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ENERGY EFFICIENCY AUDIT REPORT
COTTON PROCESSING TEXTILE FACTORY
"PARVI MAI"

Varna, Bulgaria

PREPARED BY:

INTERNATIONAL RESOURCES GROUP, LTD.
Washington, DC

and

ECOTECHPRODUCT, LTD.
Sofia, Bulgaria

U.S. EMERGENCY ENERGY PROGRAM FOR EASTERN & CENTRAL EUROPE

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
BUREAU FOR EUROPE
WASHINGTON, DC 20523

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List of Acronyms/Abbreviations

A.I.D.	U.S. Agency for International Development
BTU	British Thermal Unit
°C	degrees Celsius
GCal	Giga-calories
IRG	International Resources Group, Ltd.
kWh	kilowatt hours
kV	kilovolts
kVa	kilovar
lv	leva; Bulgarian unit of currency - at the time of audit, 15 lv = U.S.$1.
lx	lux (lumens per square meter)
m^3	cubic meters
PPM	parts per million
ROI	return on investment
USD	U.S. Dollar
V	Volt

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The Energy Conservation Audit Team of the International Resources Group, Ltd. (IRG) wishes to acknowledge assistance provided by the Ministry of Industry, the Committee on Energy, and its Inspectorate for Energy Utilization in arranging visits to participating facilities. IRG also would like to thank the U.S. Agency for International Development, European Development Resources Section, Office of Energy and Infrastructure for coordinating the entire project.

Work under the A.I.D.-funded Emergency Energy Program at the "Sodi" Soda Ash Plant, Devnia, was conducted through a cooperative effort by the factory management and staff; Committee on Energy; Ecotechproduct -- a private sector energy conservation consulting firm; and IRG.

It is IRG's hope that the exchange established through this initiative is maintained and expanded in the future.

PREFACE

In the wake of the political and economic collapse of the Soviet Union, the nations of Central and Eastern Europe confront an energy situation for which there is no historical precedent. Overnight long-standing supply agreements for oil, natural gas and electricity supplies from the Soviet Union have been curtailed or discarded with attendant dramatic increases in the prices of these commodities. In addition, as the veil of secrecy has been lifted in these nations, the devastating legacy of years of neglect of coal and other fossil fuel pollution and an aging, largely unsafe, and unregulated nuclear power industry are vital issues that need to be addressed in light of the fundamental structural reform of these Central and Eastern European economies. Democracy for these countries means change amidst great political and economic uncertainly.

For Bulgaria, the general atmosphere of crisis in the regional energy sector is compounded by the fact that all of its natural gas and coke and most of its petroleum is imported. Moreover starting in April 1991, the electric power supply imported from the Soviet Union, which previously accounted for a significant amount of Bulgaria's electricity supply, was cut off. Furthermore, domestic electricity production from nuclear power, previously a major source of energy, has been decreasing since the autumn of 1991, as the Kozloduy nuclear power station was taken off-line due to safety concerns. Given these concerns, energy efficiency must play a vital role in transformation of the energy and industrial sectors in Bulgaria.

To support the transition from Soviet-based dependence to democracy, based on free market principles, the United States, in 1989, instituted a program to assist the countries of Central and Eastern Europe with humanitarian aid, technical assistance and direct economic aid. The U.S. focused initially on Poland and Hungary, where this transition was in its most advanced stages. Since that initial commitment to Poland and Hungary, the U.S. has expanded its focus to include Czechoslovakia, Bulgaria, Romania and Yugoslavia as technical assistance recipients in Eastern and Central Europe. In the future, large scale assistance is likely to be given to the Baltic States, Estonia, Latvia and Lithuania, as well as the republics of the former Soviet Union -- and possibly Albania.

Grants and other assistance to Central and Eastern Europe already account for a U.S. commitment of $1.5 billion since 1989. In Fiscal Year 1991, alone, grant assistance to the region totaled about $450 million. Many of these special assistance grants were funded through the U.S. Agency for International Development, with implementation assistance by various U.S. agencies and private sector organizations.

One important initiative under the U.S. technical assistance program was the U.S. Agency for International Development Emergency Energy Program for Eastern and Central Europe, Component #1: Industrial Energy Efficiency Improvement. This program was designed to address regional energy sector problems on a short-term basis and to identify and implement energy efficiency initiatives. This effort combined in-plant, on-the-job training with identification and implementation of energy management practices and low-cost measures to be implemented during the period of the contract work. This report outlines the activities of the Industrial Energy Efficiency Improvement project in one plant in Bulgaria.

The purpose of the Industrial Energy Efficiency work was to improve in the short-term the efficiency of energy use by industry. Specific objectives included:

1) fostering improved management of energy use in industrial plants by identifying and implementing immediately cost-effective "low cost/no cost" energy efficiency improvements;

2) transferring energy auditing and management techniques including financial and economic analysis techniques; and

3) providing equipment to implement low-cost options, to improve monitoring and energy management, and to identify additional energy efficiency opportunities.

To accomplish these objectives the following actions were undertaken:

1) Eight industrial facilities were selected as target plants for audits. The plants were selected on the basis of:

- potential for significant energy savings;
- the likelihood that the plants will continue operating in the new economic climate;
- applicability of results to similar plants in Bulgaria to which the energy conservation measures developed in this program could be applied.

2) Two Audit Teams went to Bulgaria on two separate occasions, each Team visiting four plants to perform energy audits and conduct training.

3) The Teams identified, specified, and procured energy efficiency equipment to be used by the plants to implement short-term energy efficiency improvements.

4) Representatives of the Audit Teams returned to the plants in January 1992 to assist in implementation of the audit recommendations, and to monitor the energy improvements actually achieved.

5) The Teams presented a wrap-up workshop for plant managers and technical staff of the participant plants and other similar plants throughout the country. The seminar was held in Sofia, January 27-29, 1992.

The Bulgaria Light and Heavy Industry Audit Teams each audited four plants:

<u>Light Industry</u>
Serdika Dairy Processing Plant - Sofia
Pharmacia Pharmaceutical Company - Stanke Dimitrov
Parvi Mai Cotton Textile Processing Plant - Varna
Dobritch Poultry Processing Plant - Tolbuhin

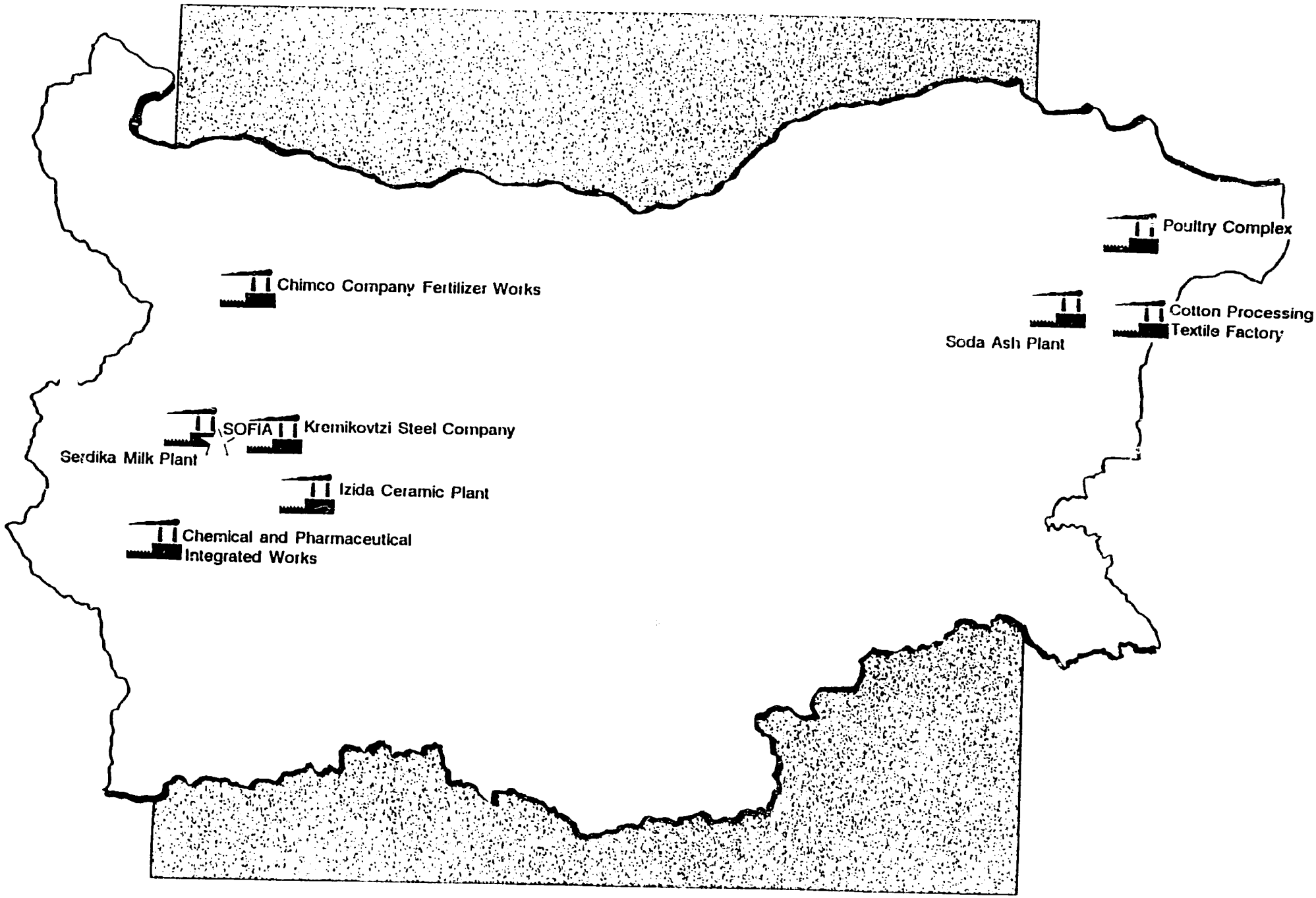


Figure 1. Location of eight industrial plants audited by the IRG team.

Factory

Heavy Industry
Izida Ceramic Facility - Elin Pelin
Kremikovtzi Steel Plant - Sofia
Chimco Ammonia and Urea Facility - Vratza
Sodi Soda Ash Plant - Devnia

The Audit Teams collected data at every plant on the costs of producing steam and electricity, primarily using plant records, audit measurements, and interviews with plant officials. In some cases, the Audit Teams counselled the plants in the establishment of systems for cost accounting in the plant, particularly where it related to energy costs per unit of output. The Industrial Energy Efficiency activities had tremendous success and generated letters of support from several plant managers.

