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INDUSTRIAL PROFILE REPORT

POLAND

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TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1
2.	INDUSTRIAL TEAM	3
2.1	Industrial Energy Efficiency	3
2.2	Decision Making Practices	3
2.3	Energy Management Practices	4
3.	COGENERATION TEAM	5
3.1	Cogeneration Energy Efficiency	5
3.2	Decision Making Practices	6
3.3	Energy Management Practices	6
3.4	Energy Pricing Policies	7
3.5	Investment Policies	8

APPENDIX I COMMENTS AND RECOMMENDATIONS - NITROGEN PLANT AT WLOCLAWEK

APPENDIX II COMMENTS AND RECOMMENDATIONS - CEMENT PLANT WIERZBICA

APPENDIX III COMMENTS AND RECOMMENDATIONS - STEEL PLANT AT OSTROWIEC

APPENDIX IV COMMENTS AND RECOMMENDATIONS - NITROGEN WORKS AT KEDZIERZYN

APPENDIX V COMMENTS AND RECOMMENDATIONS - COGENERATION PLANT AT OSTROWIEC

APPENDIX VI COMMENTS AND RECOMMENDATIONS - Łęg PLANT AT KRAKOW

APPENDIX VII COMMENTS AND RECOMMENDATIONS - WOLA DISTRICT HEATING PLANT AT WARSAW

APPENDIX VIII COMMENTS AND RECOMMENDATIONS - BLACHOWNIA COGEN PLANT AT KEDZIERZYN

APPENDIX IX RECOMMENDATIONS FOR LONG-TERM ENERGY EFFICIENCY PROGRAM

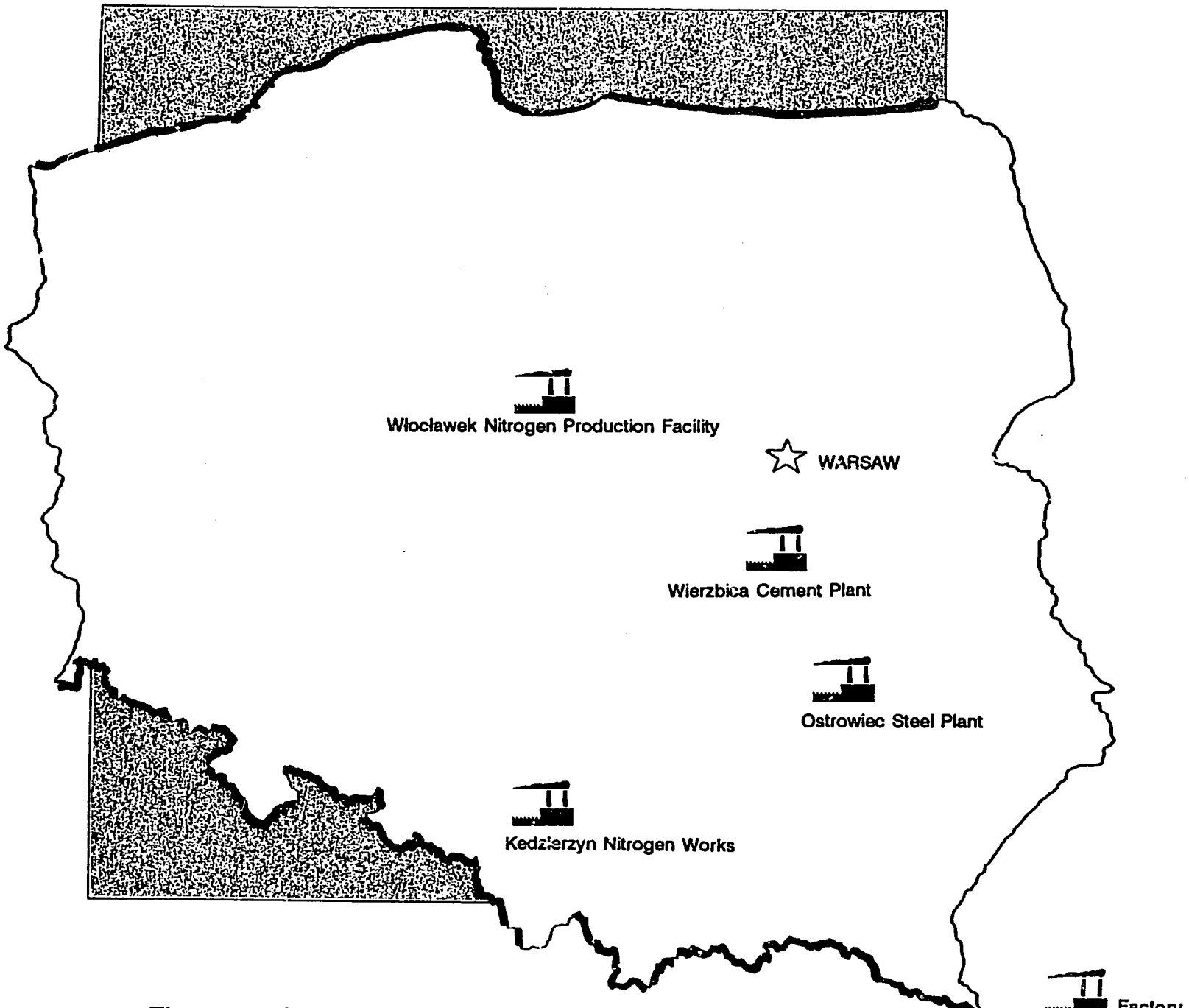

Figure 2. Location of plants audited by the IRG Team

1. INTRODUCTION

Under the U.S. Agency for International Development (A.I.D.) Emergency Energy Program, two Energy Audit Teams from International Resources Group (IRG) visited five cogeneration power plants and four industrial facilities in Poland. The goals in conducting these energy audits were to:

- foster improved management of energy resources by recommending "low-cost/no-cost" improvement measures;
- transfer energy auditing and economic project analysis techniques to relevant personnel in the plants;
- provide low-cost equipment to support the improvement of energy efficiency.

In light of dramatic increases in energy prices for both the power and industrial sectors in Poland during the past two years, attention to energy-efficiency issues will be vital to the survival of many industrial enterprises as they attempt to compete in an international market economy. For power producers, particularly district heating facilities, energy efficiency