing potentials for good energy savings or vitally important improvements in hospital activities;
- measures not requiring large capital investments;
- measures not requiring long time design and installation works;
- measures with relatively short payback period;
- low level of risk in implementation;
- potentials for implementations in other hospitals.

2.2. Description of Hospital

The Regional Hospital is a typical hospital facility of medium-to large sized Bulgarian cities. Its structure consists of 12 buildings, including:

- "Old Hospital" - Administration and Therapy block, 4 floors, built in 1928;
- Surgery block, 7 floors, built in 1967;
- Skin block, 6 floors, built in 1980;
- Infection clinic, 2 floors, built in 1963;
- Polyclinic, 3 floors, built in 1972;
- Gas station, Boiler house, Laundry, Kitchen, Maintenance and repairing block, Garages;

Total building area - 58,000 m^2;
Number of hospital beds - 932;
Personnel -1,164.

A sketch of the main blocks of the hospital is shown in Fig.1.

2.3. Organizations involved in the Project

According to the Memorandum of Understanding, the participation and responsibilities of the organizations, involved in the sequence of the project activities are as follows:

N	Activity	Term	Logistical/Technical Responsibility	Financial Responsibility
1	Energy Audit	30.09.97	AEE, URCB, Limited assistance from Electrotek	Municipality, AEE
2	Financial Analysis	15.10.97	AEE, URCB, Limited assistance from Electrotek	Municipality, AEE
3	Business plan	15.10.97	AEE, URCB, Limited assistance from Electrotek	Municipality, AEE, Presented to Electrotek
4	Detailed implementation schedule and shared saving agreement	30.10.97	AEE, URCB, Municipality Electrotek	
5	Equipment procurement and shipment	30.11.97	AEE and Electrotek	Electrotek - (USAID donation) and other financial sources
6	Equipment installation	20.12.97	AEE, Hospital	Municipality, Partially Electrotek
7	Long term monitoring and maintenance	30.06.97	AEE, Hospital	Municipality, AEE

Detailed financial responsibilities of Bulgarian participants of the Project are as follows:

- Municipality covers all direct costs of Energy Audit, Installation works and Long term monitoring and maintenance, estimated at 10,000 USD. This sum is related with the measures selected to be implemented with the support of USAID. Part of the savings after the implementation of these measures will be invested in the next list of efficient measures.
- AEE covers all indirect costs of Energy Audit, and Long term monitoring and maintenance, estimated at 8,000 USD.
- URCB participates with manpower, including in the project team 4 specialists from energy and financial departments during the period of August 1997 to July 1998 at 25% of their capacity.

2.4. Project Management and Shared Savings Arrangement

Project Team:

1. Dr. Dimitar Baev, CEM - project manager
2. Prof. Garabet Mumdgian, CEM
3. Dr. Nikola Stankov, CEM
4. Dr. Tsancho Tsanev
5. Dr. Dejan Yordanov, CEM
6. Yordan Katsarov, CEM
7. Mr. Stefan Pertov - Deputy Director of the hospital
8. Mr. Stojan Penchev - Head of the Energy-Mechanical department
9. Mr. Asen Kolev - Hospital Energy Manager

Project team organization

Project management and administration- D. Baev
Project scientific consultant - G. Mumdgian
Hospital's project coordinator - S. Petrov

Building Energy Audit:

D. Yordanov
D. Baev

Heat Supply and Distribution System Audit
N. Stankov
J. Katsarov

Electrical Consumption Audit
Ts. Tsanev
D. Baev

All team members are members of the Association of Energy Engineers and Certified Energy Managers. They have an experience in development, implementation, monitoring and evaluation of the Demonstration Energy Efficiency Project in the Regional Hospital "Dr. T. Venkova", Gabrovo.

The following ESCo, related with the AEE - Bulgarian chapter and its team are involved in the Project support, implementation and installation works:

- Energy Efficiency System Ltd.
- Magnetelectric
- Tetiva Ltd.

- Risk Engineering Ltd.
- Argus'91, Varna

A shared savings agreement will be signed after the acceptance of the Business plan and the selection of the projects to be implemented. A possible sharing of the savings between Hospital, Municipality and AEE during a period of 3 years is: 50:30:20.

2.5. Energy Consumption Data

The monthly consumption of oil #6 in kg. is shown in the next table:

Month	1994 kg	1995 kg	1996 kg	1997 kg
January	470,448		342,000	355,500
February	245,516	602,868	304,000	194,000
March	385,465	308,700	252,000	175,729
April		242,300	167,684	169,374
May		111.000	74,426	56,000
June		59,300	86,736	76,100
July	740,471	93,600	40,260	62,200
August		101,400	80,360	
September	510,264	66,400	79,595	
October	97,477	209,900	104,200	
November		293,712	175,100	
December	435,007	409,882	307,100	
Total	**2,884,648**	**2,498,992**	**2,013,461**	
Specific consumption kg/m^2	**49.73**	**43.09**	**34.71**	

Two main regimes can be defined clearly - a winter and summer one. In the months from May to October the heat is used for DHW, the laundry, the steriliser, as well as for domestic consumption in the boiler house.

The total electricity consumption of the hospital according to electricity bills for 1994, 1995, 1996 and 6 months of 1997 is given on the Table.