Program Rationale

While this program was clearly a logical starting point for improved energy use patterns, it is only a beginning. Although all activities under the Industrial Energy Efficiency project were conducted using a relatively small budget for equipment purchases, the energy savings results were significant. Thus, the program demonstrated the tremendous potential for energy savings through low cost and no cost mechanisms. Moreover, these programs represented important energy savings initiatives that were implemented on a timely basis, within a matter of months.

These initiatives should serve as a cornerstone for a new way of approaching energy savings in Bulgaria. They represent the lowest cost and most readily implemented energy savings initiatives available. Furthermore, the energy savings techniques/measures identified and implemented in this Emergency Energy Program should be applicable to other similar facilities and process units throughout Bulgaria. As a result, these low cost techniques for improving energy efficiency, and thereby improving economic efficiency in industrial facilities, should serve as a model for restructuring energy use in the Bulgarian industrial sector.

The project also highlighted a number of issues that fundamentally affect the ability of industrial entities to solve energy problems. Basic issues such as industrial energy pricing, environmental regulation, legal reforms, corporate organization and management structure, personnel training, and the overall economic environment all affect the ability of industrial concerns to implement energy savings opportunities. Thus, the Industrial Energy Efficiency Improvement project attempted to address issues of micro-level plant organization and management, training, and economic evaluation at each of the plants. In addition, the IRG Team has outlined key macro-level issues which must be addressed by the Government of Bulgaria before comprehensive energy efficiency initiatives are enacted. These issues are addressed in this report as well as in Industrial Profile Report and the Policy and Institutional Analysis Report for Bulgaria, both prepared as part of the Industrial Energy Efficiency Improvement project.

Ultimately, the IRG Team is convinced that the overwhelming potential for energy and cost savings in the Bulgarian industrial sector will provide sufficient incentive for plant managers and industrial executives to actively promote the need for reforms that encourage energy conservation and improved economic efficiency.

1. EXECUTIVE SUMMARY

The "Parvi Mai" Cotton Processing Textile Factory in Varna is a large integrated facility which produces carded cotton yarn, dyed yarn, and crude and finished fabrics. The production process is based on cotton processing (80 to 85% of the raw material is imported and the rest is of domestic origin). The plant has spinning, dyeing, weaving, and finishing departments in separate buildings scattered throughout a large property. The dispersion of buildings and the use of processes that require various combinations of wetting, drying, and heating, result in substantial energy use and dumping of heat. The plant consumes an average of 5,205 tons of mazut (fuel oil) per year, based on 1990 figures.

Currently, the total cost of plant energy (approximately 10,000,000 leva/year) represents 10% of the sale price of products, although for cotton, energy costs plus dyes and other materials constitute 50% of the product cost. Of the 10% that is energy cost, approximately one percentage point or 1,000,000 levas/year could be saved with improved condensate return, repair of leaks, and boiler flue-gas instrumentation as recommended in this report. Such savings are achievable even though this is a relatively well maintained plant.

Principal areas for reduction of energy consumption per unit of product exist in more capital-intensive efforts such as installing recuperators, reducing water consumption, and moving toward the state-of-the-art for this industry. For example, more than 40% of the energy presently consumed could be saved by using state-of-the-art equipment and improved factory logistics. Movement towards the use of more sophisticated equipment and methods is anticipated by plant management, pending stable market conditions.

Other areas of promise include better heat utilization of the present geothermal water supply, using hot water for space heating rather than steam, and recovering heat from waste water. Recommendations include limited evaluation of these areas during the follow-up visit.

Results of the Emergency Energy Program, Industrial Energy Efficiency

As a contribution to the improvement of energy efficiency in this plant, some new equipment and instruments were purchased by IRG through the U.S. Agency for International Development (A.I.D.)-funded Emergency Energy Program for Eastern and Central Europe. Items purchased included:

- Portable Infrared Thermometer
- Oxygen Analyzer
- Fluorescent Light Fixtures (various)
- Industrial Stethoscope
- Temperature Humidity Meter & Recorder
- Pressure Recorder

More capital intensive recommendations were outlined for the longer term; all recommendations are included in **Table 1**.

Table 1. Summary of Opportunities for Energy Savings, Cotton Processing Textile Factory, Varna

I. No Cost/Low Cost Measures Evaluated	Investment (lv)	Energy Savings (KWh/year)	Cost Savings (lv/year)	Payback (years)	Recomm.
Adopt energy management program	-	3,448,300	1,000,000	0.3	yes
Install stack gas analyzer (or O_2 and T sensors)	30,000	258,600	75,000	0 6	yes
Repair steam leaks	15,000	1,551,700	450,000	0.1	yes
Replace insulation on steam and condensate lines	5,000	120,700	35,000	0.2	yes
Restore condensate system	80,000	862,100	250,000	0.4	yes
Replace fluorescent lamps or disconnect ballasts	400,000	344,800	100,000	4.0[1]	yes
II. Capital Intensive Measures Evaluated					
Install heat exchangers on finishing machine dryers	560,000	2,672,400	775,000	0.9	yes
Heat recovery from waste water	-	-	-	-	NEI
Replace air conditioning units	-	-	-	-	NEI
TOTAL	1,090,000	9,258,600	2,685,000		

NEI - Not enough information available about key investment parameters, including management payback requirements, at the time of audit to recommend implementation of the project. The Team does not suggest that these investments are not sound, but stresses a more comprehensive analysis of the return on these investments must be conducted before investment funds are allocated.

NOTE - Where necessary for currency conversions, an exchange rate of 15 leva = US$1 has been used in this report, since it was the exchange rate in effect at the time the audit work was conducted. In January 1992, the exchange rate value was closer to 25 leva = US$1.

[1] Estimated cost savings resulting from this investment includes only energy savings, thereby excluding savings derived from increased personnel productivity, estimated to be substantial enough to justify this investment.

2. PLANT BACKGROUND

The "Parvi Mai" Cotton Processing Textile Factory in Varna produces carded cotton and dyed yarn for its own use, in addition to crude and finished fabrics. Production is based on cotton processing (80 to 85% of the raw material is imported, while the remainder is of domestic origin). The plant operates 2 shifts a day for an average yearly operation figure of 4,500 hours per year. The production and mazut (fuel oil) consumption, as well as production capacity and mazut consumption per unit of production, statistics for 1990 and the first quarter of 1991 are included in **Appendices I, II, and III**, which are summarized in **Table 2**:

Table 2. Energy Consumption at "Parvi Mai", April 1990-March 1991

April 1990 - March 1991					
	Production			Mazut Consumption	
	Unit	Capacity	Actual	Tons	per Unit
White Yarn	Tons	1,900	845	213	252 kg/Ton
Dyed Yarn	Tons	2,300	1,481	524	354 kg/Ton
Crude Fabric	m_2	13,000	11,811	2,262	192 kg/m2
Finish Fabric	m_2	25,000	12,206	2,206	171 kg/m2
TOTAL				5,205	

Note: There is no measurement instrumentation installed to determine energy consumption in different departments. The amount of mazut consumption shown in the table was estimated by plant personnel, who used empirical methods. The same method was also used to determine the electric power consumption in different departments.

2.1. Boiler Operations

The cotton processing textile factory has a steam boiler plant with the following equipment:

- 2 KM-12 units with steam capacity of 12 tons/hour each
- 2 PK-10 units with steam capacity of 10 tons/hour each
- 1 PK-6.5 unit with steam capacity of 6.5 tons/hour

Operation of boilers:

- Winter operation mode - two KM-12 boilers and one PK-10.
- Summer operation mode - one KM-12 boiler and one PK-10.

During the April 1991 audit, two boilers were operating; one, the KM-12 had recently been adjusted by a Bulgarian private firm. Measurements for this boiler are presented in **Appendix I** and demonstrate the boiler was operating at conditions close to the optimal.

The second boiler operating during the April audit was a PK-10 unit. It used a significant amount of excess air (see **Appendix II**). The PK-10 was an older model steam boiler equipped with two fans for fresh air; unfortunately, one fan was broken at the time of audit. The flue gas pipe was not sealed at the flanges or at the control gate, so additional suction of fresh air was observed. As a result, it was not possible to adjust the steam boiler optimally.

2.2 Condensate Systems

Condensate systems in this plant were relatively well maintained, compared to average Bulgarian standards. Nevertheless, there were problems with the quality of the steam traps and condensate pumps, making the real return of condensate less than 50%.

Due to the lack of automatic control of the condensate in all condensing tanks, and non-return of condensate from distribution heating station (sizing department), leaks totalled 23,720 tons/year, or 28.86% of total condensate. Due to faulty steam traps, the temperature of the condensate is 107°C in the Finishing Department's heating station, and 95°C in the Dyeing Department's heating station.

During the winter, the plant uses heat from the Finishing Department condensate for space heating; the resulting energy savings are approximately 587 Gcal. In warmer seasons, the condensate is not used for heating; this results in losses from the Dyeing and Finishing Departments of 1071 GCal/year.

After analyzing steam consumption from the winter and summer, it appeared that 30% additional condensate could be recovered by the plant. The Energy Conservation Audit Team also noted opportunities for the plant to use condensate from the Dyeing Department, rather than steam, by installing heat exchangers for space heating. Potential savings from these initiatives total 350,000 lv annually from an investment of approximately 40,000 lv.

2.3 Electrical Distribution Demand

Electrical distribution demand was logged hourly, but appeared to receive minimal attention by plant managers. Moreover, the plant did not take advantage of Time-of-Day rate schedule savings opportunities.

The Cotton Processing Textile Factory is connected with the city electric substation through three 20 kV lines; there are five small substations in the factory (each department has its own). The power capacity of installed transformers is shown in **Table 3** below.

Table 3. Capacity of transformer power at "Parvi Mai"

No.	Substation	Power Transformers			Metering
		Number of units	Voltage (kV)	Power (kVA)	
1	Dyeing Department	2	20/0.4	1,000	at 20 kV
2	Spinning Department	1	20/0.4	1,000	at 0.4 kV
3	Weaving Department	2 + 1	20/0.4	1,000+630	at 20 kV
4	Steam Power Station	1	20/0.4	1,000	at 20 kV
5	Finishing Department	2	20/0.4	1,000	at 20 kV

1. Power records are not regularly kept, and daily power consumption is not being registered. Normally electric consumption is recorded once per month.