represents a way to reduce input costs in the face of uncertainty about how quickly energy subsidies will be removed from the residential sector. Thus, energy efficiency, combined with education in strategic planning and economic analysis of operations and investments, has great potential to revive the Polish industrial sector, plagued by economic troubles since the late 1980s.

There are 55 thermal power stations in Poland with a total generating capacity of 26,800 megawatts (MW). One plant alone, Belchatów, accounts for 4,320 MW; the other 54 have a combined capacity of 22,500 MW. The IRG Cogeneration Audit Team visited five plants representative of the Polish power-generating sector having a total capacity of 1036 MW. Similarly, the Industry Audit Team visited four plants representative of Polish industry. Thus, conclusions reached in this report, although derived from observations made at eight plants, can be applied throughout the industrial sector.

Insight into Polish production, distribution, and use of industrial energy was gained during plant audits and energy management seminars. These activities were augmented by meetings with representatives of the Ministry of Industry, Westinghouse, the World Bank, and the Polish Foundation for Energy Efficiency; participation in an energy seminar conducted by the Ministry of Industry; and discussions with the "Energy Partners Group" on planned cogeneration project near Kraków; members of the Group include Hart Associates, Asea Brown Boveri, and HydroCo (a subsidiary of Niagara Mohawk).

Key industry representatives were anxious to identify and solve basic problems of energy production, distribution, and industrial energy use. With a few exceptions, industry as a whole is handicapped by the legacy of centralized economic planning. Specific obstacles to further industrial development include:

- Less than adequate technology;
- Antiquated equipment design - even if the equipment itself is fairly new;
- Poor infrastructure - communications, financial systems, roads, water quality, and mechanical contractors;

- Limited experience in decentralized planning and decision-making;
- An unrealistic and highly subsidized pricing system.

