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INDUSTRIAL PROFILE REPORT

BULGARIA

PREPARED BY:

INTERNATIONAL RESOURCES GROUP, LTD.
Washington, DC

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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U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
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PREFACE

Bulgaria is in the early stages of the continuing transition from a centrally planned economic unit of the Council for Mutual Economic Assistance (CMEA) to a free market economy. While political independence began in 1989, economic changes did not initiate until late 1990, when CMEA infrastructure, trading patterns, and financial arrangements were discarded in favor of the international market-oriented economy.

Fundamental economic changes that have occurred since the CMEA's collapse happened so suddenly, industrial facility managers were unable to plan and implement an orderly transition. In the new economic climate that emerged, energy became a major issue to the survival of industrial facilities, since many price controls for energy were removed at the same time traditional energy-supply relationships were disrupted.

In response to the extensive energy-related problems of the Bulgarian industrial sector, the U.S. Agency for International Development (A.I.D.) initiated the Emergency Energy Program for Eastern and Central Europe in early 1991. As part of this project, a team from the International Resources Group, Ltd. (IRG) conducted detailed energy audits of eight industrial facilities in the country to assist Bulgarian industry in improving overall energy efficiency. This Industrial Profile Report was prepared based on the observations and conclusions of the IRG Team. Specifically, this report includes a brief discussion of energy efficiency, decision-making, and management practices observed in the demonstration facilities to illuminate the state of these issues in Bulgaria's industrial sector.

1. INTRODUCTION

Many obstacles to energy efficiency improvement, decision-making, and effective management in the current market environment originated in the centralized economy which characterized the Bulgarian industrial sector until 1990. For example, under the former system, export of manufactured products was arranged through state-owned trading organizations representing an entire "combine", or group, of manufacturers. When these "combines" became separate enterprises, managers of the production facilities were responsible for sales as well as production, despite the fact the production unit probably had no relevant experience. Some factory managers have negotiated with independent trade organizations to assist them in international sales.

In addition, salaries of plant managers were only slightly higher than worker salaries and were unrelated to enterprise profitability. These factors nullified incentives for industrial managers to improve economic efficiency and profitability. Similarly, the low priorities assigned to plant cleanliness, neatness, and worker safety reflect priorities and incentive structure of the former system. In general, factories were overstaffed, due to an abundant, inexpensive labor force. Adherence to the government production quota was the controlling factor in industry, while profitability, efficiency, and environmental protection were of secondary importance to industrial managers.

Previously, industrial managers were required to seek funding from the government for capital improvements; government policy on such financing, however, was somewhat arbitrary, insofar as capital for favored plants was appropriated without repayment obligations. Less favored plants were required to borrow capital from the government at modest interest rates (a 6% rate was common). Enterprises which were heavily in debt now face annual nominal interest rates of 50 - 60 percent. Although inflation-adjusted rates (real rates) are fairly low, the nominal increase has strained industrial cash flow, since industrial sales prices have not always kept pace with inflation. Moreover, the government has yet to reduce the historically high industrial tax rates. This combination of high tax and nominal interest rates is a serious economic concern for industry.

Management of energy costs must become a major management priority. To this end, it is important to correct the erroneous assumption that significant energy savings involve major capital investments. As demonstrated by the A.I.D.-funded Emergency Energy Program, major savings are possible through the use of no- or low-cost energy conservation initiatives. Hopefully, this program has made Bulgarian industrial managers aware of the existence, importance, and effectiveness of such measures. If managers and workers are cooperative and motivated, energy conservation, increased productivity, and improved product quality can be achieved within any of several organizational structures.

As Bulgaria completes its transition to a market economy, economic and political imperatives are changing the approach of industry to many issues, including those of profitability, management, decision-making, employee health and safety, and overall efficiency. For example, removal of price subsidies, and realignment of the Bulgarian currency have forced industry to face world prices for almost all production inputs, necessitating major operational and management changes. Exposure to Western environmental and liability legislation has dramatically affected how industry views environmental issues.

1.1 Energy Conservation and the Decision-making Process

Before 1990, energy conservation was not a primary industrial concern, due to low energy costs under the CMEA pricing system. Energy supplies, including imports from other CMEA countries and the former USSR, were also relatively abundant. Industrial decision-making under the former system for most important decisions occurred at very high levels of government, despite the fact government decision-makers generally had little knowledge of plant specifics. Although routine decisions about production goals occurred regularly, others were made on an *ad hoc* basis, causing bureaucratic delays.

Limited recognition of the importance of energy savings was formalized in 1980 when the government established the Inspectorate for Energy Utilization within the Ministry of Energy to review designs for energy-efficiency measures at new industrial facilities. The Inspectorate was also charged with helping reduce electricity demand in light of national shortages. In 1985, the government broadened the Inspectorate's mandate to include working with existing industrial plants to reduce consumption of all forms of energy. The Inspectorate now is authorized to inspect industrial plants and levy fines if energy-saving recommendations are not followed; however, the fines are not overwhelming and have been designed as incentives rather than penalties. Due to the low prioritization of efficiency and economy of energy utilization by the government, the Inspectorate has no portable measuring equipment nor training programs for the staff.

Factory personnel themselves are generally aware of energy-saving measures that should be implemented, but even though plants often have the resources to implement these opportunities, they choose not to do so. Lack of action on these issues could be the result of some or all of the following:

- Management and factory staff aren't aware of the magnitude of energy losses. Instead, the focus has been on obvious, large energy inefficiencies that would require major capital investments to address;
- Poor communication between plant technical personnel and plant decision-makers prevent management from learning about energy losses or inefficiencies that can be remedied;
- Management is overwhelmed with other urgent problems arising from the current political and economic upheaval;
- Plant staff lack the necessary training to conduct economic analyses of energy losses/savings potential.