   Time-of-day tariffs were calculated at the following rates in April 1991:

   Peak - 0.56 lv/kWh
   Mid - 0.28 lv/kWh
   Off - 0.12 lv/kWh

   Usage schedules for each month of 1991 are listed in **Table 4.**

Table 4. Time-of-Day tariffs by month

Month	Peak	Mid	Off
Oct. - Feb.	8 to 10 am 6 to 9 pm	6 to 8 am 10 am to 6 pm 9 to 10 pm	10 pm to 6 am
March	8 to 10 am 7 to 9 pm	6 to 8 am 10 am to 7 pm 9 to 10 pm	10 pm to 6 am
April - May	8 to 10 am 8 to 10 pm	6 to 8 am 10 am to 8 pm	10 pm to 6 am
June	8 to 10 am 9 to 10 pm	6 to 8 am 10 am to 9 pm	10 pm to 6 am
July	9 to 11 am 9 to 10 pm	6 to 9 am 11 am to 9 pm	10 pm to 6 am
August	9 to 11 am 8 to 9 am	6 to 9 am 11 am to 8 pm 9 to 10 pm	10 pm to 6 am
September	9 to 10 am 8 to 9 pm	6 to 9 am 10 am to 8 pm 9 to 10 pm	10 pm to 6 am

2. **Table 5** details the number of units, installed power capacity and number of breakdowns recorded for electric motors within the plant.

Table 5. Status of electric motors within "Parvi Mai", 1990

Department, Working Place	Units	Inst. Power Capacity of one motor, kW	Breakdowns (%)
Weaving Dep. - Cond. Chamber			
Fans	4	75	25
Pumps	4	28	10
Other	538	1,844	1
Spinning Dep. - Cond. Chamber			
Fans	3	75	25
Pumps	3	28	10
Ring Machine	41	12.5	5
Other	335	1,282	22
Dyeing Dep. - Cond. Chamber			
Fans	2	15	1
Fans	1	30	1
Fans	1	50	1
Pumps	2	10	10
Other	594	2,126	
Finishing Dep. - Cond. Chamber			
Fans	12	17	1
Other	489	1,917	2
Steam Power Stat.			
Compressors	2	145	-
Compressors	1	132	25
Compressors	1	75	-
Fans	2	55	25
Other	115	832	15

Team members noted that electric-motor breakdowns were caused by a range of factors including failures in bearings, loom blocking, overload protection failures, flooding, and overheating of windings. Power consumption and motor voltage measurements are presented in **Table 6**.

Table 6. Energy consumption and voltage measurements by plant and machine

Place of Measurement	Electric Motor Power (kW)		Loading %
	measured	nominal	
Weaving Department			
Cond. Chamber - fans	29.4	75	39
Loom type STB2-216	1.81	2.2	82
_____#_____	2.05	2.2	93
_____#_____	2.11	2.2	96
Loom type STB4-216	2.84	2.95	96
Spinning Department			
Cond. Chamber - fans	32	75	43

Note: If motor efficiency is under 45%, its replacement with a smaller one would be expedient. If the efficiency greater than 70% of the nominal power, its exchange for a smaller one is not recommended.

2.4 Lighting

Lighting in the textile factory at the time of audit came from a mixed group of sources, including daylight (from ceiling and wall windows) and fluorescent lamps. Direct sunlight is detrimental to the textile production process; as such, the ceiling windows are frosted during summer and part of the spring and autumn months in order to avoid direct sunlight. Consequently, electric lights must be used during the day in this factory, resulting in relatively high electricity costs. In April 1991, electricity costs averaged 0.29 lv/kWh for the facility.

At the time of audit, installed lighting capacity at the plant was 850 kW, which was nearly 8% of total electricity use at this facility. The fluorescent three-tube fixtures used in some of the workshops were of an enclosed type, designed for protection from dust. Of the lamps and lighting fixtures the Energy Conservation Audit Team observed, approximately 60% were not working and were either burned out or removed, but not replaced.

Although Team members observed lighting quality throughout the plant, detailed audit measurements were only taken in the Weaving and the Spinning Departments. The measured lighting intensity in the various working departments of the plant varied between 150 and 580 lx. These measurements, conducted on a sunny day, in the presence of strong natural lighting (50 - 100 lx), suggest that typical light intensity is much lower.

In the Weaving Department, approximately 1,000 lamps were functioning of the 3,000 estimated to be necessary for optimal lighting in the workshop. Of the non-operational lamps, approximately 60% of these were burned out, but had not been replaced. Due to the nature of the work, light in the Weaving workshop should be of a relatively high intensity. However, the poor state of the lamps suggested a decrease in personnel productivity of up to 6% could have taken place. Leakage losses (ballast) due to burned out lamps are about 10 watts/lamp. For 1,400 burned out lamps, estimated losses are 14 kW, or an average sum of 9,100 lv per year, working one shift.

In the Spinning department, Team members measured the lighting intensity in the finishing, carding, and non-spindle spinning machine premises, with the measured intensity of lighting in the first finishing area varying from 40 to 400 lx, lower than the recommended level of 750 lx. Team members also observed 460 burned-out lamps, and leakage losses of 3.5 kW, or 2,200 lv per year. More than 900 lamps would be needed to ensure adequate necessary lighting.

In the second finishing area, the measured intensity of lighting ranged from 84 to 400 lx, compared to the optimal level of 750 lx. Approximately 130 burned out lamps were observed by the Team, with the total number of lamps required for this section estimated to be 270.

For the carding premises, the measured lighting intensity ranged from 150 to 360 lx, versus the standard. The Energy Conservation Team observed approximately 180 burned out lamps, with leakage losses of 1.4 kW, or 910 lv per year. The total number of lamps required to maintain adequate lighting was estimated to be 360. Measured intensity of lighting in the non-spindle spinning machines area ranged from 140 to 350 lx, clearly lower than the recommended level.

2.5 Heat Balances - Steam

At the time of audit, the factory's heat balance included the following losses:

- 2 - 2.5% due to steam leaks
- 3.9 - 4.5% due to lost condensate
- 0.2 - 1% due to uninsulated surfaces
- 0.5 - 1% for mazut preheating in railway tanks
- 2% from the distribution heating system.

Total losses traditionally varied between 8.6 - 10%. At the average steam production rate of 22.9 GCal/hour, the utilized energy for plant processes was between 20.6 to 20.9 Gcal/hour, respectively to 31.2 to 31.7 tons/hour of steam.

Total condensate return observed at the plant was between 40 and 49%, but the heat of evaporation was not fully utilized. The temperature of the condensate ranged between 87 and 100°C. However, as mentioned above, approximately 25% of the condensate was used during the winter for space heating.

Similarly, a rough estimate indicated that 10.6% of purchased fuel (Mazut) was lost, representing an amount of approximately 779 tons/year. Boiler efficiency at the time was about 75% for two of the boilers and 67% for the others; the specific heat of this fuel is 9.5 GCal/ton.

Balances of heat loss due to steam leaks, lost condensate, and uninsulated surfaces are shown in **Table 7**.

Table 7. Balance of heat losses and their primary causes

Losses	Heat Power		Losses/Savings
	GCal/hour	million BTU/hour	lv/year
Steam Leaks	0.466	1.85	336,000
Not Insul. Surf.	0.52	0.206	33,632
Lost Condensate	0.89	3.53	565,079
TOTAL	1.41	5.59	934,711
Note: Savings calculated on the base fuel price of 1,200 lv/ton.			

These figures suggested the need for equipment to measure pressure and temperature at all significant steam stations in the plant, as well as for operational and maintenance improvements. Opportunities for energy efficiency improvements for steam systems included:

- Condensate system reconstruction
- Steam leak repairs
- Insulation replacement
- Process design investigations.

Although each of these opportunities had great potential for savings, the Energy Conservation Audit Team indicated that condensate-system initiatives represented the most significant opportunities. The value of this type of initiative is derived from the fact that condensate has a cost value of 500,000 lv/year, and approximately 45% of this is presently economically recoverable. Specific recommendations for condensate system improvements are included in **Sections 5 and 6**.

2.6 Heat Balances - Water

During the energy audit, temperature and flow rates of wastewater were measured (temperature of 42 to 45°C and flow rate of 10 to 12 l/sec). The average consumption of water in 1990 at 24 hours operation was 35 l/sec, compared to 28 l/sec at 16 hours operation during the first three months of 1991; this reduction was due to the plant being off-line during February 1991.

Approximately one-half the total amount of water consumption is typically lost during processing. Improving water-processing efficiency therefore represents a great opportunity for enhancing energy efficiency. Moreover, Team members identified ar opportunity to recover the heat of wastewater and to preheat the make-up city water, of which consumption was 10 l/sec at the time of audit. Inlet/outlet temperatures of hot water are shown in **Table 8**.

Table 8. Inlet/outlet temperatures of water used at "Parvi Mai"

Water	Temperature, °C		Flow Rate
	Inlet	Outlet	l/sec
Waste	45	30	10
Make-up	15	30	10

Assuming that average operations are at least 4,000 hours/year, the heat exchange temperature difference is 15°C; if two heat exchangers are installed (one working and the other as a stand-by to be used during cleaning), approximately 2,160 GCal of energy could be saved each year. At April 1991 prices, estimated savings from such water-utilization improvements would be 356,000 lv/year, with an investment cost of 400,000 lv.

2.7 Heat Balances - Fabric Dryers

Fabric drying in the plant is completed using one of two methods: drum dryers or horizontal dryers. There are two sets of drum dryers in the plant, and in these dryers, fabric runs between cylinders. Steam, subsequently, goes into the cylinders. After the process is completed, the condensate returns to the boiler, with the moisture content of the fabric and the air ejected into the atmosphere.

There are three sets of horizontal dryers in the plant. In these dryers, fabric runs horizontally, and hot air with temperatures ranging between 140 and 145°C is fed below the cloth. The air and steam mixture is then ejected into the open air. During the energy audit, temperatures and flow rates of this exhaust air were measured. The results for the three horizontal dryers are detailed in **Table 9**.