These fundamental problems will not be resolved quickly. However, most Polish industrial managers are willing to make the changes necessary to improve industry standards. With technical assistance, the Polish power industry is expected to overcome its problems and become competitive within the next five to ten years.

The Industrial Energy Efficiency Project is a USAID project that has attempted to address some of the obstacles to furthering development of the industrial and power sectors in Poland. By focusing on technological, economic, and managerial aspects of energy efficiency, the IRG Audit Teams introduced plant representatives throughout Poland to many fundamental precepts upon which Western industry has been built. This report focuses on project findings, particularly those that relate to plant decision-making practices, capital allocation, and management. In addition, this report briefly addresses specific training, financial, and technical assistance requirements in the Polish industrial sector. Additional details are included in the Appendices to this report, specific Plant Audit Reports, and the Policy and Institutional Analysis Report. These other reports have also been prepared as part of the Industry Energy Efficiency Project.

2. INDUSTRIAL TEAM

2.1 Industrial Energy Efficiency

With a few exceptions, technology and equipment in the Polish industrial sector averages approximately 30 to 40 years behind the state-of-the-art. Plants use little instrumentation, monitoring and control of pollutants from industrial sources is extremely limited, and there is a severe lack of automatic control systems used in manufacturing processes. These facts combine to adversely affect production efficiency, plant profitability, and local environmental quality.

There are also wide variations in housekeeping at individual plants, generally correlating with the quality of plant management. Moreover, the cogeneration facilities at industrial sites are severely under-utilized (20% of installed capacity), the direct result of unrealistic tariff structures for electric power from the national grid.

Over-staffing at the plants is also a common feature in the Polish industrial sector; since job security has historically been guaranteed, worker incentives were practically non-existent under the centralized economic system. These two factors have combine to decrease efficiency of the work force, in both actual production and cost control. Since 1990, however, there have been major changes in the management of labor in Poland; these have been primarily prompted by privatization initiatives. Although bonuses for management and workers have been allocated at some plants, there is still room for increased worker productivity and overall efficiency.

2.2 Decision Making Practices

Under the centralized economic system, capital investment decisions were made by the government. A typical feature of this system was that emphasis was placed on production capacity, rather than productivity or efficiency.

The management at many facilities do not understand the concept of the competitive "bottom line," which has a profound effect on plant operations. Moreover, there is a lack of personnel throughout the industrial sector with sufficient knowledge of financial management and analysis to assist with strategic planning; consequently, there are few well developed long-term planning strategies in evidence. Capabilities to conduct economic evaluations of proposed projects are weak, and often do not embody an understanding of market-driven investment principles.

Industrial plants visited by the A.I.D.-sponsored Audit Teams have improved their capabilities in strategic and economic planning since the outset of the Industrial Efficiency Project. The Kędzierzyn Nitrogen Works and the Steel Plant Ostrowiec, in particular, have demonstrated commitment to the development of these capabilities. This commitment has led, in turn, to vast improvement in their abilities to evaluate projects using economic techniques.

It is difficult to formulate specific long-term strategies for the industrial sector as a whole, since privatization is only in its initial stages. More importantly, due to numerous constraints, it is difficult to plan for long-term raw material supplies, making any detailed long-term plan

subject to change. It is vital all industrial concerns begin to consistently incorporate strategic decision-making principles into the overall management structure. In this way, plants will be flexible and far-sighted enough to adapt to a rapidly changing economic environment.

2.3 Energy Management Practices

For most Polish industries, energy costs (including natural gas as feed stock) comprise less than 27% of total production costs, which is below world standards. For this reason, most plants have not made it a priority to establish annual goals for improvement in energy consumption per unit of production.