Year	Full day consump-tion kWh	Daily consump-tion kWh	Night consump-tion kWh	Peak consump-tion kWh	Total consump-tion kWh
1994	974,520	567,540	194,100	381,420	2,117,580
1995	1,013,120	705,600	242,340	435,720	2,396,780
1996	1.115,680	679,780	247,740	401,520	2,480,720
6-months 1997	528,160	273,960	94,340	200,700	1,097,160

Remarks:

- During 1994 and part of 1995 the Surgery block was in fundamental repairing works that influenced the total consumption;
- In the end of 1996 the Sterilization block has been introduced in operation with installed capacity of 180 kW.

2.6. Subsystem's related data

■ *Building Envelope*

All the symbols dimensions and abbreviations used in the down listed descriptions are in accordance with ASHRAE fundamentals Handbook 1997.

- Walls

Outer walls are different for groups of buildings, depending on the year of finishing. There are two main groups of buildings, later called "old" and "new" group.

The old group consists of buildings N 1, 8, 10, 11, 12, 13 and 14. Their walls are made of bricks, plastered from inside and outside, with R factor 0.79 [(m^2K/W)] for building 1 an R = 0.59 [(m^2K/W)]for the others.

The new group consists of buildings N 2, 3, 4, 5, 6, and 9 and their walls are made of sandwich panels with R factor 0.63 [(m^2K/W)].

- Floors

The floors over unheated rooms consist of armoured concrete slab, plastcring layer from the side of non heated room and marble cover from the side of the heated room. R value is 0.50 [(m^2K/W)].

- Roofs

The roofs of all buildings from Old group are made from clay tiles oner wooden construction with an air insulation, plastered from inner side. There is one different building - N 10, with a concrete roof. The R value for N 10 is 0.40 [(m^2K/W)] and for other buildings R = 0.50 [(m^2K/W)].

As a whole the walls, floors, ceilings and roofs are in good condition and satisfy the standard requirements.

Fenestration

The following types of windows and doors are installed in the hospital buildings:

A - double glassed wooden frame windows;
B - double glassed wooden frame balcony doors;
C - double glassed wooden frame balcony glass-case;
D - single glassed aluminum frame windows;
E - double glazing plastic framed doors;
F - single glassed iron framed glass case;

There are 26 different sizes of windows installed in the hospital buildings. Another 11 types of doors were detected.

The inspection of the windows and doors has indicated the following :

- The windows are in quite good condition;
- The percentage of broken glasses is under 5%;
- The average dimension of the openings around the windows is 1-2 mm. Quite unexpected was the fact that the most recently installed fenestration (in 1993) - that of plastic frames had openings reaching 2 cm. From the northern side of building N 6.
- About 20% of the lockers do not operate properly.

The conclusion is that the envelop and fenestration are not the factors that affect very much the energy consumption of the buildings. Even more - the new buildings does not have lower thermal consumption than the old ones. Building N 6, for example, has been under refurbishment from 1990 to 1994, but has been put into operation without air conditioning systems, though there are 18 operation rooms, 36 reanimation rooms and more than 30 rooms serving the operation rooms, because of lack of financing. A lot of compromises had been made in order to save money. The fenestration used in the building had to be among the best - double glazing with plastic frames, but has the biggest openings around the windows. It is difficult to find out the reason for this, but the most probable are either low quality of the product - the window, or lack of experience in

installing this type of windows. In both cases it is not right now the moment to change the envelop and/or fenestration of the building.

- ***Air-conditioning System***

There is no an air-conditioning system in the hospital at the moment. There are projects for such system for buildings N 5, 6, and 8. In building 6 some temporary air ducts are installed for exhaust relieve air, but only for operating complex on the 6th floor air ducts for supply air are installed. A duct network has been installed in Building N 5, but an air conditioning has never been put into operation, because a chiller has never been installed in the hospital. Based on preliminary calculations, an amount of 3,000,000 USD is needed in order to purchase the equipment nd carry out the necessary installation work for buildings N 5 and 6.

HEAT SUPPLY SYSTEM

BOILER HOUSE

BOILERS

There are 3 pcs of firetube boilers for saturated steam with the following characteristics:

2xPKM6.5-output: 2x6.5 t/h
power: 2x4.71 MW
1xKM12 - output: 1x12 t/h
power: 1x8,35 MW

Features:

- main fuel - heavy oil #6;
- ignition fuel - gas propane-butane, light oil #2;
- steam pressure in working conditions - 7-8 bar;
- max. steam pressure - 13 bar;
- insulation statement - good.

Control systems:

- water level control in the boiler - on/off control of the feed-pumps;
- water quality control - manually, chemical analyses;
- start/stop boiler operation - programmatic sequenced the procedures of venting, ignition etc.
- steam pressure control - see "Burner Control System";
- control panel.

Protections:

- high and low water level in the boiler - turn off fuel supply system;
- high steam pressure - tuned up high pressure control valve to turn off fuel supply system + safety valve;
- fire sensor system - photo relay control of the flame;
- alarm system and shut-down panel.

Time table:

- winter period - normally boiler KM12; or 2 * PKM6.5
- summer period - normally boiler 1 * PKM6.5.

BURNERS

For boilers PKM6.5

Type of burner: METEOR 450, made in Bulgaria.
Capacity: max. 450 kg/h - heavy oil #6.
Features: 3-stages burners with 3 nozzles.
Capacity regulation:

- oil is released at start when solenoid valve and the safety solenoid valve is open;
- the intermediate load cuts in when solenoid valve #2 opens;
- full load is reached when solenoid valve #3 opens;
- the capacity is regulated by opening and closing solenoid valves #2 and #3 by means of shut on/off pressure control devices, but manual control of the inlet heavy oil pressure;
- electrically controlled opening air damper on positions depending on the number of activated stages (control of fuel/air ratio).