Within certain limits, organizational structure is a less important factor in establishing an energy-efficiency enterprise than a number of other criteria, such as interest in and commitment to energy efficiency by the senior ranking officer; a rational, thorough energy policy; a competent technical person or group to oversee energy initiatives; and a reliable communication system between the plant management and the technical energy person.

1.2 Electric power

Bulgaria is critically short of electric power. In 1991, brownouts -- reductions in the voltage that that flows to each consumer -- and rolling blackouts were instituted. As a result of reduced industrial

production and lower industrial demand for electricity, rolling blackouts are not needed. Time-of-day prices for electricity are in place (although there is no separate demand charge) and the demand component of electricity costs which represent depreciation, return on investment, and return on capital is not adequately represented in charges per kilowatt-hour (kWh), as it is currently billed to all classes of consumers, and the government plans to impose a demand charge in the future. Although industrial users are opposed, many understand capital charges are necessary if electricity prices are not to be subsidized. Time-of-day rate differentials are clearly effective in discouraging use of power during peak demand periods.

While some industrial facilities generate power on-site, others use fuel produced as a by-product of industrial operations. The Audit Team did not observe industrial cogeneration in Bulgaria, however, due to low electricity prices which discourage production of cogenerated electricity.

2. PLANT-SPECIFIC COMMENTS

Comments presented below illustrate the state of energy efficiency in Bulgarian industry by outlining salient features of plant energy-management structures where they are typical of Bulgarian industry as a whole.

2.1 Kremikovtzi Iron and Steel Works

Observations on Energy Efficiency. Kremikovtzi is energy inefficient, but substantive steps involving large expenditures of capital are working remedy these inefficiencies. Installation of a computerized energy-optimization system is underway, and a major waste-heat recovery project is planned. Prior to the implementation of the Emergency Energy Program, few low- or no-cost energy efficiency activities had been initiated, except those related to space heating. Managers and staff assigned little priority to energy-saving opportunities, including relatively low-cost initiatives such as repairing leaks in the steam distribution system and reducing energy losses due to inadequate thermal insulation and non-functioning steam traps. Kremikovtzi also lacks instrumentation to measure combustion efficiency.

The Decision-making Process. Kremikovtzi's process for decision-making has changed in response to new free market conditions. Since 1990, the President has made the plant investment, production, and maintenance decisions and functionally serves the same role as a General Manager; the President receives recommendations from Department Managers before making decisions. The Technical Department oversees energy conservation throughout the plant, and many managers have become involved in small, but important, steps to improve energy efficiency. For example, the plant has begun to repair insulation and steam leaks, reduce non-productive use of lighting, and to optimize oxygen levels in combustion processes.

Management Practices. In April 1991, plant management did not actively encourage employee involvement in productivity, quality, and energy conservation issues. Managers and supervisors were reluctant to express their views and identify energy-saving opportunities. Instead, management appeared to be overwhelmed by the implications of a move to a free market economy. Since the Audit Team's first visit, the plant has trained several staff in energy efficiency issues, instituted energy efficiency incentive programs, and has attempted to make individual divisions responsible for monitoring energy consumption.

2.2 Serdika Milk Processing Plant

Observations on Energy Efficiency. Boiler maintenance was good, although leaks in the air and flue gas duct joints were evident, and maintenance was lax in non-production equipment. Steam traps in the condensate system were almost totally inoperative, resulting in substantial energy losses and unnecessary expenditures. The plant has never returned a high percentage of condensate to the boilers, but much of this is due to contaminated condensate which is discarded to avoid risk of leaks of recycled contaminated water near food. Given time and relief from its pressing problems of financial survival, plant management is committed to improving energy efficiency, and is particularly interested in possibilities for using heat found in contaminated condensate without risking food contamination; this can be accomplished by using heat exchangers, or the contaminated condensate, for space heating.

The plant emits heavy black soot, a serious problem since the plant is located near a residential area. Plant management staff seemed to recognize and understand the problem residents faced and wished to remedy it. Soot emissions primarily occur during boiler start-up, and management is working to eliminate the problem by converting the boiler fuel and firing system to utilize clean, easy to fire fuels during startup. After stable conditions have been established, Serdika will use its usual supply of heavy oil.

Decision-making Process. During the first audit visit, the plant had no standardized decision-making process for capital investments, and was noticeably lacking in its experience in developing strategic planning documents and investment programs. This lack of experience had an important adverse effect, since capital resources are extremely scarce, and the plant has been "rationing" such funds to only those activities necessary for continued production. Allocation of funds was based on one simple principle -- economic survival -- as perceived by the plant manager.

There have been at least two changes in senior management, including the energy manager, since the initial audit. While these changes were intended to improve management capabilities, they have resulted in a loss in continuity regarding energy efficiency issues. Return visits and continued assistance by Ecotechproduct and IRG have, however, provided some continuity, so that management is ready to assign a high priority to energy efficiency.

Management Practices. Serdika is clean by Bulgarian standards, but "housekeeping" inadequacies (lack of painting, failure to replace damaged pipe insulation, and others) were apparent and may be as much the result of resource scarcities as management inattention. Current management includes appropriate plant personnel, including a labor-union representative, in the decision-making process. Involvement of labor representatives in management decisions, to some extent, may be a holdover from the previous economic system, under which government regulations required management to clear its decisions with the labor committee.