Lack of instrumentation to sub-meter fuel and electric power usage within a large manufacturing facility is the main reason plant managers are not able to measure the energy efficiency for each production unit. Under these conditions, it has been difficult to institute any system of incentives or penalties related to energy use by production department. In at least one case, however, workers expressed the desire to share benefits derived from energy efficiency efforts. Similarly, suggestions were made in one plant to establish a bonus system for energy efficiency suggestions.

However, management staff at one plant suggested that high-wage taxes (4 to 1) required by the government are the main reason pay increases are not a cost- effective incentive mechanism for an industrial facility. Costs of using pay increases as an incentive will remain relatively high until changes are made in government policy.

In several instances, the operating and maintenance functions of the plant are managed separately. Poor performance and lack of accountability have been direct results of this practice. Due to distorted energy cost structure, management decisions related to energy-efficiency practices are fundamentally affected. For example, plants which burn fuel oil and natural gas tend to monitor boiler efficiency more closely than plants that burn domestic coal, a highly subsidized fuel.

Electric power from the grid remains unrealistically inexpensive. As a result, there is a general lack of interest in improving electrical efficiency for equipment or industrial processes. However, the situation is changing rapidly as energy price adjustments are made incrementally. Three of the four industrial plants visited (Steel Plant Ostrowiec, Cement Plant Wierzbica, and Kedzierzyn Nitrogen Works) indicated electricity load-management systems were a top priority for investment under the Emergency Energy Program and similar initiatives. Generally, managers of industrial plants are sensitive to the economic effects of changing energy costs, but have few requisite skills for conducting such economic analyses. A related seminar/training session would be valuable to managers throughout Poland at this critical stage.

3. COGENERATION TEAM

3.1 Cogeneration Energy Efficiency

As mentioned above, emphasis on energy conservation was not a priority under the previous regime. Since 1989, however, this issue has become a major concern, and the power/cogeneration industry is responding rapidly to the new emphasis. As a result of inexperience with energy efficiency projects, technologies, and economic evaluation techniques, such initiatives have not always been as successful as desired. Nevertheless, the commitment and enthusiasm of management personnel throughout the power sector will promote significant improvements over the next few years.

Industry is currently operating under several handicaps when carrying out effective energy improvement programs. These include:

- Attitude of the work force - Under the central economic system, workers were paid little, given little responsibility, and not rewarded for good performance. Consequently, most workers developed an indifferent attitude toward work. Activities to help overcome this include: 1) intensive retraining programs; 2) institution of work standards with rewards for good performance and penalties for poor performance; 3) establishment of incentives for energy-saving projects; and 4) development of goals for department or shifts, rewarding those who attain the goals.

- Antiquated equipment and technology - Many power plants are quite old, having been in operation for more than 20 years. In many cases the plants were not up to US standards even when they were built. In the long-term, existing equipment should be replaced with newer technology. This is not a viable option for the short-term, however; plants must instead attempt to incorporate energy-saving technology into existing operations. Appropriate technologies include: 1) improved instrumentation and control systems (e.g., oxygen analyzers); 2) improved burner designs; 3) variable speed controls on large water pumps; and 4) high-quality steam traps.

- Management practices vis a vis labor utilization - Every plant visited by the Audit Team had more manpower than was needed to operate effectively. Based on capacity rating, plants often had at least twice as many people as necessary. At operating rates, personnel redundancies totalled approximately 400%. Yet, despite the overstaffing, three plants visited by the Audit Team (Wola District Heating Plant, Lodz, and Blachownia) had poor housekeeping and maintenance standards. In one plant, for example, the Audit Team estimated 100 people should have been working in the boiler and turbine areas. However, the Team did not encounter a single operator during two and one-half days in the plant.

  It is recognized the issue personnel of cannot be dealt with adequately until the Polish economy generates more jobs. In the meantime, plant managers should make every effort to keep personnel occupied in tasks including cleaning up dirt

and scrap, completing maintenance tasks, painting, and attending training programs. Getting the operating personnel actively involved in improving the overall operation and efficiency of the plant will have positive long-range effects on the workforce. Given the number of people on the payroll at most plants, every facility in Poland should be extremely neat and well-maintained.