For boiler KM12

Type of burner - 1 nozzle, manual operation of air and fuel supply.
Capacity: max. 800 kg/h heavy oil #6.

MAKEUP WATER AND FEED-WATER TANKS

Feed-water pre-treatment procedure is realized in makeup water department to the Boiler House.

There are 3 pcs. of regeneration filters and 1 pcs. of salty solution filter for re-establishment of the regeneration resin:

- type of the regenerating resin - vofatit;
- concentration of the salty solution - 12% NaCl.

Recommended maximum impurity concentrations:

		Boiler feed-water	Boiler water
Total hardness	mg/l	0,02	-
Total alkalinity	mg/l	1,3	24
Chloridity	mg/l	7	300-400

There are is no specific conductance measurements. The concentration of dissolved solids in the water is controlled by blowdown - approximately on every 2 hours. The blowdown is going into the blowdown vessel and then into the sewer.

There is no measurement of makeup water flow to the feed-water tanks.

There are two feed-water connected tanks which are situated in the Boiler House and collected the return condensate and makeup water. There is no deaerator.

The condensate from consumers, are collected into the feed-water tanks to the boiler house..

Feed-water passed to the boilers by means of 1+1 feedmultistages pumps to the every unit.

STEAM SUPPLY SUBSYSTEM

The scheme of the steam supply system in Boiler House is shown on Fig.2, where:

- SCHP - high pressure - 7 bar main steam collector, collected steam from boilers PKM6.5 N1 and N2, boiler KM12 and distributed steam to Laundry (demand 7bar) and Hospital Substation (demand 2 bar);
- SCMP - medium pressure steam collector - 4.5 bar, distributed steam to Sterilization Dpt -p.10 (demand 4.5 bar) and the other consumers -p.6 to p.12 with demand 2 bar ;
- SCLP - low pressure steam collector - 2 bar, distributed steam to p.13 to p.15 with demand 2 bar.

Remark: There is no pressure reduction valves in order to reduce collector' pressure according to demands of the consumers in boiler house and in the different substations. The insulation of the collectors are in a very bad conditions. There are no steam flow meters at all.

FUEL SUPPLY SUBSYSTEM

There are 9 pcs. main heavy oil tanks (2 x 10 m^3), 1 pcs. light oil tank (1x10m^3), and 1 pcs. daily heavy oil tank (1 x 3 m^3), situated in the Boiler House. Heavy oil heating is organized by means of steam coils installed in the tanks.

In order to increase heavy oil temperature up to 120-130 °C for better burning process, there are 3 heavy oil heaters to the boilers.

Range of heavy oil temperatures:

- after receiving tanks - T_{RT}=50-60 °C;
- after daily tanks - T_{DT}=60-70 °C;
- after heavy oil heaters - T_{HO}=120 °C;

Steam is also supplied to the heavy oil heaters directly from the boilers trough handle valves, reducing the steam pressure. The condensate from the heavy oil tanks and heaters is drained by steam traps and collected into the blowdown vessel and then into the sewer, due to the possible oil contamination in it.

SUBSTATIONs

There are 5 consumers (substations) for heating and hot water supply, which belong to the Hospital. Two of them, therapy and account dpt are used low pressure steam for heating. The rest are used steam - hot water heat-exchangers for heating. All of them are used steam - water heat-exchangers for domestic hot water. All heat exchangers are well equipped with suitable control devices (DANFOS Controls) for heat consumption during last two years (FIG 2), but in account dpt condensate from steam heating is thrown out. The reason is - lack of suitable premise, condensate tank and equipment to it. There are another 7 consumers (substations) for heating , hot water and steam, which have to pay for heat according to the heating volume. These substations are approximately in a good condition. The insulation in all substations have to be changed.

LAUNDRY

There are following heat consumers in the Laundry:

4 pcs - Washing machines , using direct low pressure steam. Indirect high pressure steam use: 4 pcs. pressing machines, 2 psc calanders type sterilizer and 1 psc steam dryer. There are no steam condensate traps at the outlet of calanders. The existing condensate recovery system is not designed properly.

Heat Balance

Hospital's heat balance is obtained on the base of the total heavy oil fuel consumption in 1996, equalized to available heat in the fuel or vice versa. The following data are used for heat balance accounting:

- Heavy oil fuel consumption in 1996	B_y=2013 t/y
- Low calorific value of heavy oil (>3,5% S)	Qr = 39780 KJ/kg
- Heavy oil temperature	Tho = 120 °C
- Heavy oil price	Z = $ 210
- Average boiler efficiency	η= 83 %
- Average steam pressure in boilers' outlet	Psteam = 7 bar
- Enthalpy of saturated steam at 7 bar	h = 2767 KJ/kg
- Average feed water temperature	T fw = 60 °C
- Enthalpy of feed-water	h fw = 257 KJ/kg
- $\Delta h = h - h_{FW}$	Δh = 2510 kJ/kg
- Assumed heat supply system efficiency through the main steam pipelines to the substations	η_s = 96 %

Heat balance consists of:

- Determination of heat consumption in Substations on the base of the heating volume and steam demand