2.3 State Chemical and Pharmaceutical Plant "Pharmacia"

Observations on Energy Efficiency. The only evidence of an energy management program at the time of the audit was a list of "Energy Consumption Limitations," derived from limitations imposed by the Inspectorate for Energy Utilization. At that time there was a limited awareness of the importance and potential benefits of energy conservation. However, management and key staff members had the technical background to appreciate the imperatives of energy conservation, and only lacked applied experience with energy efficiency measurements, evaluation and technologies and had not recognized the significant energy and cost savings obtainable through low cost and no cost energy conservation measures.

Decision-making Process. High corporate tax rates have restricted the accumulation of capital which, in turn, limited new investment programs of all kinds. However, "Pharmacia" plans to use its own capital to install a heat recovery waste burner. While use of economic decision-making criteria at this plant is commendable, there is need for more formal education/training in strategic planning and economic decision-making. Since the initial energy audit, plant managers have devoted much thought and attention to energy management. Assuming the instrumentation is available, the plant is in position to implement economically attractive energy conservation opportunities.

Management Practices. Management has involved a large number of key staff in the energy audit project. Moreover, the management demonstrates concern for serious environmental problems and

has attempted to address these issues by requesting assistance from two firms. Moreover, although the plant may not have met all Western standards for cleanliness and neatness, the rooms where final products were produced or packaged were clean.

2.4 Izida State Ceramic Plant

Observations on Energy Efficiency. This industrial plant is a inefficient energy user, in part, due to a lack of instrumentation necessary for effective monitoring of energy use. Current plant design includes two electrically heated production furnaces, consuming some 8,000,000 kilowatt hours (kWh) of electricity per year. However, management staff were receptive to the project-initiated energy efficiency measures from the outset. Overall, the plant is cleaner than the industry average, and there were fewer surplus workers. In addition, worker health and safety hazards are less threatening than at larger heavy-industry plants.

Despite a high level of management interest, the "energy ethic" has not completely filtered down to all plant personnel. Even in organizations with strong commitment and loyalty to management concerns (as at Izida), it is often difficult to ensure appropriate actions are taken on all levels. Dedicated employees have concerns other than those of energy efficiency, (i.e., product quality, production rates, plant cleanliness, and safety). Finally, "organizational inertia" often delays full implementation of even the best new ideas. Attitudes change slowly, and it is not surprising that workers in Bulgaria are not yet as alert as they should be regarding energy issues. For example, recommendations were made, but not implemented, on keeping furnace doors and building doors and windows closed.

Decision-making Process. Izida is an expert plant, whose management understands competitive economics. However, management has not, until recently, been required to face fully competitive international markets, due to previous direct or indirect government subsidies. Nonetheless, Izida has a strong record in international exports and appears to be making a successful transition to the free market economy. Although Izida is nominally a state-owned company, management has full financial responsibility since the government is funding this enterprise. However, new ownership is not in place, creating a difficult situation for management.

Management Practices. Relations between management and technical staff are cooperative and relaxed. At meetings where the Managing Director is present, staff members often ask questions and offer comments and suggestions on energy management. The enterprise benefits enormously from this relaxed environment, and energy initiatives enjoy support at all levels. This situation is the exception, rather than the rule, in Bulgarian plants, since communication between management and technical staff has routinely been an obstacle to energy efficiency in Bulgaria, and in the U.S.

2.5 Dobritch Poultry Slaughterhouse

Observations on Energy Efficiency. At the beginning of the Emergency Energy Program, this plant had no energy management program and no technical expertise to develop and administer such a program. However, the Plant Director recognized both the need for and lack of in-house technical talent to establish and administer such a program, and was receptive to suggestions for alternative energy sources for the broiler farm and for developing a water-conservation program for the slaughterhouse. Since the energy audit, management has worked with Ecotechproduct on energy efficiency and made substantial progress in correcting energy management deficiencies observed during the original audit.

Steam distribution and condensate return systems, like others encountered in Bulgaria, were in poor condition. Steam pressure was often too high, steam traps were not functioning properly, and almost half of the recoverable condensate was being discharged to the drain. The refrigeration system was not operated according to accepted operating procedures, the ammonia condenser system for water distribution was not properly emiting its water spray, and the condensers were not functioning effectively.

Decision-making Process. As discussed above, it appeared management would require outside assistance to develop a standardized procedures for making investment decisions regarding energy efficiency. Until 1990, the plant used the same procedures as all other state-owned facilities. Under this system, income from an enterprise was passed on to the State, and the State allocated an operating budget to the plant. With the demise of this system, plants such as the Poultry Slaughterhouse still rely on the State for some capital funding; however, the State is limited by lack of local and convertible currencies in meeting investment needs. Furthermore, this system does not include mechanisms to economically evaluate capital investments. Thus, such allocations at Dobritch, as with other state-owned entities, are largely determined within the framework of the system.

Management Practices. This plant is relatively clean, and management is aware of environmental problems, but has few resources to deal with them. Management also recognizes employee training and professional development, participation in energy conservation, and response to health and safety issues as important concerns, but financial constraints limit the company's ability to address them.

Since the energy audit, management has enthusiastically embraced the concept of energy efficiency, and on its own initiative, prepared an interim report on progress made to date in energy conservation. They also carefully reviewed the draft audit report as part of their study, and seriously considered the Team's recommendations. Furthermore, management recognizes that part of a successful strategy for economic survival is cost control, including energy expenses.

2.6 Integrated Cotton Textile Plant "Parvi Mai"

Observations on Energy Efficiency. Parvi Mai is clearly concerned with energy shortages and the economic impact of energy prices on manufacturing costs. Factory managers estimated energy consumption by process functions and have identified the finishing and dyeing operations as most energy intensive; the Audit Team recommended refinement of the estimates based on those measurements. As an example of creative marketing, Parvi Mai is implementing a program to reduce energy waste and provide the same quality of service (reliable supply and maintenance) to its off-site heat supply program to convert this obligation from the past into a successful business.