Table 9. Air temperatures and flow rates of the horizontal dryers

Horizontal dryer #	Outlet Air temperature, °C	Flow Rate m^3/hour
1	105	56,160
2	107	12,000
3	103	10,000

The energy saving potential for direct recuperation of exhausted air is presented in **Table 10.**

Table 10. Energy Savings Potential

Dryer #	Energy Savings		Approx. Cost of Investments, lv
	GCal/year	lv/year	
1	3,373	556,500	400,000
2	740	122,000	90,000
3	584	96,400	70,000
Total	4,697	775,000	560,000

These savings estimates reflect assumptions that systems will operate 4,000 hours per year, outlet exhaust temperature is 30°C, the difference in the heat exchanger temperature is 10°C., and that the heat energy price is 165 lv/GCal.

2.8 Heat Balances - Air Conditioning

The Energy Conservation Audit Team analyzed the operation of air-conditioning units in the Spinning, Weaving, Dyeing, and Finishing Departments to determine the impact of air-conditioning operations on overall plant heat balances.

In the Spinning Department, there were four Bulgarian-manufactured air conditioning sets; two of these units had an average output of 120,000 m^3/hour, while the others had outputs of 60,000 m^3/hour. All four units used an adiabatic process. The cooling process for these units was carried out by water from the urban water-main. During winter, air was heated indirectly by steam with temperatures up to 35°C. The system worked using positive pressure. There was no automatic temperature and humidity control system in place; heating and wetting were manually controlled. Wetting was performed in spraying chambers by nozzles with heated water. In the winter there was 100% recirculation, while recirculation is available in both spring and autumn, fresh air 50% by 50%.

The Weaving Department also had four Bulgarian-manufactured air conditioning sets, each of which had an output of 120,000 m^3/hour. The processes for these units were the same as in those in the Spinning Department.

The Dyeing Department had two of the Bulgarian-manufactured air conditioning sets, one of which had an output of 60,000 m^3/hour with a spraying chamber, and the other had an output of 45,000 m^3/hour running dry. The processes of these units were the same as those in the Spinning Department, although there was no air recuperation, due to the large amount of separated humidity present.

Finally, the Finishing Department contained twelve Bulgarian-made sets, with four of these producing an output of 120,000 m^3/hour, and the other eight 50,000 m^3/hour, all running dry. Air from these units was discharged at temperatures between 20 and 22°C. In addition, there were no automatic controls for these units.

3. ENERGY MANAGEMENT

3.1 Energy Management Structure

Since the onset of rapidly increasing energy prices, the plant management staff of "Parvi Mai" had been aware of the significant impact these escalating energy prices had on manufacturing costs. Consequently, prior to the April 1991 audit, management had already made cursory estimations of energy consumption within the plant. This energy-monitoring process was achieved through analyzing electricity and fuel oil invoices. Similarly, staff identified and investigated several innovative projects designed to improve energy efficiency, including an in-plant incentive program and an off-site heat supply program. Unfortunately, the plant had no formal procedures or organizational structure to identify and implement such energy-saving projects, and although familiar with the concepts of investment evaluation, management had no formal system for using economic criteria to evaluate investment projects.

3.2 Energy Management Seminar

Recognizing the importance of energy management in determining the overall efficiency of industrial energy use, the Energy Conservation Audit Team presented a seminar at "Parvi Mai" which addressed a number of energy management issues. Recommendations presented in the seminar were designed to provide an overall framework for improved energy management and training related to energy efficiency.

Issues crucial to any discussion of energy management include:

- Economic Principles - it is important in any energy management regime to view energy costs as production input costs. In addition, concepts related to the benefits and costs of energy efficiency investments and return on investment must be analyzed. The in-plant seminar attempted to define the economic benefits and costs of conservation opportunities. This was coupled with an introduction, explanation and the determination of the return on investment (ROI), as well as with the use of payback periods of individual opportunities as tools for ranking and prioritizing projects.

- Energy Management Programs - specific programs which could help foster an energy ethic within a plant should be encouraged. These programs could include incentive/disincentive, "turn out the lights" campaigns, etc. A comprehensive energy management program also should incorporate an effective mechanism for energy cost accounting. Such a mechanism might require the purchase of and training in the use of computer accounting software, etc.

- Energy Monitoring - successful improvement in energy utilization in an industrial facility is contingent upon continued monitoring of energy use. Increased energy prices in Bulgaria have forced new emphasis on this issue. As such, energy

efficiency training must encompass economic justifications for the selection of instruments to monitor energy use; and

- Energy Surveys - energy surveys and audits similar to those conducted under the A.I.D.-funded Emergency Energy Program should be part of an overall energy management framework. In particular, energy surveys should attempt to regularly evaluate such important areas as:

  - steam leaks
  - condensate leaks
  - insulation opportunities (water, steam, refrigeration)
  - electrical opportunities
  - lighting
  - water leaks
  - air leaks
  - boiler operations
  - refrigeration
  - air conditioning

Issues addressed at the April 1991 seminar were dealt with in further detail at the January 1992 Energy Management Workshop in Sofia, during which a representative of the Parvi Mai plant made a presentation. An excerpt of the presentation on Energy Management Practices presented at the January seminar is included as **Appendix IX**.

3.3 Training Requirements

Training requirements for this plant vary by personnel area. At a minimum, all plant personnel should receive basic training in energy awareness. In addition, technical and managerial personnel should receive more extensive training in economic and technical areas through seminars, training retreats, and where feasible, outside training courses at technical institutes.

As outlined in the energy management seminar, training in energy awareness, economics, and energy cost accounting are crucial elements in improving plant energy efficiency. At almost every level, improved training in economics, data collection, and low-cost, energy-management techniques would yield significant energy savings.

It is particularly important that divisions responsible for overseeing energy utilization and energy efficiency activities receive training in such key areas as:

- energy cost accounting - this type of training would be particularly useful if it involved practical skills training related to use of energy cost accounting software packages. Even if it is not possible to purchase and utilize more sophisticated computer accounting programs, plant personnel can learn the basic tools used to maintain solid cost accounting standards.

- energy efficiency investment planning - again, training in investment planning would be extremely useful if it included familiarization with the tools used in some energy investment planning programs such as the "Envest" program.

Refresher courses and subsequent programs for all plant personnel should focus on specifics of the plant's energy management program; key energy waste areas; identifying and solving energy-conservation problems; and energy conservation monitoring and incentive schemes. In addition, training initiatives for managers should address economic issues (with varying degrees of specificity depending on job requirements) including investment evaluation tools, plant profitability, export benefits and principles, and employment issues. Finally, training programs for department heads, engineers, and technical specialists should address a variety of technical issues such as thermodynamics (as applied to steam and refrigeration systems), engineering economics, and detailed energy management techniques.

4. ENVIRONMENTAL CONSIDERATIONS

Wastewater treatment at "Parvi Mai" consisted of neutralization in two of four tanks alternately, after which the neutralized wastewater was discharged into the Cherno More (Black Sea). In the past, sludge was partially dewatered by pressing. At the time of audit, however, the presses were inactive, and as a result, the sludge had a high water content when dumped.

Although the wastewater discharge content satisfied environmental regulations in existence in April 1991, the water was alkaline (a pH level of 9 to 9.5) and not biologically treated before discharge. Thus, water quality was poor by most modern standards. In a climate of increasing environmental legislation in Bulgaria, it is likely the environmental standards regulating this discharge will become more stringent, with clear adverse economic implications for the facility.

As a matter of interest, the municipal water treatment plant was operating at its capacity during the April visit, and would not have additional capacity available for treatment of Parvi Mai waste. Moreover, the Black Sea is polluted, both from direct sources and from the Danube and streams and other countries bordering the Black Sea.

5. ENERGY EFFICIENCY IMPROVEMENT OPTIONS

Listed below are options for improving energy efficiency use within the plant. Clearly, all these practices and projects will help conserve energy in the facility. However, given the reality of scarce resources for implementing these projects, the IRG Energy Conservation Audit Team recommended some of these options be given priority. This prioritization is included in **Section 6**, while this section outlines the wide variety of options available for energy efficiency improvement. The ultimate decisions regarding implementation of alternative options will depend upon criteria set by the plant management -- including acceptable payback periods, and upon overall corporate strategy.

5.1 No or Low Cost Options

For the purposes of this paper, "no-cost" items refer to projects which will be initiated at plant expense, in cases where expenditures are involved. Although few of these recommendations are literal "no-cost" propositions, they should all be possible to implement within the existing framework of plant expenditures (i.e. leva purchases, improved maintenance, and housekeeping). Local investment and installation labor for low-cost initiatives will be provided by the plant, and hard currency for some low-cost items will be available under the A.I.D.-funded Emergency Energy Program. Justifications and specifications for these items are detailed in **Appendix VI**.

1. **Adopt an energy management program.** This "no-cost" project has potential savings of more than 1,000,000 lv/year with an ROI exceeding 100%, and a payback period of less than three months.

2. **Install a stack gas analyzer (or O_2 and T sensors).** This project would cost approximately 30,000 lv and result in annual savings of 75,000 lv with a ROI of 100% and a payback period of 0.6 yr. Purchase of a portable oxygen analyzer and an infrared thermometer will be financed by A.I.D.

3. **Repair steam leaks.** This project would cost 15,000 lv, and result in savings of 450,000 lv/year, making its ROI greater than 100% in a payback period of 0.1 year.

4. **Replace insulation on steam and condensate lines.** The cost of this project would be 5,000 lv, and the resulting savings would be 35,000 lv/year, with a ROI of greater than 100%. The payback period would be 0.2 year.

5. **Restore condensate system, replace steam traps and condensate pumps.** This project would cost 80,000 lv to implement. However, savings from this project are estimated to be 250,000 lv/year, with a ROI of 100% and payback period of 0.4 year.

6. **Replace fluorescent lamps or disconnect ballasts.** The complete implementation of this project will cost approximately 400,000 lv, and will yield a savings of 100,000 lv/year, at a ROI of 100% and a payback period of 4 years.[2] A.I.D. will help finance the purchase of new fluorescent fixtures.

5.2 Capital Intensive Options

The following three capital-intensive, energy-efficiency options were discussed with plant management and initial comments made concerning each. However, since requisite data was not available for the last two options and feasibility studies had not been conducted for these two projects, the IRG Team was not able to make a definitive recommendation about any option other than the first. Team members recommend a comprehensive evaluation be made of both the technical and economic aspects of the other investments prior to commitment of any investment funds.

1. **Install air heat exchangers on finishing machine dryers.** This project would cost an estimated 560,000 lv and result in savings of 775,000 lv/year, with a ROI in excess of 100%, and a payback period of 0.9 year.

2. **Heat recovery from waste water, preheating of municipal water and other water conservation projects.**

3. **Replace air conditioning units.**

[2] The lev value of savings included in this calculation includes only energy savings, thereby excluding savings derived from improved productivity which are projected to be substantial enough to recommend the implementation of this project.