Consumers	Heat consumption, GJ/year			Steam consumption t/year		
	winter	summer	total	winter	summer	total
laundry	9,700	8,715	18,415	3,865	3,472	7,337
Sterilization	2,383	2,481	4,864			1,938
Kitchen	357	286	643	142	114	256
Blood center	1616	261	1887	643	104	747
Orthopedic	235		235	94		94

facroty						
Shop	11		11	4		4
Maintenance dep.	1258	264	1532	505	105	610
Medical University	5,257	2,244	7,501	2,094	894	2,988
Polyclinic	7,733	1,650	9,383	3,081	657	3,738
Oncology	687	283	970	274	113	387
Radiology	1.806	742	2,548	719	296	1,015
Service rooms	54		54	22		22
External consumers	11,937	6,495	18,432	4,756	2,588	7,344

Annual production of heat - 66,464 GJ/year;
Annual production of steam - 26,480 t/year;

Heat losses in boiler house:

- measured current efficiency - 86%;
- operating efficiency - 83.0%

Heat losses from nonreturned condensate on the base of preliminary balance of returned condensate in the boiler house and some assumption about the structure of the losses - approx. 18%

Electricity system

Electricity is supplied to the hospital by ring network at 20 kV and then is transformed to 0.4 kV by four transformer stations:

- TS N1 - 2 x 630 kVA;
- TS N2 - 2 x 630 kVA;
- TS N3 - 2 x 400 kVA;
- TS N4 - 1 x 400 kVA;

In case of supply brake or failure a diesel motors coupled with electric generator is automatically switched on in order to ensure the electricity for the hospital. It should supply the surgery, emergency, gynecology and the lifts.
The electricity consumed by the hospital is measured by three one tariff electric meters and three 3 tariff meters at the high side of the transformers. The data are gathered monthly for billing purposes only. The one tariff metering does not allow to take advantage of existing different loads during the three tariff zones and especially at night.

The main consumers of electrical energy are:

- Laundry, including different types of electrical motors;
- Kitchen, including different types electrical heating devices;
- Sterilization block with installed capacity of 180 kW;
- Special medical equipment, including roentgen;
- Lighting (see next table).

Number of installed lighting fixtures in the Hospital

Blocks	Luminescent 3 x 40 W	Luminescent 2 x 40 W	Luminescent 1 x 40 W	Incandescent
Surgery	389	946	16	328
Therapy	305	89	-	89
Skin department	8	280	-	48
Emergency	104	224	23	51
Gynecology	44	155	-	132
Total	850	1,694	39	648

In order to determine the regimes and the consumption of the different consumers 24-hours load patterns has been measured by the installed meters and using additional portable measuring equipment.

The annual consumption of the kitchen and laundry is given in the next Table:

Year	1994	1995	1996	6 m. 1997	Total

Consumption kWh	511,536	557,039	34,995	158,234	1,574,804
% from total consumption	24	23	14	14	19

The average annual electrical energy consumption of the sterilization block is estimated after measurements at 9% from total consumption or 208,080 kWh.

The power factor is in the required limits and there is no need of corrections.

The following parts of the consumed electrical energy by tariff zones has been determined:

- peak zone - 32%;
- daily zone - 50%;
- night zone - 18%.

Conclusions from the analysis of the electrical part:

- There is no potentials for low-cost energy savings in the supply network and transformer stations because of the high requirements for reliable electricity supply;
- The possible energy saving measures are:

- replacement of the existing one tariff electrical meters by three tariff ones;
- sifting from the peak tariff zone of the operations of the largest consumers, not related with the medical works;
- improvements in lighting systems such as:
    - replacement of the existing incandescent lamps 75 W with energy effective compact lamps 11 W;
    - replacement of the conventional ballasts by electronic ones;
    - sectioning of the lighting systems;
    - local lighting introduction;
    - automatic lighting control
    - maintenance improvements

2.7. Energy Conservation Opportunities (ECO) - Technical and Financial Details

Technical details, energy and cost saving estimations and required investments are given for each of the proposed measures. Financial analysis is based both on simple payback and NPV calculations.

The results of the **risk analysis** and estimations are incorporated in the accepted value of the discount rate.

The level of the risk of the project, having in mind Bulgarian common and specific project conditions (using the method of accumulated risk) consists on three components:

- return of no risk investment in Bulgaria - 8%;
- branch risk (no stabile legal frame, prices, institutions) - 8%;
- project risk (problems with Municipality budget, radical changes in the Hospital) - 4%.

Total discount rate: 0.20

Measure B 1 : Installing of AC System in surgery rooms at building 6, VIth floor

Initial Conditions:

The air-conditioning system is a single zone, operating at 100% fresh air with air flow of 8,500 m^3/h. A chiller with capacity 40 kW is selected. For the winter period there is a steam heater, and for summer operating of the system - a chillier - evaporator of refrigerator with direct evaporation and air-cooled condenser, which is installed on the roof of the building.. The parameters of the outside air for Varna are 34^0 C and 44% RH. The relative humidity level in the rooms is kept by a steam humidifier. The machine room is in a sound insulated chamber situated at the top of the building. The fresh air is taken from the north-eastern face of the building, while the relief air is transported to the top of the building and through nozzles is send in atmosphere. For the surgeries and serving rooms 4 ceiling air-distributing panels are selected from "Weisstechnik" Co - Types OP 4402, OP 5532 and OP 7532. Only the fans are installed but have never been put in operation.

Description of Action / Results:

An installation of a new air-conditioning system is proposed on EPCH size 13 module of SEMKO, an air cooler chiller or heat pump with capacity of 14kW at 35^0 C outside air and 4 ceiling air distributing panels with 3 stage of filtration for surgeries. With the new AC system the parameters of the microclimate of rooms will be proved to the standard level required. The aim is to multiply this energy measure instead of the conventional systems designed before for the other 17 surgery rooms.