Decision-making Process. Prior to the audit, the plant had no formal procedures or organizational structure for identifying and implementing programs in energy savings. However, managers recognized some energy recovery in the dyeing plant and installation of heat exchange equipment will be required. These and other proposals have yet to be evaluated adequately, since management has little background in economic or financial analysis of investments, adversely affecting the decision-making process.

Management Practices. After the initial audit, this plant was reportedly near financial collapse due to the general decline in the Bulgarian economy. Management succeeded in keeping the company alive and is confronting the reality of financing new investments at high nominal interest rates and managing existing levels of debt at these interest rates, placing a strain on corporate cash reserves.

High income taxes have also become a problem for the enterprise as it has recovered from its economic slump.

2.7 Chimco Ammonia and Urea Production Facility

Observations on Energy Efficiency. All equipment at Chimco, with the exception of the oxygen plant, is imported from the West. The air separation plant and part of the ammonia plant are relatively modern but differ from Western standards in that Western plants are larger and more efficient. The plant has a fair amount of instrumentation, although some equipment is outdated and may be unreliable. Instrument availability at this plant is the result of its foreign exchange liquidity from hard currency exports. Chimco has an active energy-conservation committee made up of senior managers, and new employees receive a course on the importance of energy conservation. The company also recently initiated a number of improvement projects including repairing the powerhouse boiler and installing modern control instrumentation.

Decision-making Process. Even though plant management has a comprehensive understanding of rational economic decision-making, until late 1991 this state-owned company was not fully free of direct or indirect government subsidies. Chimco has a well established international market which extends beyond the former CMEA countries; its competitive position in the international market is adequate and has helped the company survive and prosper despite the near collapse of the domestic chemical fertilizer market.

Management Practices. Chimco is not as clean as comparable Western plants, but demonstrates a high level of management and employee concern for "housekeeping" issues. Plant environmental problems include air pollution from ambient emissions of ammonia, urea, and sulfur dioxide, and releases of ammonia into local water sources. Plant managers expressed interest in addressing these problems; in the absence of reasonable and enforceable national environmental legislation, however, management is delaying action.

2.8 Soda Ash Plant

Observations on Energy Efficiency. Plant management monitors its use of electric power very closely, and imposes penalties on process managers who exceed their allocated electric power quotas. Sodi management is also aware of the adverse environmental impact of water discharges into the Black Sea. Mitigating the impact of this environmental problem will require substantial capital expenditures, and there is no proven technological basis for dealing with saline water except through the expensive process of evaporation. In the absence of national legislation, management is delaying action.

Decision-making Process. Plant managers have a solid understanding of economic decision-making principles, although they have not, until recently, been fully financially accountable since, this plant was a unit of the state-owned Polychim conglomerate. Management has been involved in competitive export markets and is no stranger to free market economics; through their export, it has access to adequate amounts of foreign currency for its current needs. For example, the company is actively studying the possible impact on its market competitiveness of relatively newly-discovered sodium carbonate and bicarbonate deposits in Turkey, and is assessing the corporate strategy it should adopt to meet these challenges.

3. CONCLUSIONS

Although the Audit Teams observed a wide range of technological, personnel, and managerial standards in the eight plants visited under the Emergency Energy Program, a number of common elements were present at all facilities. These elements combine to provide a cursory profile of the industrial sector in Bulgaria as it relates to energy use.

Attention to energy conservation issues varied widely; energy inefficiency was evident, however, in every plant, and exist for a number of reasons. Lack of instrumentation necessary to effectively monitor energy consumption and the use of inherently inefficient Eastern Bloc technologies are two main causes of industrial energy inefficiency. Equally important, subsidized energy inputs have historically discouraged efficient energy use. Moreover, until the initiation of the Emergency Energy Program, managers in all the demonstration plants were too overwhelmed with the pace and magnitude of economic changes to devote adequate time and consideration to any single problem, including energy efficiency.

Neither management nor technical staff were given guidance or encouragement on energy efficiency from the previous regime, and consequently were simply unaware of the magnitude of easily preventable energy losses. With the demise of the former government, myopic production considerations ceased to be the focus of enterprise management. Instead, efficiency and profitability, hallmarks of free market economies, gained transcendence.

Communication in large organizations is rarely as effective as needed under the best of circumstances. The legacy of central planning and single party rule has further complicated the communication process, by making Bulgarian workers eager to "keep a low profile and not make waves."

Demonstration plants were organized along functional lines, with production/operations, maintenance, packing and shipping, finance, utilities, engineering/technical services, and administrative/purchasing divisions. However, these enterprises differed from Western organizations in that they lacked internal sales or marketing divisions, since this function was handled by separate, state-owned trading companies. Since 1990, enterprises managers, previously concerned only with production, were forced to expand their marketing functions despite their relative inexperience in this area. Consequently, marketing became a high management priority in nearly every production plant.

State-owned companies and plants in Bulgaria were historically not subject to complete financial accountability, due to government subsidies. Consequentiy, they had less incentive to save energy. Although the situation has changed and energy efficiency is an important factor in economic survival, managers have largely ignored the potential for low- and no-cost energy saving measures. To some extent, this inaction is the lack of awareness of the magnitude of avoidable energy (and financial) losses due to energy efficiency.

Even in instances where industrial managers and technical staff are aware of the importance of efficient energy use, institutional issues have inhibited widespread improvement in energy efficiency. Lack of financial resources (local or hard currency) and the inavailability of most instrumentation needed for energy audits, monitoring, and control, have made the purchase of even inexpensive equipment and control systems difficult for most plants.