6. RECOMMENDATIONS AND CONCLUSIONS

The following recommendations and conclusions represent those areas which the IRG Energy Conservation Audit Team believes should be priorities for "Parvi Mai".

6.1 Improved Energy Management

Priority areas for corporate energy management at this plant should be the establishment of training initiatives to improve energy efficiency awareness, data collection techniques, energy cost accounting, and energy investment planning capabilities and the creation of a comprehensive energy management program, including energy management committee.

In conjunction with improved training, management should establish energy management criteria, including minimum acceptable investment payback criteria and incentive/disincentive schemes for encouraging energy savings. In addition, management staff should conduct a comprehensive evaluation of investment options, both low-cost and capital intensive to determine the cost of required investments; and the payback on investment (in terms of energy saved, losses avoided or production increases), to prioritize investment opportunities.

6.2 Improved Operating Practices and Operational Changes

The following recommendations reflect changes in operating practices, housekeeping, and maintenance which can yield significant energy savings with minimal investment cost. These recommendations include focusing attention on energy management, condensate and steam systems, lighting, and instrumentation and dryers, in addition to changes in boiler operation.

1.	**Energy Management**	The Team recommends the Plant establish an energy management program to ensure awareness of energy issues at "Parvi Mai" and that appropriate mechanisms exist for monitoring energy use and encouraging energy savings.
2.	**Condensate**	Repair and restore condensate systems at the Plant, hospital, and school, provide a limited amount of equipment (pumps, fittings and traps) to demonstrate a workable system, and replace insulation on steam lines.
3.	**Instrumentation**	Prioritize the purchase, installation, and use of energy meters and portable instruments to identify energy waste areas, monitor improvements, and provide data for evaluation of energy efficiency investments. Priority items should include oxygen analyzers, recording meters, temperature monitors for stack gas, and oil guns.

4. **Steam Systems** — Repair steam leaks, replace insulation on steam lines, and replace steam traps.

5. **Lighting** — Install new high-efficiency fixtures and replace burned-out lamps, replace fluorescent lamps, and disconnect ballasts.

6.3 Recommended Capital Investments

Equipment Purchased Under the Emergency Energy Program:

1. **IR Thermometer** — The portable infrared thermometer will be used to identify damaged insulation or heat losses from other sources throughout the plant. Cost of the item was $437; estimated savings from this instrument are expected to be more than $1,200 per year.

2. **Oxygen Analyzer** — This item will be used to monitor excess air in the combustion process. Cost of the item was $476, with savings estimated at $2,600 per year.

3. **Fluorescent Lights** — More efficient fluorescent lights will replace burned-out fixtures within the plant, achieving a higher level of light at a lower energy-consumption rate. Cost for these fixtures was $27,486; savings are estimated to be approximately $6,667. However, additional economic savings will be achieved through productivity increases, bringing the payback period for this item to approximately one year.

4. **Industrial Stethoscope** — The industrial stethoscope will be used to check for steam trap leakages. Cost of this item was $451; resulting energy savings are valued at $4,200 per year.

5. **Temp/Humid Meter** — The temperature and humidity meter and recorder will be used in the installation of air heat exchangers on finishing machine dryers, which will use energy more efficiently than the current process. Moreover, the instrument will enable plant personnel to take measurements that would assist in the periodic purge of non-condensables to maintain the low pressure of condensate. This would allow for significant energy savings in refrigeration.

6. **Pressure Recorder** — The pressure recorder will be used as part of the plant's energy management program, and will allow energy managers to monitor pressure in the plant.

Detailed specifications and justifications for this equipment are included as **Appendix VI**.

Other Recommended Capital Projects

Since the U.S. Agency for International Development is not in a position to finance all of the opportunities available for energy efficiency improvements, the IRG Energy Conservation Audit Team recommends a number of other investment projects for the plant to implement on its own. These recommendations include

1. **Insulation** — The plant management should purchase insulation for condensate and steam lines as part of a comprehensive condensate and steam system improvement initiative.

2. **Steam Traps** — The plant management should upgrade the plants steam traps, purchasing new, higher quality traps to replace faulty traps, on an incremental basis.

3. **Dryers** — The plant should purchase and install air heat exchangers on finishing machine dryers.

APPENDIX I

PRODUCTION AND ENERGY CONSUMPTION - MAZUT

1. White Yarn

Period	Production Tons	Mazut Total Tons	Mazut/Product kg/Ton
Jan. - March, 1990	457	131	288
April - June, 1990	455	98	215
July - Sept., 1990	-	-	-
Oct. - Dec., 1990	249	74	297
Jan. - March, 1991	141	41	290

2. Dyed Yarn

Period	Production Tons	Mazut Total Tons	Mazut/Product kg/Ton
Jan. - March, 1990	594	267	450
april - June, 1990	533	165	310
July - Sept.. 1990	432	124	287
Oct. - Dec., 1990	280	129	461
Jan. - March, 1991	236	106	449

3. Crude Fabric

Period	Production Tons	Mazut Total Tons	Mazut/Product kg/Ton
Jan. - March, 1990	3,682	912	248
april - June, 1990	3,314	552	167
July - Sept., 1990	3,511	533	152
Oct. - Dec., 1990	2,541	573	226
Jan. - March, 1991	2,445	604	247

4. Finished Fabric

Period	Production Tons	Mazut Total Tons	Mazut/Product kg/Ton
Jan. - March, 1990	5,379	1,090	203
april - June, 1990	3,925	635	162
July - Sept., 1990	4,371	643	147
Oct. - Dec., 1990	2,283	452	198
Jan. - March, 1991	2,349	476	202

APPENDIX II

PRODUCTION AND ENERGY CONSUMPTION - WATER

Period	m^3
January - March, 1990	210,000
April - June, 1990	210,000
July - September, 1990	205,000
October - December, 1990	178,000
January - March, 1991	106,000

APPENDIX III

PRODUCTION AND ENERGY CONSUMPTION - ELECTRIC POWER

Month	Power (el.) kWhr			
	Off Peak	Mid	Peak	Total
4-90	312,608	905,592	304,990	1,523,190
5-90	220,168	680,928	222,636	1,123,732
6-90	174,124	679,218	153,126	1,006,468
7-90	229,696	747,950	170,028	1,147,674
8-90	466,236	795,330	195,368	1,456,934
9-90	222,064	788,570	117,002	1,127,636
10-90	205,764	624,884	287,422	1,118,070
11-90	119,916	449,700	201,980	771,596
12-90	104,558	420,224	171,140	695,922
1-91	156,020	570,164	227,700	953,884
2-91	11,176	28,696	11,332	51,204
3-91	143,168	485,924	167,768	796,860
Total	2,365,498	7,177,180	2,230,492	11,773,170

APPENDIX IV

STACK GAS ANALYSIS - BOILER #3 (12 tons/hour)

Position		1	2	3
Date:	4-26-91			
Time		14:27	14:33	15:05
Oil Pressure	kg/cm^2	10	10	11
Combustion Eff.	%	77.6	78.1	78.4
Ambient Temp	°C	22	23	25
Stack Temp	°C	187	187	189
Oxygen	%	4.3	3.8	2.2
Carbon Monoxide	PPM	0	0	15
Carbon Dioxide	%	7.7	8.0	8.7
Combustible Gases	%	0.06	0.04	0.09
Excess Air	%	23	19	11
Oxides of N	PPM	274	281	255
Sulfur Dioxide	PPM	688	791	712

Conditions:

1. Existing condition.
2. According to the instruction.
3. This is the best efficiency that was reached using the available control system.
4. Fuel in computer was 16,230 Btu/lb versus approx. 16,500 as estimated for Mazut.

APPENDIX V

STACK GAS ANALYSIS - BOILER #4 (10 tons/hour)

Position		1	2	3
Date:	4-26-91			
Time		16:01	16:10	16:40
Oil Pressure	kg/cm²	6	6.5	7
Combustion Eff.	%	61.7	65.0	67.0
Ambient Temp	°C	24	25	25
Stack Temp	°C	190	184	190
Oxygen	%	15.1	14.9	14.0
Carbon Monoxide	PPM	6	33	14
Carbon Dioxide	%	2.7	2.9	3.4
Combustible Gases	%	0.14	0.15	0.12
Excess Air	%	233	205	173
Oxides of N	PPM	77	55	77
Sulfur Dioxide	PPM	337	270	214

Conditions:

1. Existing condition.
2. According to the instruction.
3. This is the best efficiency that was reached using the available control system.
4. Fuel in computer was 16,230 Btu/lb versus approx. 16,500 as estimated for Mazut.