The measure is of highest priority of the Hospital and Municipality because of its vitally important contribution to health and life protection. Having in mind the expected support from the Hospital and Municipality, the level of risk of this measure , estimated through discount rate is accepted at 0.08.

Financial Analysis:

The electrical energy savings are on the bases of the comparison with the installation of a conventional AC system.

Material & Labor Costs	Installation/ Design Costs	Total Project Costs	Annual O&M Costs
$ 34,850	$ 4,000	$ 38,850	$ 0

Benefits Energy Savings	% Savings	Physical Savings	Money Savings in $US

Fuel (x1000 m3)			
Electricity (MWh)	87	72	4,392
Total Savings	87		4,392
Payback (years)			8.84

Prices and producers

- zone thermostat 15÷30 °C, 1 pcs, $ 150/pcs, USA
- heat recovery unit Semco EPCH size 13, 1 pcs, $ 14,000/pcs, USA
- air distribution pannel with HEPPA filter at 3rd stage, 4 pcs, $ 2,800/pcs, USA
- cooling unit York, 1 pcs, $ 9,500/pcs, USA

Implementation schedule: two months after contract agreement.

Lifetime of the measure: approx. 22 years.

NPV: Investment -$ 41,750; Annual savings - $3,085; Discount rate - 0.08
NPV = (8.8694 x 4,392 = 38,954) - 37,850 = +1,104;

This measure is not very effective from point of view of the current situation in the hospital and energy saving potentials. But it is extremely important for the quality of medical services and human life protection.

Measure B 2 : Installation of Solar Collectors for hot water heaters

Initial Conditions:

In all buildings there are steam heaters for hot water supply. Most of the buildings have flat roofs, which can be used for installation of solar flat plate collectors for hot water supply.

Description of Action / Results:

The annual solar radiation for Varna region is 5,214.3 MJ/m^2. For the summer period from April to September the amount is 3,826.2 MJ/m^2. If a reasonable efficiency is assumed at 0.8 for the collectors and 0.5 for heatexchangers, an amount of 1,989.6 MJ/m^2 can be extracted. It means an average value of 331.6 MJ/m^2 monthly for the summer period. Measured through fuel economy, it means 16 kg heavy fuel monthly per square meter, estimated at boiler efficiency of 89% and heatexchanger's efficiency of 65%. The proposal is to install such a system at the roof of inclination, a total collector's area of 100 m^2 is available. Leaving some place for installation and place for operation and maintenance, an area of 56 m^2 could be used for collector's area.

Financial Analysis:

Material & Labor Costs	Installation/ Design Costs	Total Project Costs	Annual O&M Costs
$ 19,000	$ 6,000	$ 25,600	$ 0

Benefits Energy Savings	% Savings	Physical Savings	Money Savings in $US
Fuel (kg)		5,376	3,763
Electricity (kg)			
Total Savings			3,763
Payback (years)			6.8

Prices and producers

- Flat solar collectors 56 m^2, $ 14,600, Bulgaria or USA;
- Heatexchanger for hot water supply 3 m^2, $4,000, Bulgaria;
- Pump for water spply $750, USA;
- Thermostat $150, USA

Implementation schedule: two months after contract agreement.

Lifetime of the measure: approx. 12 years.

NPV: Investment -$ 25,600; Annual savings - $3,763; Discount rate - 0.20
NPV = (4.4393 x 3,763 = 16,705) - 25,600 = - 8,895;

Measure B-3 : Boiler house efficiency improvement

1. Initial Conditions:
   - 2 Firetube boilers type PKM6.5 (6.5 t/h sat. steam @ 13 bar gauge, 4.71MW), 1 Firetube boiler type KM12 (12 t/h sat. steam @ 13 bar gauge, 8.35MW). Operating range 7 - 8 bar gauge. During the audit the KM12 - boiler was not running and its

systems were not audited. Burner of PKM6.5 - 3 Power levels, low burning efficiency. Boiler efficiency was measured 86.8% at design value of 90% during operation, but taking into account regime factor and manual adjustment of the burner oil pressure, it was estimated about 83%. The deaerator is not existing. Water treatment at low level, no conductivity measurement. The boiler blowdown is controlled manually according to the chlorides analysis results, no waste heat utilization. Insulation state - satisfactory.

2. Description of Action / Results:

- Change of 1 burner (PKM6.5) with more effective new one, automatically controlled fuel/air ratio and modulated control of the boiler's load. Fuel: Heavy oil #6. Voltage 380V, 3 ph. 50Hz. Load rate 110 - 460 kg h.f.o/h (1200-5170 kW)
  - efficiency increasing about 3.5% from 2013 t.f.o/y ≈ 80 t.o/y at fuel oil price $210/t - Total saving $16685/year.
  - noticeable environmental impact.
  - independant of the load steam quality, produced in boiler house at 7 bar.