Moreover, industrial management inexperience with investment decision-making can result in haphazard use of available investment resources. Standardized practices in making investment decisions are rare and inadequate. Industrial decision-makers in Bulgaria do not have sufficient understanding of the value of small energy-saving initiatives, and are more interested in complex technologies. Overall, managers have not, until recently (through the energy audits and in-plant training programs) been aware of the magnitude or value of what appeared to be small energy losses. For example, few plants considered the effective performance of steam traps or condensate recovery programs -- both of which are low-cost -- to be high payback initiatives.

Due to increased awareness of the importance of small energy losses, managers at all eight demonstration plants have become interested in analyzing and implementing smaller-scale, low-cost initiatives in energy conservation. Efforts to promote a "efficiency ethic" have been limited, and little attention is given to basic measures such as keeping furnace doors and building doors and windows closed, and turning out lights in vacant rooms. Few effective energy management programs exist in Bulgaria, again due to the lack of equipment availability and lack of management understanding of the benefits of energy management. Ultimately, however, economic survival imperatives, combined with increasing energy prices, will promote increased interest in energy saving initiatives throughout Bulgaria.

APPENDIX I

RECOMMENDATIONS FOR TECHNICAL ASSISTANCE, TRAINING, FINANCING, ETC.

After visiting the eight industrial facilities, the IRG Industrial Energy Audit Team drew critical conclusions about the current framework for energy use in Bulgaria. Based on these conclusions, the Team has made preliminary recommendations for a long-term energy efficiency program to be implemented by USAID. The recommendations address technical assistance, equipment, financing, and training issues. In addition, the Team has formulated a strategy to encourage Bulgarian private-sector participation in the long-term program.

Technical assistance

Fundamental technical assistance needs in the energy management field are similar for both small and large industries. As such, a comprehensive energy efficiency program in Bulgaria should include the following elements:

- **Combustion and Thermal Efficiency.** Since many plants have steam boilers, the combustion and thermal efficiency of boilers should be a major element of concern in any long-term program. Moreover, because nearly all the steam boilers burn heavy oil, a long-term program should examine the feasibility of burning natural gas. Since both oil and gas are imported and costly, attention to conservation is vital.

- **Steam Distribution.** Steam distribution systems should be examined for energy savings opportunities, since many obvious energy savings opportunities in the steam distribution systems were noted in the plants audited.

- **Condensate Recovery.** Condensate recovery systems should be installed or (in cases where they already exist) repaired, since in an energy/cost efficient plant, most of the condensate can be returned to the boiler. The Audit Team noted that a very low percentage of condensate was actually being returned to the boilers. The Audit Teams recognize that contaminated condensate requires special handling and the economics of disposal vs cleanup vs heat recovery can only be evaluated on a case-by-case basis.

- **Refrigeration Systems.** Refrigeration systems utilizing ammonia as the working fluid are common and should be analyzed for energy savings opportunities. In plants where industrial refrigeration systems use ammonia as the working fluid, many low-cost and more capital-intensive improvements are possible. The team believes these energy efficiency improvements can be highly replicable throughout the Bulgarian economy.

In addition to the above, improved technical communication networks related to energy management are needed throughout Bulgaria before a long-term energy efficiency program can succeed.

Consideration should also be given to helping create a technical society devoted to energy management. Part of the technical assistance effort should be devoted to developing long-term cooperation between Bulgarian organizations and appropriate divisions of U.S. technical societies devoted to energy conservation.

Another initiative is to provide foreign assistance to domestic manufacturers of energy-conservation equipment, since these manufacturers are reputedly failure-prone. This assistance could include US-sponsored joint ventures, straight technology transfers (such as improved designs and/or construction materials), funding of improved manufacturing machinery, and training in manufacturing techniques and quality control.

Training

Training in the following areas is appropriate for all types of industrial plants:

- **Energy Management and Organizational Principles** - Energy management and data systems; plant organization to achieve efficiency.
- **Economic Principles** - Including basic economics; economic evaluation methods and techniques; plant profitability; economic implications for employment; energy cost accounting.
- **Energy Waste Reduction** - energy conservation opportunity identification and solutions; energy monitoring; energy conservation success feedback.
- **Technology** - technology of identification of energy conservation opportunities; solutions to problems; available technologies.
- **Strategic Planning** - investment planning; cost/benefit analysis; return on investment
- **Business Management** - how to form, structure and manage a business
- **Environmental Impact Assessment**

Information on instruments, technical literature (both in the form of books and periodicals) should be made available, at technical universities and in all seven of the cities where the offices of the Inspectorate for Energy Utilization are headquartered.

Financing Requirements

Factories in Bulgaria generally need financial assistance for the modest repairs to existing systems and the purchase and implementation of capital-intensive projects that will help the inefficient Bulgarian industrial facilities to compete in the world market. The lack of both local and hard currency availability constrains plant investments. Furthermore, the undeveloped Bulgarian banking system and lack of national liquidity make domestic investment financing non-existent.
International commercial lending to Bulgaria is problematic as well, since Bulgaria is heavily debt laden and perceived as a risky investment.

Consequently, the much needed capital for investment in Bulgaria's industrial sector is likely to come from two general sources: multilateral/bilateral lending/donor agencies and joint venture investments. The financing requirements for improvements throughout the industrial sector will be tremendous.

Opportunities to Support Local Private-Sector Energy Efficiency Service and Equipment Companies

Bulgaria appears to have the personnel resources and the interested entrepreneurs required to galvanize private sector involvement in energy efficiency. However, there is a serious lack of domestically available instrumentation (portable and fixed) for auditing and monitoring energy efficiency. Many of the small companies do not have the in-house expertise or the equipment to provide a full range of energy conservation services.