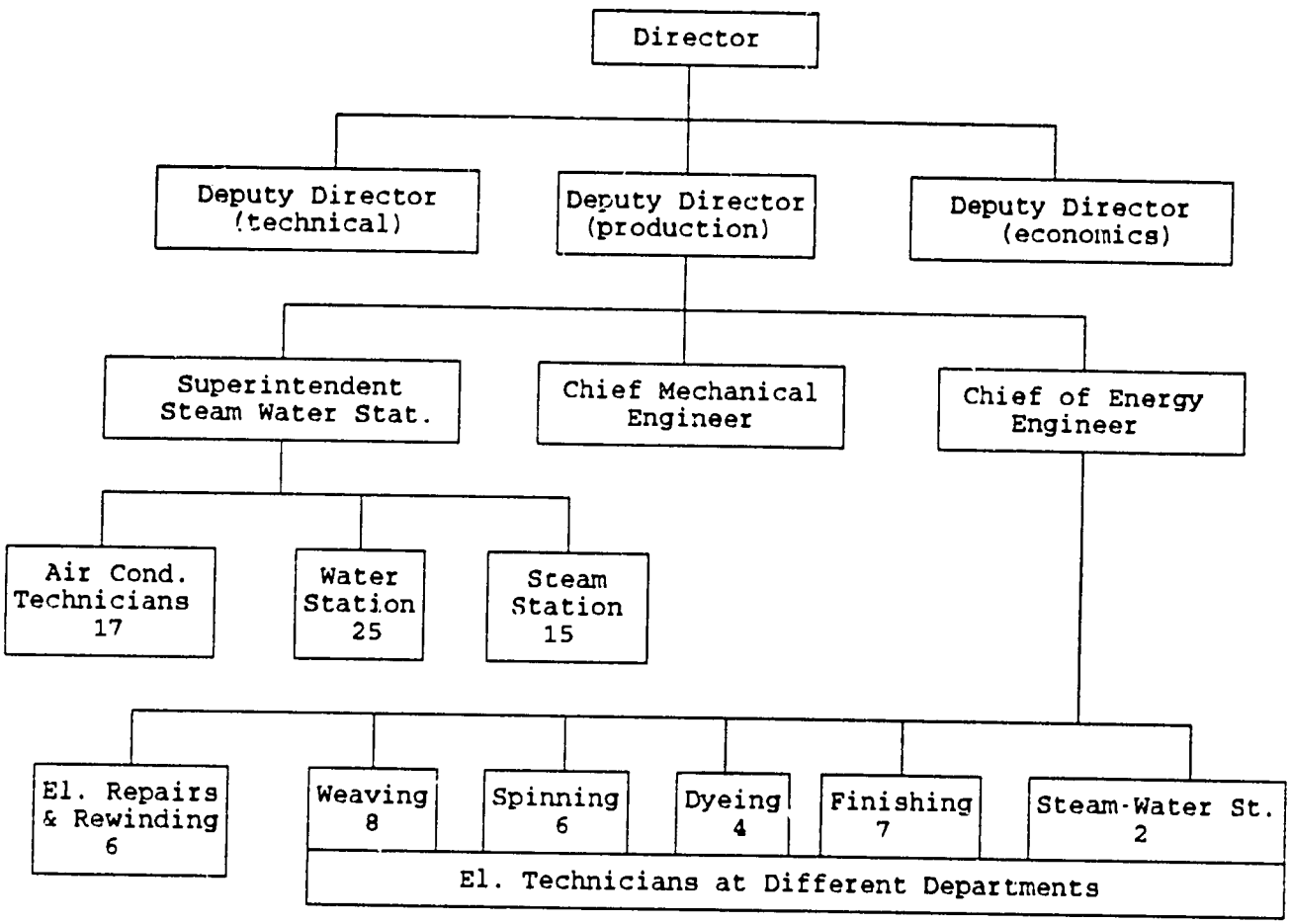
APPENDIX VI

PARTICIPANTS IN MEETING
APRIL 1991

Meeting
April 26, 1991 Friday
Textile Plant - Varna

Name	Position	Plant
Norbert Methven	Engineer	International Resources Group
Christian Spassov	President	Ecotechproduct
Ivan Nickolov	Computers & Heating	Ecotechproduct
Miglena Gaberova	Heating & Refrig. Eng.	Ecotechproduct
Svetla Razmova	Inspector of Energy consumption	Energy Department
Emil Nikolov	Inspector of Energy consumption	Energy Department
Veliko Stoianov	Inspector of Energy consumption	Energy Department
Radko Voev	Inspector of Energy consumption	Energy Department
Veltcho Stoianov	Inspector of Energy consumption	Energy Department
Ovanes Tahtshian	Deputy Director	Textile Plant
Onnik Pilibosiyan	Chief Energy Engineer	Textile Plant
Georgi Ivanov	Chief Steam Station	Textile Plant

TEXTILE PLANT IN VARNA
April 30, 1991



APPENDIX VII

EQUIPMENT SPECIFICATIONS AND JUSTIFICATIONS FOR PURCHASE OF EQUIPMENT

COTTON PROCESSING TEXTILE FACTORY

All consumable items and critical spare parts must be provided for two years usage. Two sets of operating and maintenance manuals are required. The equipment must be durable and proven for the service desired. Metric units are to be used unless otherwise specified. 220 V, 50 hertz power is available. Units should be complete and ready for installation with all required equipment. Quotations should provide complete installation sketch and description of all equipment to be supplied.

1. **Industrial Stethoscopes** -- to be used with other appropriate equipment in support of the adoption of an energy management program. Stethoscopes would also be useful in repairing condensate systems in the plant.

2. **Pressure Recorder** -- to be used as part of the establishment of an Energy Management Program for the plant to achieve energy savings by allowing for additional pressure monitoring. With Pigtail for steam Dickson Company Model 798-001100 or equivalent, Accessory kit Dickson Model 798-001400 or equivalent, Pens Dickson Model 700-022200 or equivalent, and AA batteries Dickson Model 19111 or equivalent. 7 day - kpa Model from Dickson Company or equivalent is recommended.

<u>For Energy Management Program</u>:

Estimated annual energy savings:	3,448,276 KWh/year
Estimated cost savings:	1,000,000 levs/year ($66,666)
Estimated cost:	15,000 levs ($1,000)
Estimated payback:	3-5 months

3. **Portable Infrared Temperature Measuring Instrument** -- to be used in conjunction with the flue gas analyzer and the oxygen analyzer to assess stack emissions and help minimize emissions, affecting the most efficient air/fuel mixtures. By installing oxygen and temperature instrumentation, boilers will be able to operate more efficiently. The infrared temperature measuring device also will be able to provide necessary measurements associated with rebuilding the condensate recovery system. Dickson Company model IR-550 or equivalent is recommended.

4. **Oxygen Analyzer** -- to be used in conjunction with the Infrared Temperature device and flue gas/emissions analyzer to evaluate stack gas emissions, helping minimize emissions and affecting efficient air/fuel mixtures. By installing oxygen and temperature instrumentation, boilers will be able to operate more efficiently. Davis Instruments Model BC 108101 or Universal Enterprises Model C5A or equivalent is recommended.

5. **Replacement Oxygen Sensors** -- to provide replacement sensors for the oxygen analyzer, ensuring the effective operation of this instrument in the future. This would facilitate the analysis of stack emissions. By installing oxygen and temperature instrumentation, boilers will be able to operate more efficiently. Davis Model BC 108927 or Universal Enterprises Model AO51 or equivalent are recommended.

Items 4 - 5:

Estimated annual energy savings:	258,621 KWh/year
Estimated cost savings:	75,000 levs/year ($5,000)
Estimated cost:	30,000 levs ($2,000)
Estimated payback:	0.6 years

6. **Energy Efficient Fluorescent Lighting Luminaries** -- design for textile weaving room with (partial) 30' x 40', 100 footcandles, 3 1/2 feet above the floor, 220 V., 50 hertz, and dust resistant. Replacement of fluorescent lamps will lead to more efficient energy use and may also increase productivity through better lighting.

Item 6:

Estimated annual energy savings:	344,828 KWh/year
Estimated cost savings:	100,000 levs/year ($6,667)
Estimated cost:	400,000 levs ($26,667)
Estimated payback:	4 years[3]

7. **Temperature and Humidity Recorder** -- to be used in the installation of air heat exchangers on finishing machine dryers, which will use energy more efficiently than the current process. With charts (Dickson Co. Model 650-047300 or equivalent), AA Batteries (Dickson Model 19111 or equivalent), pens and chart storage (Dickson Model 800-080012). Dickson Company Model TH8-7C or equivalent is recommended.

8. **Portable Humidity and Temperature Meter - Vaisala** -- with 9V Duracell battery. The instrument will provide measurements that will enable the plant to install heat exchangers on finishing machine dryers. Davis Instruments Model HM 34 or equivalent recommended. The instrument would also enable plant personnel to take measurements that would assist in the periodic purge of non-condensables to maintain the low pressure of condensate. This would allow for significant energy savings in refrigeration.

[3] The lev value of savings included in this calculation includes only energy savings, thereby excluding savings derived from improved productivity which are projected to be substantial enough to recommend the implementation of this project.

For items 7 and 8:

Estimated annual energy savings:	2,672,414 KWh/year
Estimated cost savings:	775,000 levs/year ($51,667)
Estimated cost:	560,000 levs ($37,333)
Estimated payback:	138% return on investment in 0.7 years

TEACHING TOOLS

1. **Video tapes** -- videos on Principles of Operating Steam Traps, Trouble Shooting Steam Traps, Steam Trap Repairs, The Air in Steam, Guidelines for Steam Efficiency, Solving Water Hammer Puzzle, and A Matter of Principle - Comparison of Disc vs. Bucket Steam Traps. These videos, available through Armstrong Machine Works would be used as teaching tools designed to complement efforts to rebuild and maintain condensate systems and repair steam leaks.

2. **Overhead Projector** -- overhead projector with high intensity position and three spare lamps. 220 volts, 50 hertz. Lanier Presentation Systems or equivalent recommended. To be used by the Committee on Energy as a teaching device in support of work to rebuild and maintain the condensate system and repair steam leaks, thereby contributing to the overall energy efficiency of the plant.

3. **Transparency Film** -- Transparency Film 8 1/2 x 11" for use with plain paper copiers. 3M Model PP2200 or equivalent is recommended. Transparencies will be used with the overhead projector as part of a teaching strategy designed to support the rebuilding and maintenance of the condensate system and the repair of steam leaks.

4. **Projection Screen with Retractable Floor Stand** -- Approximately 42" x 42" screen. A teaching tool to be used by the Committee on Energy that will complement activities designed to rebuild and maintain the condensate system and repair steam leaks.

Items 1-4:

Estimated energy savings	see above
Estimated cost	$2,800

APPENDIX VIII

SAMPLE WORKSHEETS USED IN CONDUCTING THE "PARVI MAI" ENERGY AUDIT

ELECTRICAL OPPORTUNITIES

Date apr. 26. 1991 г.
Area

	Location (Be Specific)	Comments •	Tag No.	Type ••	Kwatt / HP	No.	Repair Costs $	Savings $/Yr•••	RC %
	Replacement of lamps with more efficient — 40% (working one shift)								
							(9 L/lam)	L/Yr	
1.	Текстил УФХ								
	Weaving dept.	indoor		FL	240 kW	3000	27000	62500	
2.	Предачи УФХ								
	Spinning dept.								
2.1	Ринг машини								
	Ring machines dept.	indoor		FL	72 kW	900	8,100	18720	
2.2	Машини за карда								
	Carding machines dept	indoor		FL	29 kW	360	3,240	7500	
2.3.	Машини за подготовка								
	Preparatory dept.	indoor		FL	22 kW	270	2430	5600	
2.4	Машини без вретено								
	Non-spindle machines dept.	indoor		FL	22 kW	270	2,430	5600	
							43,[illegible]	99,600	
	10% — Replacement of ballasts of lamps with more efficient								
							(35 L/lam)		
2.	Мазилка УФХ								
	Weaving dept.	indoor		FL	240 kW	3000	105,000	16000	
2.	Мазилка УФХ								
	Spinning dept.								
2.1	Ринг								
	Ring machines dept	indoor		FL	72	900	31,500	4700	
2.2.	Дарани								
	Carding machines dept.	indoor		FL	29	360	12,600	1900	
2.3.	Подготовка								
	Preparatory dept.	indoor		FL	22	270	9,450	1400	
2.4	Безвретенни машини								
	Non-spindle machines dept.	indoor		FL	22	270	9,450	1400	

Not economic

• Indicate whether it is inside or outdoor lighting.
•• For type show MV = mercury vapor, HPS = high pressure sodium, INC = incandescent, and MH = metal halide.
••• Unless actual HP is known, multiply nameplate HP rating by 1 HP costs.