3. Financial Analysis:

	Material & Labor Costs	Installation / Design Costs	Total Project Costs	Annual O&M Costs
Burner- 1 pcs	***$ 24 140***	***$ 2 000***	***$ 26 140***	-
			$ 26 140	

Energy Savings	% Savings	Physical Savings	Money Savings in US$
Fuel [t] Electricity [MWh]	*3.5* -	*80 t/y* -	*16685*
Total Savings			*16685*
Payback [year]			*1.56 y*

4. Material Costs and Producers:

- Burner - Optional Production - RMS11- Weishaupt (Germany) - $ 24 140;

5. Implementation Schedule:

1. New Burner - one month after contract agreement

6. Lifetime of measure:

- Approx. 10 Years

*7. **NPV:*** Investment -$ 26,140; Annual savings - $16,685; Discount rate - 0.20
NPV = (4.1925 x 16,685 = 69,951) - 26,140 = + 43,811;
IRR = 1.68

Measure B-4: Steam distribution system improvement

1. Initial Conditions:

- Includes steam lines and steam distribution headers and lines from the boiler house to the consumers. There is no pressure reduction valves to the steam distribution system in order to control pressure requirements of the different consumers - 7 bar for Laundry, 4.5 bar for Sterilization Dpt and 2 bar for the rest (steam heating, heaters for heating and domestic hot water) - FIG 1. The design of the whole system is not proper. The insulation is not good.

2. Description of Action / Results:

- Mounting of pressure reduction valve 7/2 bar 4"(DN 100).
  - avoiding losses of bad utilization of flash steam due to nonreduction of the steam down to 2 bar gauge ≈ 571 ton steam/y. ≈ 103 t.f.o/y at $210/t.f.o - Total $ 21 630/y.
- Mounting of pressure reduction valve 7/4.5 bar ¾".
  - avoiding losses of bad utilization of flash steam due to nonreduction of the steam down to 4.5 bar in sterilization ≈ 60 ton steam/y ≈ 2.8 t.f.o/y at $210/t.f.o.Total $576
- Redesigned of the steam distrbution pipelines to the proper headers
- Change the insulation of steam pipelines and headers in boiler house and substation
  - improvement of steam quality
  - decreasing of heat losses

3. Financial Analysis:

Material & Labor Costs	Installation / Design Costs	Total Project Costs	Annual O&M Costs
$ 3 829	*$ 250*	*$ 4 079*	-
$ 833	*$ 150*	*$ 983*	
Energy Savings	% Savings	Physical Savings	Money Savings in US$
Fuel [t] Electricity [MWh]	*5.2* -	*105.8 t/y* -	*22 206* -
Total Savings			*22 206*
Payback [year]			*0.23 y* *(≈ 3 months)*

4. Material Costs and Producers:

- Pressure Reduction Valve 2300 4'(DN 100) - 6.9/(0-3.5)bar +SSP 50 +kit. Flanged .Part Numbers: 402496, 400553, 400643 - HOFFMAN, USA ≈ $ 3 829
- Pressure Reduction Valve 2100 ¾" - 7/4.5 bar + SSP 225 + kit.Screwed NPT. Part Numbers: 402442, 400554, 400641 - HOFFMAN, USA ≈ $ 833

5. Implementation Schedule:

1. Redesign of the steam distribution pipelines the proper header
2. Mounting of the pressure reduction valve

3. Change of insulation.

6. Lifetime of measure:
   - Approx. 10 Years

7. ***NPV:*** Investment -$ 4,079; Annual savings - $22.206; Discount rate - 0.20
   NPV = (4.1925 x 22,206 = 93,099) - 4,079 = + 89.020;
   IRR = 21.8

Measure B-5: Laundry energy efficiency improvement

1. Initial Conditions:

- Consists of 4 pcs - Washing machines , using direct low pressure steam. Indirect high pressure steam use: 4 pcs. pressing machines, 2 psc calanders type sterilizer and 1 psc steam dryer. There are no steam condensate traps at the outlet of calanders. The existing condensate recovery system is not designed properly.

2. Description of Action / Results:

- Installation of 4 psc. ¾" inverted bucket steam traps with filters (Pmax = 8.6 bar), 100 kg/h capacity, model B1125, Part Number 404337 - HOFFMAN, USA.
  - expected steam savings about 48 t/y or 3.9 t.f.o/y at $210/t.f.o ≈ $ 819/y.
- Reconstruction of the existing condensate recovery system - flash tank.
  - used flash steam about 135 t/y ≈ 10.3 t.f.o/y at $210/t.f.o = $ 2 168/y

3. Financial Analysis:

	Material & Labor Costs	Installation / Design Costs	Total Project Costs	Annual O&M Costs
Steam Trap	*$ 400*	*$ 200*	*$ 600*	-
Fl. Tank	*$ 1 200*	*$ 500*	*$ 1 700*	
			$ 2 300	

Energy Savings	% Savings	Physical Savings	Money Savings in US$
Fuel [t] Electricity [MWh]	*0.71* -	*14.2 t/y* -	*2 987*
Total Savings			*2 987*
Payback [year]			*0,77 y* *(9.2 months)*

4. Material Costs and Producers:

- Steam traps
  - 4 pcs ¾" type IB - model B1125, Part Number 404337 - HOFFMAN, USA 4x100=$400
- Flash Tank - Bulgarian made ≈ $ 1 200

5. Implementation Schedule:

1. Steam traps
2. Flash Tank

6. Lifetime of measure:

- Approx. 10 Years

*7. **NPV:*** Investment -$ 600; Annual savings - $2,987; Discount rate - 0.20
NPV = (4.1925 x 2,987 = 12,523) - 600 = + 11,923;
IRR = 19.9

Measure B-6: Substations energy efficiency improvement

1. Initial Conditions:

There are 5 consumers (substations) for heating and hot water supply, which belong to the Hospital. Two of them, therapeutical and account dpt are used low pressure steam for heating. The rest are used steam - hot water heat-exchangers for heating. All of them are used steam - water heat-exchangers for domestic hot water. All heat exchangers are well equipped with suitable control devices (DANFOS Controls) for heat consumption during last two years (FIG 2), but in account dpt condensate from steam heating is thrown out. The reason is - lack of suitable premise, condensate tank and equipment to it. There are another 7 consumers (substations) for heating , hot water and steam, which have to pay for heat according to the heating volume. These substations are approximately in a good condition. The insulation in all substations have to be changed.