There is a large pool of trained engineers in the State industry-specific consulting or engineering firms (Energoproekt, Chemcomplex, Promproekt, etc.). These firms are undergoing major personnel cutbacks, which will provide a great personnel resource for the development of private sector energy conservation firms. However, to facilitate the absorption of these skilled technicians into private sector firms, it is recommended that funding organizations consider assisting these state-owned firms with the privatization of appropriate sections of their organizations in order to meet energy management needs in the context of a private
sector economy. In addition to the industry service firms, some technical departments of large heavy industries might split into private sector technical services firms.

To facilitate the implementation of energy efficiency programs in Bulgaria, it is recommended that funding agencies consider facilitating the development of at least two, and more if possible, Bulgarian private sector energy conservation companies in each of the following areas of energy conservation expertise:

- Industrial Boiler Efficiency, including combustion and thermal efficiency
- Steam Distribution and Condensate Return Systems
- Industrial Ammonia Cycle Refrigeration Systems
- Electricity Power Factor Improvement
- Lighting Efficiency

Additional, more specialized consulting expertise should be fostered in the more specialized areas of energy conservation in mineral processing, industrial processes and metals and non-metals fabrication.

Another area, Manufacture of Energy Efficient and Reliable Equipment for Steam Distribution and Condensate Return Systems, and for energy efficient electric motors might merit consideration as well. To facilitate the development of Bulgarian private sector firms, funding agencies could help to foster joint venture arrangements between U.S. firms and local firms. Moreover, the funding agencies could promote local production of basic energy efficiency equipment through similar joint venture arrangements.

Need to Change Market or In-Plant Incentives

National and International market incentives. Large manufacturing complexes located in Bulgaria probably will not survive without substantial markets beyond the national borders. These presently state-owned enterprises will have to be come fully responsive to free market incentives and become fully accountable for income, financing and legitimate expenditures associated with the operation (including the costs of worker benefits that may have been previously borne by the state).

For enterprises with primarily domestic markets, the decontrol of prices and the end of central planning, combined with limited domestic purchasing power, should provide sufficient incentive to reduce costs in order to compete. There now appears to be no intention on the part of the government to support or maintain the former monopolies, and the development of a very competitive system is to be expected.

In-plant incentives. Within all plants that were audited, a worker education process is required to assist the workers, and many managers and supervisors, in understanding the implications of market economics on plant operations. Consequently, plant personnel may need to be offered incentives in addition to training to promote an "energy ethic" in all plant employees. Similarly, a system of "disincentives" or consequences for energy waste should perhaps be established.

Opportunities to Support Local Private-Sector Manufacturers of Energy Audit and Monitoring Instruments

Technical Assistance and licensing arrangements or joint ventures in manufacturing with western country manufacturers is needed to help Bulgaria meet the large domestic need for portable and fixed instrumentation for energy conservation. Where the Bulgarian market is not deemed large enough for domestic manufacturing,
either mechanisms to establish viable importing ventures or to develop manufacturing and sales organizations that could serve both a domestic and export market needs to be explored.

APPENDIX II
PLANT SPECIFIC RECOMMENDATIONS

Recommendations outlined below address specific technical assistance, equipment, financing, training and other issues at the eight facilities visited by the audit teams. These recommendations are intended to be supplementary to the general recommendations outlined in Appendix I.

KREMIKOVTZI IRON AND STEEL WORKS

1. Technical Assistance

Specific technical assistance projects to consider include:

- Modification or replacement of the cold rolling line drive trains and control system. If found economically feasible, this will eliminate wasted electrical energy when the cold rolling line is operating at less than full capacity.

- Modifications to the heat input and combustion gas exhaust system for the batch- type bell annealing furnaces. Alternatives to consider include retirement of the very energy inefficient bell annealing furnaces.

2. Training

Training in techniques of economic analysis to supplement the staff's technical knowledge is critical. In fact, given the extremely limited capital resources available, training in, and application of, economic analysis is necessary for the plant to establish an effective priority system for implementing energy saving programs.

Similarly, additional training in energy conservation technology and methodology should be undertaken. Use of case studies and specific examples of effective energy conservation practices and programs in the OECD iron and steel industries could be useful.

3. Financing Requirements

It is recommended that if Kremikovtzi appears to be, after careful evaluation, a likely survivor, then comprehensive energy audits should be conducted for the entire plant before final investment financing requirements are determined. These audits should include detailed examination of the air separation plant, the coke ovens, blast furnace , steel converter furnaces and the hot rolling mill.

In addition to the above mentioned technical programs, improved technical communications networks related to energy management are needed throughout Bulgaria before a long-term energy efficiency program can succeed. Technical communications networks would include such activities as a university and professional society lecture series, professional society newsletters, formation of manufacturers associations (which will likely be formed if they do not already exist), and meetings of these associations, newsletters and meetings, popular periodicals and newspapers, and radio and television programs/appearances by interested parties, etc.

Technical assistance programs can provide industrial firms and private sector energy conservation consulting firms with the resources to establish technical and economic in formation libraries and to improve these firms capabilities to conduct effective training programs.

Consideration should also be given to providing assistance with the formation of an organization devoted to energy management. A part of the technical assistance effort should be devoted to establishing long-term cooperation between the Bulgarian organizations and the appropriate divisions of US professional societies devoted to energy conservation.

It is recommended adequate resources be allocated for whatever technical and management cooperation may be negotiated between Bulgarian and US organizations in the field of efficient energy management. US professional societies have limited resources and are not likely to be able to fund even very much in the way of the travel expenses for meetings among US and Bulgarian professional organizations that would like to cooperate in the field of efficient energy management. These US professional societies have much to offer, and it is suggested that support for vigorous interactions between Bulgarian and US professional organizations with expertise in energy management be provided.