инж. Е. Николов

STEAM LEAKS TEXTILE PLANT

Date 04.26.1991
Area

Location (Be Specific)	Comments	Tag No.	* Size	Repair Costs $	Savings $/Yr
Boilers station	glands of valve	6	W	180	54000
	— " —	1	M	30	45000
Steam pipe line for cotrol	Breakdown	1	M	56	60000
M. St for control	flanges of valve	1	M	30	45000
M. St Dyeing department	flanges of valve	1	W	30	9000
M St " department	glands of valve	1	M	30	45000
Steam pipe line for Dyeing depart.	Brake down	1	M	156	78000
Total				512	336000
Water Treatment Plant					
Gate valve stem		1	M	588	40,000
" " flange		2	M	400	74,000
				1500	450,000
Other					

* Can use the following code for leak size: W = wisp, M = moderate, S = severe.

For 12 months leaks, wisp = , moderate = , severe = .

cpw/0212/c25-4
2C 02/12/86

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Textile plant

CONDENSATE LEAKS

Date 04 26 1991
Area

Location (Be Specific)	Comments	Tag No.	* GPM	Repair Costs $	Savings $/Yr	RC %
Hot sizing department	Leaks of Cond. Line	15m		1020	28080	
In all Hot b. baths of automatic level control of the condensate		5m		5000	256560	
High temperature in Dyeing vat - bath				30000	67064	
Total				36020	351704	

* all condensate returned at 55 psig values.

For 12 months leaks, 1 GPM = .

cpw/0212/c25-5
2C 02/12/86

INSULATION OPPORTUNITIES TEXTILE PLANT

Date 04 26 1991
Area

Location (Be Specific)	Comments *	Tag No.	Length **	Wid. **	Dia. **	Repair Costs $	Savings $/Yr	RC/Saving
in door								
Boilers station	st t=150°C	0,71	5		4,5	46	1040	1447
cond tanks	cond t=80°C	5				32,5	629	1033
H.St Finishing dpt	cond t=100	6				390	1101	1934
H.St Tasselling depart	st t=160	0,716	6		1 1/2"	465,4	1146	1587
H.St Dyeing depart.	st t=150	1,35	5		86	870	1797	2728
H.St for heating hospital	cond t=85	7	1,5	1	1000	455	881	1446
Kindergarden hostel	st t=150	0,64	4,5		4,5	41,6	1003	1302
	st t=150°C	7,03	40		56	457	1233	15209
	cond t=100	7,03	40		56	457	5392	7604
	st t=150	1,19	10		1 1/2"	773,5	1797	2645
	st t=150	1,7	5		108	110,5	2359	3306
	st t=150	2,09	5		133	135,8	2584	3720
in the open								
in front of yard st.	st t=150	3,4	10		108	221	4718	6613
steam for preparing	st t=150	0,58	2		108	44,2	943,6	1323
					Total	29904	33631,6	51897
							36,300	
						say 5,000		

* Indicate what it is: tank, pipe, duct, etc.
** Show all dimensions in feet, except show pipe diameter in inches.

For pipe, annual cost (multiply by 2 for outside items).
For flat surfaces, annual cost (multiply by 2 for outside items).

APPENDIX IX

EXCERPT OF A PRESENTATION BY MR. BARRY TUNNAH AT THE ENERGY MANAGEMENT WORKSHOP

SOFIA, BULGARIA

JANUARY 1992

ENERGY MANAGEMENT PRACTICES: A BRIEF REVIEW

I. INTRODUCTION

Why is energy conservation important? The simplest answer is that it makes a firm more profitable. By practicing good energy management techniques through a well structured and organized company plan, management and employees become more aware of how energy is being used, of the actual costs of energy, and of the methods and equipment that can be used to control and reduce energy waste.

Energy management is a disciplined activity, organized for the more efficient use of energy without reducing production levels or lowering product quality, safety, or environmental standards. The underlying principle is cost effectiveness. Energy management therefore requires both technical and financial evaluations. A systematic and structured approach to energy management is required to identify and to realize full potential savings.

It is apparent that many companies and plants have not identified even simple energy conservation measures with short payback periods, and many who have identified such opportunities fail to implement them. Many studies show that the main barriers to action on energy conservation are:

* lack of knowledge of what is technically possible
* inappropriate financial analysis methods
* management attitudes towards energy efficiency

The greatest successes generally occur at companies where management visibly supports an integrated energy management program.

At the plant level, benefits include:

* lower production costs and higher profits
* better competitive position

* improved ability to withstand future energy cost increases
* improvements in productivity in general
* environmental benefits

The potential benefits of solid energy management are entirely dependent on the nature of the plant concerned. However, savings for a plant which is starting an energy management program are often 20 to 30 percent of present energy consumption, and even more in many cases. For most firms, energy conservation makes very good business sense.

II. THE ENERGY MANAGEMENT APPROACH

2.1 Where To Start

How does a company begin to address the problem of controlling energy consumption and costs? The answer will depend to a great extent on the company concerned -- its current organization and management philosophy. Two points are particularly important.

* top management must be fully committed to controlling energy costs
* the appropriate organization must be set up to implement, and be accountable for, the energy management program

2.2 Top Management Commitment

The decision of company management to control energy costs is a vital first step. This must be clearly stated and understood by all within the company. An important part of top management commitment is to set up the responsible organization for implementing the energy management program. This is commonly at two levels, the Energy Manager and the Energy Committee.

2.3 The Plant Energy Committee

Because energy concerns different departments within a firm, an effective energy management program will involve many people. In some companies, a committee is formed to include representatives of important departments. While unnecessary bureaucracy must be avoided, there are advantages to having an active Energy Committee at the plant:

* it can encourage communications and the sharing of ideas
* it can serve to obtain agreements on energy saving projects which affect more than one department
* it can provide a stronger voice to top management than a single manager normally could

Membership will depend on existing management structures at the type and quantity of energy used. When should the Committee meet? Normally a monthly meeting is usual, so that monthly production and energy consumptions may be reviewed, including a comparison of actual performance against previously set targets. Other items for the agenda should be a review of the status of energy conservation investments, in progress or planned.

2.4 The Energy Manager

Forming an Energy Committee is not enough: someone is needed to implement the policies and directives of the Committee, and to provide the data needed by the Committee to make decisions. Appointing an Energy Manager is therefore an essential step in implementing an energy management program in most companies. The role will vary from company to company but he will normally be concerned with the following tasks:

* collecting and analyzing energy related data regularly
* monitoring energy purchases
* identifying energy saving opportunities
* developing projects to save energy, including the necessary technical and economic evaluations
* implementing energy saving projects
* maintaining employee communications and public relations

In some companies, particularly the smaller ones, the Energy Manager may report directly to the General Manager or Plant Manager and may be part-time. Larger companies may appoint a full-time Energy Manager and give him one or more technical assistants, thus forming an "energy conservation group". Wherever possible, the Energy Manager or Group should be independent of the main operating departments: reporting to the highest level, such as the Plant Manager, can often give the needed independence and authority.

The skills and experience of the Energy Manager need careful consideration. Technical competence is usually regarded as the primary qualification, although this may not be as important as often thought. In smaller companies, good technical skills may be helpful because the Energy Manager will probably carry out much of the work himself. In a larger company, where technical skills are more readily available, the Energy Manager may well be someone with experience in accounting or general management.

The particular skills that are important for an Energy Manager include administration and communication. Most Energy Managers need to spend much of their time convincing their colleagues and top management to take a specific line of action. Some typical qualifications are:

* familiarity with the plant, processes and quality needs
* ability to collect and analyze data
* knowledge of energy-consuming equipment and factors affecting its efficiency
* engineering skills to size and select equipment, supervise installation and ensure correct maintenance
* ability to communicate and interact well with both plant management and with line operators and maintenance workers
* good judgement to know when to call upon outside help such as consultants or equipment vendors
* proper perspective of the role played by energy in the company, in relation to other elements such as raw materials, capital and labor
* ability to use initiative, a "self starter"

Above all, the Energy Manager needs an open mind to view problems from different perspectives and the skill to convince others that savings are both possible and worthwhile if the right measures are taken.

III. MEASURING ENERGY AND ITS COSTS

3.1 Introduction

Energy management is concerned with the efficient transfer of the energy in fuels and electricity into useful work or heat. It is essential to be able to measure energy inputs and outputs, using various types of meters and instruments, either fixed in the plant or, in some cases, portable. It also requires knowledge of fuel, steam and electricity characteristics to enable comparisons to be made on a common basis.

3.2 The Heating Values of Fuels

An important characteristic of an energy source is the energy contained per unit of mass or volume (the heating value, heat of combustion or calorific value). There are two values associated with fossil fuels, a higher (or gross) heating value and a lower (or net) heating value. The higher heating value includes the latent heat of water vapor formed during combustion as it condenses back to the liquid state. The heating value generally determined in the laboratory is the higher value. The difference between the higher and lower heating values for a fuel is a function of the hydrogen content of the fuel, as this determines the amount of water formed. Some typical ratios of lower to higher heating values are:

	Ratio LHV/HHV
Natural gas	0.90
Fuel oil	0.94
Coal	0.98
Electricity	1.00

In carrying out energy related calculations, it generally makes little difference which heating value is used. The essential principle is to be consistent and use the same basis for all fuels. The convention used should always be clearly stated.

3.3 Unit Energy Costs

An important step to controlling energy costs in a plant is to determine the unit costs of the different energy forms. For example, the cost may be constant, irrespective of the level of consumption (e.g., 150 USD per ton of a specified fuel oil). Some fuels and electricity may have a tariff which varies in accordance with the quantity consumed in a set period of time (e.g., 4.5 US cents per kWh of electricity up to 100 kWh per month, 2.5 cents per kWh thereafter). There may also be other complication factors, such as a "demand charge" for electricity or gas, which is a cost element set by the highest actual level of demand in the period (e.g., 25 USD per kW maximum demand) or even by the maximum contract or maximum allowable connected load. Some forms of energy are also subject to a surcharge for peak period. Electricity consumption

may be subject to a "power factor penalty" through which the plant is penalized if it consumes too much reactive power.