2. Description of Action / Results:

- Installation of condensate station - Serial Number SCC - 1 - set: pump, receiver, level control system, with max. capacity 250 kg/h - HOFFMAN, USA
  - losses reduction with 1370 t. cond./y * 0,12 $/t ≈ 164 $/y, condensate heat losses 402 GJ/y ≈ 12.1 t.f.o./y * $210/t.f.o. ≈ 2 541 $/y, flash steam losses 367 GJ/y ≈ 11 t.f.o/y * $210/t.f.o. ≈ $ 2330/y. Total savings: $ 5 035/y

3. Financial Analysis:

	Material & Labor Costs	Installation / Design Costs	Total Project Costs	Annual O&M Costs
Condensate station	*$ 1 330*	*$ 600*	*$ 1 930*	-
			$ 1 930	

Energy Savings	% Savings	Physical Savings	Money Savings in US$
Fuel [t] Electricity [MWh]	*1.15* -	*23.1 t/y* -	*4 871* -
Condensate [t]	*5*	*1370 t/y*	*164*
Total Savings			*5 035*
Payback [year]			*0.4 y*

4. Material Costs and Producers:

- Condensate Station - 1 pcs, Serial Number SCC - 1, capacity 250 kg/h- including: pump, receiver, level control system - HOFFMAN, USA - $ 1 330

5. Implementation Schedule:

- Preparing of suitable premise.
- Installing of the Condensate station.

6. Lifetime of measure:

- Approx. 10 Years

7. NPV: Investment -$ 1,930; Annual savings - $4,871; Discount rate - 0.20
NPV = (4.1925 x 4,871 = 20,422) - 1,930 = + 18,492;
IRR = 9.6

Measure E-1: Installation of a three tariff electric meter

1. Initial Conditions:

Part of the electricity consumption of the hospital is measured now by 3 one tariff electric meters at the high side of the transformers. This is not optimal since it does not allow to take advantage of different electricity prices during day, night and high tariff zones. The price of kWh for the different zones varies between $0.0194 and $0.0826 depending on time and season during the year, thus offering a large money saving potential for the hospital.

2. Description of Action / Results:

To replace the existing 3 one tariff meters by 3 three tariff meters.
In order to estimate the money saving potential of the replacement measure calculations were made based on prices for a kWh during different time and season intervals. The load pattern for a typical winter and summer day was taken to estimate the percentage of electricity consumption during different tariff zones. Based on that the total consumption during the zones was obtained and compared to the existing case of one tariff zone metering. The difference in value is significant which allows to propose this measure as of first priority.

- The average annual consumption measured by one tariff meters is 1,047,851 kWh;
- The average annual costs measured by one tariff meters are:
  1,047,851kWh x 0.0615 USD = 64,442 USD
- The average annual costs measured by tree tariff meter are:

Peak: 1,047,851 kWh x 0.32 x 0.0771 USD = 25,852.5 USD;
Daily: 1,047,851 kWh x 0.50 x 0.0416 USD = 21,795.2 USD;
Night: 1,047,851 kWh x 0.18 x 0.0207 USD = 3,904.3 USD;
Total: = 51,552.0 USD;
Cost savings: 64,442 - 51,552 = 12,890 USD

3. Financial Analysis:

Material Costs	Installation/ Design Costs	Total Project Costs	Annual O&M Costs
3 x 1,000 = $3,000	3 X $250 = $750	$3,750	

Benefits	% Savings from base case	Physical Savings	Money Savings
Energy Savings			in $US

Fuel (MBTU)	-	-	-
Electricity (kWh)	20	-	12,890
Total Savings			12,890
Payback (years)			0.29

4. Prices and producers

Price of a new three tariff electricity meter and installation costs are quoted by Magnetelectric Co, Sofia. The meter should comply with the European standard of 50 Hz.

5. Implementation schedule: one month period after contract agreement

6. Lifetime of the measure: 10 years

*7. **NPV:*** Investment -$ 3,750; Annual savings - $12,890; Discount rate - 0.20
NPV = 4.1925 x 12,890 = 226,568 - 3,750 = +222,818;
IRR = 59.4

Measure E-2: Replacement of incandescent lamps

1. Initial Conditions:

There are two main types of lamps used in the hospital for lighting purposes: incandescent and fluorescent lamps. The installed wattage of incandescent lamps is more than two times higher than for fluorescent lamps. Therefore the substitution of incandescent lamps with higher efficacy compact lamps is proposed.

2. Description of Action / Results:

The number of incandescent lamps to be replaced is 400.. The proposed system assumes that all the 400 70 W lamps will be replaced by 14 W (including ballast loss) high efficiency compact lamps.

Capacity reduction: (75W - 14W) x 400 = 24.4 kW;
Annual consumption reduction: 61 kW x 2,880 hours = 70, 272 kWh, including:

- peak energy - 35,136 kWh;
- daily energy - 17,568 kWh;
- nigh energy - 17,568 kWh;

Electricity costs savings: 2,709 + 731 + 363 = 3,803 USD;

This calculations do not take into account savings from longer life time of the compact lamps.