For an effective program there would be the need for at least 3-months per year of coordination time alone even with the assumed availability of industry-sanctioned and partially supported volunteer participants. Overseas communications costs between the interested parties coupled with costs of technical reports and other publications that the US side would likely find itself obligated to send. Finally, it should be recognized that, at least in the beginning years, the benefits to US organizations in terms of reciprocal technical information is likely to be modest -- the Bulgarians will benefit the most. In addition to the availability of necessary travel and communications resources, as a minimum, such cooperative agreements should be designed with concrete goals and objectives along with an initial set of specific activities, a schedule and assignment of resources.

Another technical assistance initiative is to provide foreign assistance to Bulgarian manufacturers of energy conservation equipment since the products from Bulgarian manufacturers have reputedly been failure-prone. This proposed technical assistance can take the form of US-sponsored joint ventures, or straight technology transfers (probably in the form of improved designs and/or materials of construction) and funding of improved manufacturing machinery and training in manufacturing techniques and quality control.

4. Training

Training in energy management and organizational development, economic principles, strategic planning, and environmental impact assessment is appropriate for all types of industrial plants:

In addition to the modest instrumentation and controls that will be made available through the Emergency Energy Program, more instrumentation and controls are needed to provide operators and supervisors with a continuous indication of key energy parameters, and to provide process data for analyses and tracking of energy conservation performance by the plant technical staff. Installation and use of these proposed measuring instruments and energy-related process controls are likely to result in improvements in production rates and in the quality of output.

Financing will need to be arranged for the two major technical assistance efforts listed above.

5. Opportunities to support development of local private technical services and energy efficiency equipment companies

Some technical groups of the Kremikovtzi Iron and Steel Works may be considered for restructuring as one or more private sector technical services companies. These companies could serve various ferrous metal foundries and fabricators, (and possibly non-ferrous metals enterprises) in Bulgaria, as well as in other Central and East European foundries.

SERDIKA MILK PROCESSING PLANT

1. Technical Assistance

The Serdika Milk Processing Plant, by virtue of its location in Sofia, the number of systems common to industrial plants in Bulgaria and the great number (30) of milk processing plants in Bulgaria, can serve as a focal point for technical assistance from sponsors such as US AID. Joint efforts among assistance and development finance organizations will be appropriate in this context.

Technical assistance in the field of energy conservation can be supplemented by technical assistance to Bulgarian manufacturers of equipment (including steam traps, valves and pumps, pressure, draft, flow and temperature measurement equipment).

In the absence of a separate economics training component, any technical assistance program should include training in economic analysis. Economics has been a neglected field, and consequently in-depth education in economics (including economics in engineering, business, scientific and agriculture curricula) must be a central component of any training initiative.

2. Financing Requirements

Energy efficiency improvement needs for this plant include:

- Installation of reliable and accurate (according to Western industrial standards) instrumentation for measurement of flows, temperatures and pressures (or drafts).
- Reconstruction and extension of non-contaminated steam condensate return systems, replacement of steam traps, and repair of pump and valve packing glands.
- Modification of the ammonia refrigeration system condensers to improve water flow distribution, and installation of one or more liquid ammonia pumps -- both measures designed to reduce refrigerant compressor energy requirements.
- Replacement of some cold storage area wall thermal insulation, reinsulation of some refrigerant piping, and addition of automatic defrosting equipment.
- Replacement of outdoor and storage area lighting with high pressure sodium vapor lamps.

In the long-term, old and inefficient refrigeration compressors need to be replaced. No cost estimate is available, but this will require major capital- intensive equipment purchases. Purchase of the

equipment and the services of a manufacturer's representative t o oversee installation will require foreign exchange.

3. Opportunities to support development of local private technical services and energy efficiency equipment companies.

Should US AID and/or other international assistance/financing organizations choose to adopt the Serdika Milk Processing Plant (or another industrial plant), as a focal point for technical assistance and technology transfer, the plant also can be used as a vehicle for testing Bulgarian manufactured equipment and measurement equipment.

"PHARMACIA" PHARMACEUTICAL WORKS

1. Technical Assistance

Technical assistance to this plant can be scheduled as a follow-on after the completion of proposed work at the Serdika Milk Processing Plant.

In the environmental area, the plant is having difficulty storing or disposing the byproduct of plant operations. This byproduct is a viscous organic substance, not otherwise identified, that is combustible and may have a significant heating value. This material may meet the US EPA definition of a toxic or hazardous material. There is a large accumulation of this material on the plant site now, and more is being produced every day. The plant manager made an appeal for US technical assistance in dealing with this environmental problem. It is possible that incineration of this waste material with heat recovery could have energy as well as environmental benefits.

Should technical assistance in the field of environmental protection or waste disposal be authorized by US AID or by other organizations, consideration of this problem as a candidate for technical assistance is recommended.

2. Training

Plant personnel require training in thermodynamics (as applied to both steam and refrigeration systems), engineering economics and energy management techniques.

3. Financing Requirements

No capital intensive financing needs were identified, although resolution of the waste disposal problem noted above will require much capital. Further, investigation of the feasibility of adding cogeneration capability and investigation of the merits of replacing the existing fermenters, are recommended.

IZIDA CERAMIC PLANT

1. Technical Assistance

Plant management recognizes that variations in moisture content of molded and formed clay products in the drying ovens is an important source of energy losses. The plant needs assistance in obtaining

instruments that can monitor the water content of these formed clay products to permit closer control of the water content and for a signal to control the heat input to the drying ovens.

More importantly, the company is proposing replacement of two electrically heated furnaces with larger gas-fired furnaces which will substantially reduce electric power consumption, increase production and reduce unit energy costs.