For practical reasons, it may often be more meaningful for energy savings calculations for the Energy Manager to compute the **marginal cost** of energy, that is, the cost incurred for consuming one more unit of the particular form of energy (or conversely, the amount saved by consuming one unit less of the particular energy form). A cost-conscious manager will know the unit cost of his energy consumptions and will think in terms of cost savings when he observes operations that are perhaps not optimum or when he suggests priority for a particular maintenance job.

3.4 The Cost of Steam

This is a special case of the unit costs mentioned above. The plant Energy Manager should calculate the cost of steam and advise plant managers. The basic calculation requires the cost of boiler fuel, fuel heating value, water costs, condensate recovery temperature and rate, boiler efficiency and the steam characteristics: these are sufficient for estimating a "marginal" steam cost, one that ignores the labor cost for boiler and steam system operation, maintenance costs and the cost of capital investment. For most practical purposes, the marginal cost is sufficient for making decisions on energy saving actions or investments, as these are usually based on differences between costs and savings for various options, and the "excluded" costs are typically the same for all options.

A plant Energy Manager can develop his own graph to show his own plant situation most accurately. A graph provides a simple way of evaluating the relative merits of different fuels, the benefits of improvements in boiler efficiency, or the savings possible from reducing steam use.

3.5 Energy Accounting

Accounting for energy, in its simplest terms, means keeping accounts of energy consumption and energy purchases for the plant. At a more detailed level, it may mean assigning energy costs to different departments. The term "monitoring" is used for maintaining a careful check of energy consumption and, usually, to analyzing energy use.

IV. DATA ANALYSIS

4.1 Graphing the Data

Data should be presented graphically as a better appreciation of variations is almost always obtained from a visual presentation. For example, charts of energy consumption and production against time are drawn at many plants and are usually more enlightening than columns of numbers. However, these graphs tell us little about the relationship between energy and production and therefore are not useful for energy management. Unfortunately, many plants fail to go beyond the drawing of the basic graphs, whereas further simple analysis is needed to give us a great deal more useful information quite quickly.

4.2 Energy-Production Relationships

For a typical plant, a plot of "energy used per month" against "monthly production" can reveal a great deal about energy efficiency. Separate graphs should be drawn from fuel and electricity use. For most plants, the energy-production graph will be a straight line. There are two components of the energy consumption:

* energy directly related to production (mP)
* energy not directly related to production (e)

The energy used by the plants is the sum of the two components, represented by the basic equation for a straight line:

$$E = mP + e$$

where E is the monthly energy consumption, P is the corresponding monthly production, **m** represents the slope of the line and **e** is the y-axis intercept (daily or weekly data can be used also). Physically, "e" refers to non-production related energy, that is, energy losses or energy used for general plant services:

* lighting, office equipment, ventilation fans
* space conditioning (heating or cooling)
* unnecessary idling of production equipment
* energy in the steam lost in leaks
* radiation and convention heat losses from boilers
* heat losses from steam distribution piping

A graph of **E** against **P** will quickly show the Energy Manager the proportion of energy consumption which corresponds ton non-productive energy (services and losses). If this is high, the Energy Manager can look for ways of cutting down "e", for example:

* replace old lighting units by high efficiency lighting
* eliminate leaks from the compressed air system
* ensure equipment is switched off when not in use
* improve the insulation of the steam distribution system

To cut down on the use of "productive" energy, he might:

* reduce process temperatures to the minimum permissible
* optimize combustion efficiency of boilers and furnaces
* install a heat recovery system

Through such measures, the Energy Manager will seek to reduce the slope of the E-P line as well as reduce "e".

Scattering of points in the E-P graph is a general indication of the level of energy management in the plant. Widely scattered points usually mean that energy use is not properly controlled

controlled and operating practices in general are poorly defined and inadequately monitored by supervisors and managers.

4.3 Specific Energy Consumption

Many plants calculate Specific Energy Consumption (SEC) regularly. SEC is the energy used per unit of output, E divided by P. For a typical plant, where the E-P relationship is a straight line, we have:

$$SEC = \frac{E}{P} = m + \frac{e}{P}$$

A graph of SEC against P will therefore be a curve, not a straight line. Figure 4.3 shows a typical SEC-P graph: points lying below the curve represent improved efficiency in energy use relative to the "average performance" represented by the curve itself. Figure 4.3 also shows two points, A and B. The Specific Energy Consumption is certainly lower at B and many engineers think therefore that the point with the highest energy efficiency is B. Indeed, if the energy, production and SEC data are merely shown as a table of numbers (as too many plants do) it is quite easy to draw this erroneous conclusion. When the points are shown on a graph, it becomes clear that B is a point at which energy efficiency is relatively low while A represents a time of good operation at high energy efficiency, albeit at a low production level.

Specific Energy Consumption figures therefore have little meaning unless they are associated with a production rate. Following SEC alone is not the answer to good energy management in any plant where the production rate varies more than a few percent from day to day or month to month.

4.4 The CUSUM Technique

A simple quantitative procedure allows the Energy Manager to evaluate plant performance month by month and to estimate savings made through implementing energy conservation measures (or conversely, the losses occurring due to deficiencies in performance). The method is known as the CUSUM technique, as it relies on calculating "the Cumulative Sum of Differences". The method is applied in the following way:

(1) Plot the E-P graph for a period in which operations were generally similar and during which no major energy conservation measures were introduced.

(2) Find the best fit straight line for the data points.

(3) From each time period, compute the estimated energy use from the straight line equation.

(4) Calculate the differences between calculated energy use and actual energy consumption for corresponding periods.

(5) Compute the cumulative sum of these differences.

If the differences between actual and calculated energy consumption are random, some positive and some negative, then the cumulative sum of these differences should fluctuate around zero. If there are any significant changes in energy efficiency after the "base period" for which the straight line was derived, the differences will accumulate (either positive or negative) and a graph of CUSUM against time will show this clearly.

The Energy Manager can thus determine quantitatively the impact of a change in energy efficiency by examining the CUSUM graph. The procedure may be illustrated by a simple example:

Energy consumption and production data were collected for a plant over a period of 18 months. During month 9, a heat recovery system was installed. Using the plant monthly data, estimate the savings made with the heat recovery system. The plant data are:

	E monthly energy use toe/month	P monthly production tons/month
1	340	380
2	340	440
3	380	460
4	380	520
5	300	320
6	400	520
7	280	240
8	424	620
9	420	600
10	400	560
11	360	440
12	320	360
13	340	420
14	372	480
15	380	540
16	280	280
17	280	260
18	380	500

* Step 1 -- plot the E-P graph for the first 9 months
* Step 2 -- draw the best fit straight line
* Step 3 -- derive the equation of the line

The steps are completed in Figure 4.4 and the equation is:

$$E = 0.4\,P + 180$$

* Step 4 -- calculate the expected energy consumption based on the equation
* Step 5 -- calculate the differences between calculated and actual energy use
* Step 6 -- compute the cumulative sum of differences

These steps are done in the table below:

	E act	P	E calc	Eact-Ecalc	CUSUM
1	340	380	332	+8	+8
2	340	440	356	-16	-8
3	380	460	364	+16	+8
4	380	520	388	-8	0
5	300	320	308	-8	-8
6	400	520	388	+2	-6
7	280	240	276	+4	-2
8	424	620	428	-4	-6
9	420	600	420	0	-6
10	400	560	404	-4	-10
11	360	440	356	+4	-6
12	320	360	324	-4	-10
13	340	420	348	-8	-18
14	372	480	372	0	-18
15	380	540	396	-16	-34
16	280	280	292	-12	-46
17	280	260	284	-4	-50
18	380	500	380	0	-50

* Step 7 -- plot the CUSUM graph -- see Figure 4.5

* Step 8 -- estimate the savings accumulated from use of the heat recovery system

From Figure 4.5, we see that the CUSUM graph fluctuates around the zero line for several months and then drops sharply after month 11. This suggests that the heat recovery system took almost two months to commission and reach proper operating conditions, after which steady savings have been achieved. Based on the graph, savings of 44 toe have been accumulated in the last 7 months. This represents savings of almost 2 percent:

$$\frac{44 \times 100}{\text{energy use in months 12-18 (2352 toe)}} = 1.9\ \%$$

The CUSUM technique is a simple but remarkably powerful statistical method which highlights small differences in energy efficiency performances. Regular use of the procedure allows the Energy Manager to follow his plant performance and to spot any trends at an early date.

4.5 Performance Evaluation

Evaluation of plant performance is best done by regularly comparing the actual energy consumption with the expected consumption. Differences between actual energy use and standards based on past performance will reveal either improvements or a deterioration in

performance. The regular data indicate if and where failures have occurred and trigger the necessary remedial action: the data also provide quantified evidence of exactly how successful any energy conservation measures have been.

It is important that performance evaluations be carried out promptly at the end of each month. A review of plant performance is a useful task for the plant Energy Committee. If the analysis is left for too long, it becomes much more difficult to account for any discrepancies that are observed, and of course it is always desirable that corrective measures be taken as soon as possible.

4.6 Monitoring and Targeting

"M & T" is a management approach that enables firms to manage energy as a controllable resource in the same way as they manage other resources such as raw materials and manpower. M and T helps companies eliminate waste and also provides the incentive for further improvement by giving concrete evidence of successful energy conservation activities, from which the economic benefits of energy management become evident.

Central to the success of M and T is the establishment of "energy accountable centers" for which targets can be set. A center might consist of an individual machine, a process department or even the entire site. Recording and reporting procedures for the centers should be set up. Each center should correspond to a nominated individual responsible for operational achievements in that area. Tying resource consumption to those responsible for operational achievement is a key factor in the M and T system since it focusses attention on those with authority to effect improvements in performance. It is also essential that those held accountable for energy performance should be able to assess that performance and have the pertinent information on which to base judgements, decisions and actions to bring about improvements.

Targets may be set using a detailed engineering analysis of operations, or can be developed using historical data such as that described earlier. Graphs of E-P and SEC-P will reveal the occasions when energy efficiency are particularly high. and thus it would be reasonable to use the best historical performance (or something close to that) as a challenging but attainable target.