3. Financial Analysis:

Material Costs	Installation/ Design Costs	Total Project Costs	Annual O&M Costs
400 x $11 = $4,400	$1,200	$5,600	

Benefits Energy Savings	% Savings	Physical Savings	Money Savings in $US
Fuel (MBTU)			
Electricity (kWh)	81.3	70,272	3,803
Total Savings			3,803
Payback (years)			1.47

4. Prices and producers
Prices of substitution lamps and installation cost are quoted by Magnetelectric Co., Sofia.

5. Implementation schedule: three month period after contract agreement

6. Lifetime of the measure: 8 years.

7. *NPV:* Investment -$ 5,600; Annual savings - $3,803; Discount rate - 0.20
NPV = 3,8372 x 3,803 = 14,593 - 5,600 = +8,993;
IRR = 1.60.

Measure E-3: Shifting of the loads in laundry, kitchen and sterilization block

1. Initial Conditions:

The laundry kitchen and sterilization block of the hospital operates now from 8 a.m. to 4 p.m. which means that its main electrical loads lies in the high tariff zone for electricity pricing (between 8 a.m. and 12 a.m.). This has as a result more money spending for its operation. The proposed measure suggests to shift these loads for 1 hour out of the high tariff zone. This will enable to save money due to the difference in pricing for both zones. Two additional electric three tariff meter (for the external consumers - laundry and kitchen) should be installed to measure the effect of shifting the loads.

2. Description of Action / Results:

According to the existing situation, the average annual consumption of the three consumers is 658,080 kWh, consisting of two parts: peak one - 246,780 kWh and daily one - 411,300. The corresponding costs are: 19,027 USD and 17,110 USD or total costs: 36,137 USD.

After shifting of the loads the peak loads will be 82,260 kWh and the daily one - 575,820 kWh. The corresponding costs will be 6,342 USD and 23,954 USD or total costs 30,296 USD.

Saving: 36,137 - 30, 296 = 5,841 USD

Expected investment costs - 2,000 USD for meters and 500 USD installation costs.

3. Financial Analysis:

Material Costs	Installation/ Design Costs	Total Project Costs	Annual O&M Costs
$2,000	$500	$2,500	

Benefits Energy Savings	% Savings from base case	Physical Savings	Money Savings in $US
Fuel (MBTU)			
Electricity (kWh)	16		5,841
Total Savings			5,841
Payback (years)			0.43

4. Prices and producers
Prices of device and installation cost are quoted by Magnetelectric Co, Sofia.

5. Implementation schedule: one months period after contract agreement

6. Lifetime of the measure: 10 years

7. NPV: Investment -$ 2,500; Annual savings - $5,841; Discount rate - 0.20
NPV = 4.1925 x 5,841 = 24,488 - 2,500 = +21,988;
IRR = 8.79

Measure E-4: Occupancy Lighting Control

1. Initial Conditions:

Many of spaces that are lighted during evenings and nights are not occupied (corridors, stairs, lobbies) a measure based on occupancy lighting control can be proposed. This will save a large amount of energy during unoccupied times.

2. Description of Action / Results:

The installation of 40 occupancy sensors, controlling 40 groups of consumers in the main unoccupied spaces, is proposed.

The average demand of one group is 500W. The average annual consumption of one group (13 hours a day, 360 days) is 2,340 kWh., including 720 kWh peak energy, 180 kWh daily energy and 1,440 kWh night energy. The corresponding costs are: 56 USD (peak energy), 7 USD (daily energy) and 30 USD (night energy) or total costs - 93 USD.

The costs or 40 groups are: 93 x 40 = 3,720 USD;

Expected reduction of the total energy consumption 60%. Expected costs savings - 2,232 USD.

The investment cost is estimated to be $2,400 for the occupancy sensors and the control unit.

3. Financial Analysis:

Material Costs	Installation/ Design Costs	Total Project Costs	Annual O&M Costs
$2,400	$350	$2,750	$50

Benefits Energy Savings	% Savings from base case	Physical Savings	Money Savings in $US
Fuel (MBTU)			
Electricity (kWh)	60		2.232
Total Savings			2.232

Payback (years)			1.25

4. Prices and producers
Prices of devices and installation cost are quoted by Magnetelectric Co, Sofia.

5. Implementation schedule: one months period after contract agreement

6. Lifetime of the measure: 10 years
*7. **NPV:*** Investment -$ 2,750; Annual savings - $2,232; Discount rate - 0.20
NPV = 4.1925 x 2,232 = 9,358 - 2,750 = +6,608;
IRR = 2.4

2.8. Maintenance and monitoring plan

The responsibilities of the AEE team and the Hospital staff in training, maintenance of the installed equipment, monitoring and evaluation of the energy savings will be divided in two stages:

- 6 month after the installation - direct participation of the team, according to an agreement to be signed after the approval of the business plan;
- long term participation - periodically performed measurements, according to the methodology approved within the Energy Audit and above mentioned agreement;
- participation in the implementation of the second priority measures, according to the additional contracts.

The team of the AEE - Bulgarian chapter will be responsible (in accordance with corresponding contracts) for maintaining of installed equipment of the following the measures: B-3, B-4, B-5, B-6, E-2 and E-4. The hospital staff will be responsible for the maintenance of the other measures, after its training.