2. Training

Some training in the specialized operation of high temperature ovens (oxidizing, neutral or reducing atmosphere) is recommended.

3. Financing Requirements

The most significant financing requirement is a proposed $4 million acquisition of two higher capacity natural gas-fired furnaces to replace two electric furnaces now in operation. In addition to the energy management aspect of substituting natural gas for scarce and "rationed" electric power, replacement of these smaller furnaces will remove the only bottleneck to doubling the current production rate.

POULTRY COMPLEX

1. Technical Assistance

At the poultry slaughterhouse, operator and maintenance personnel training in energy management issues is needed. The most pressing need is to adopt better operating procedures in the refrigeration and cold storage areas, to make modest changes in ammonia condenser water distribution systems, and to improve non- condensable gas venting efficiency.

2. Training

Training is needed in management economics and energy management. This type of training is necessary even if the management hires staff economists and energy managers, since these new staff members must coordinate their own activities with those of the management and support from other personnel.

Training also is needed to make employees aware of energy losses, where they occur, how they can be remedied and the economic impact of energy losses on plant operations. In addition, maintenance employees will need specific training to insure adequate maintenance of steam traps, valves, pump shaft seals, etc.

3. Financing Requirements

The most pressing need for financial assistance is the replacement of thermal insulation in the cold storage area walls (including ceilings) and installation of more effective doors or other closures at cold storage area points of entry.

PARVI MAI COTTON TEXTILE PRODUCTION PLANT

1. Technical Assistance

Textile plant dyeing and finishing operations are different from other light industrial plants where boilers, steam and condensate systems, compressed air, lighting, electric motor drives and refrigeration systems are the common elements of plant energy systems. Consequently, it is recommended that technical assistance be extended to the Parvi Mai plant in the form of specific expatriate energy system analysis to provide specific engineering designs for energy conservation for the unique processes used in this plant, and that arrangements be made for participation in this program by personnel from other textile factories in Bulgaria to facilitate technology transfer.

2. Financing Requirements

The proposed technical assistance is likely to result in a need for capital equipment in the form of heat exchangers and other equipment for energy conservation in textile finishing and dyeing operations.

3. Opportunities to support development of local private technical services and energy efficiency equipment companies

This company will benefit from the services of a private sector technical company, provided it has the funding available to pay for these services.

CHIMCO AMMONIA AND UREA PRODUCTION FACILITY

1. Technical Assistance

The plant is in the process of modernization. In power plant improvements and in environmental protection, the plant management clearly intends to upgrade its activities. In both these areas, substantial capital expenditures will be required. Bulgaria currently lacks much of the necessary expertise to identify and evaluate the alternative solutions in these areas, and will require technical assistance.

The company is actively considering cogeneration as a possible future option. Consequently, technical assistance could hasten a favorable decision by the company to move forward with its prospective cogeneration facility.

Technical assistance can be useful in helping the company plan for improvement of the complex's environmental protection facilities, but probably the most direct route to environmental improvement in Bulgaria is to provide technical assistance to the government in developing and passing reasonable and enforceable environmental legislation into law, and expeditiously implementing that law into regulations.

2. Training

The greatest needs for training at this plant are in the fields of economics, energy management, environmental impact assessment and industry-specific environmental protection technology.

3. Financing Requirements

This plant exports a large amount of its product for hard currency. The plant recently obtained permission from the government to invest a portion of that hard currency in plant modernization and improvements, providing some financing for efficiency and industrial investments. In the past, the plant has purchased much of its process equipment from western countries using its own hard currency finances.

SODA ASH PRODUCTION FACILITY

1. Technical Assistance

Plant management is interested in obtaining current technical information and assistance from competent consultants on western design and operation of Solvay process technology. If technical assistance is considered it should include an energy efficiency component. However, the plant's continued operation as a Solvay process may be threatened by the supply of soda ash from trona deposits in Turkey. Technical assistance on any substantial scale should probably be considered only after an evaluation of the plant's future competitive economic viability.

2. Financing Requirements

This plant exports over half of its product for hard currency. The plant recently obtained permission from the government to invest a portion of that hard currency in plant modernization and improvements. Financing needs related to this plant may well be driven more by the need for equity for privatization than for modernization and improvement under the present state ownership.

Under the former regime, which had been in place for decades, there was little concern for energy conservation. Company employees were effectively shielded from any contact with Western industrial practices and policies, including concerns for energy costs and availability, and were largely unaware of the concept of energy conservation. Since the Western concept of economics was discredited in these countries and since energy prices were artificially set there was no foundation in place for concern over energy conservation. There was no specific energy management plan in place, the company had no procedures for identifying and executing energy savings investments and management's interest in energy conservation as evidenced by its contract with Ecotechproduct was clearly not effectively transmitted to the plant staff as plant personnel, including maintenance staff, displayed little incentive to take steps to identify, evaluate or execute energy savings opportunities. Moreover, factory personnel had little understanding of economic concepts, including Return on Investment and Internal Rate of Return.

Plants designed under the Communist regime had no provision for even making the basic measurements needed to ascertain how effectively energy was being used. In all the plants audited, the absence of almost any instrumentation limited any disciplined, quantitative analysis of energy use and losses. Indeed, some appropriate instruments are obtainable only with hard currency; nonetheless, simple temperature and draft monitors are available in Bulgaria. While this situation suggests management inattention to energy conservation, it should be recognized in the ensuing economic chaos following the replacement of the Communist government that plant managers had to contend with major energy price increases, energy shortages, and unanticipated raw material shortages for processing, operating and maintenance. These events taxed industrial management's ability to deal with other emergency issues.