3.2 Decision-Making Practices

In general, management and supervisory personnel in the power and cogeneration sectors are competent and as well-trained technically as their counterparts in the United States. Consequently, short-term decision-making in technical aspects of plant operations are relatively effective. Long-term strategic decisions are not as easily managed, however.

Long-term strategic planning has not been successful for a number of reasons. Most plants lack personnel with experience or training in strategic planning, and thus, management has little understanding of the techniques for evaluating and comparing alternative courses of action. Moreover, the seriousness of short-term problems, such as availability of energy inputs and capital for investment, prevent existing resources from being used to serve long-term energy efficiency problems. Accounting and record-keeping systems further complicate the process of strategic planning, since they are not geared to supply the necessary information for making long-term projections. Finally, with no national framework of objectives to guide local management in setting long-term objectives, plants are usually unable to develop cohesive, comprehensive strategic plans.

Effective strategic decision-making is key to the long-term survival of any industry. The following actions are suggested to begin improving strategic decision-making in the Polish cogeneration industry.

- Select plants that have shown competence in strategic planning and promote activities at these plants including:
  - Request outside experts (U.S. or Polish) to provide technical assistance in developing strategic plans at the plant level;
  - Send key executives to advanced training programs, such as those offered by the Harvard Advanced Management Seminar;
  - Provide specialized training in economic evaluation.
- Present intensive 3-5 day workshops on strategic planning and decision-making to invited executives from all across the industry.
- Establish a clear national framework of goals and objectives, so that local management can make plans and set priorities accordingly.

3.3 Energy Management Practices

Among plants visited by the Audit Team, there were some excellent practices directed at improving energy efficiency. These included:

- awarding bonuses to employees for energy-saving suggestions;
- establishing annual goals for energy consumption per unit of product, with monthly monitoring;
- creating "Energy Committees" to identify energy-saving opportunities and implement solutions;
- assigning specific individuals the responsibility for improving energy efficiency;
- holding regular meetings or seminars on energy-saving for all employees;
- completing daily (or weekly) analyses of energy consumption to detect potential problems; and
- scheduling operations to minimize energy demand.

In addition, each plant conducted a number of activities to address energy efficiency problems identified through the Industrial Energy Efficiency Project. Implementation of programs varied widely, from little emphasis at some sites to thorough, well-managed programs at Łęg in Kraków and Zakłady Azotowe in Włocławek.

As Poland expands its market economy, the value of energy will rise to world levels, and inefficient energy use will become increasingly expensive; this process has already begun, affecting consumers of oil and natural gas dramatically. Ultimately, all plants will be forced to give more attention to improving energy utilization. Seminars and workshops should be conducted to assist people in industry to improve their skills in energy management, and to adjust to changes required in operational and management practices.

3.4 Energy Pricing Policies

In a free market environment, energy prices are the primary force that encourages producers and consumers to use energy efficiently. Currently in Poland, there are a number of policies which prevent prices from serving as a tool to encourage energy savings. These include:

- Fuel prices - Under the previous regime, fuel prices were heavily subsidized. While the present government has reduced controls on most items, it has retained a large influence in setting fuel prices. Specifically, Polish coal is still being sold at rates below world competitive prices.

- Electricity pricing - The Polish government sets the prices at which the power grid pays for electricity and at which electricity is sold. In each case encountered by the Audit Team, the grid was selling electricity for less than it was buying it. This means the government is subsidizing the sale and, in addition, is paying for distribution expenses (and losses). Further, there are indirect costs to Poland that may be very large:

  - Potentially efficient producers are buying electricity from the grid, allowing their generating facilities to sit idle. Zakłady Azotowe in Włocławek is a good example.

  - Due to artificially low prices, there are few or no plans to upgrade generating capacity or to build new modern and efficient facilities. (In

contrast, virtually every cogeneration plant has plans to expand thermal energy capacity because it can be sold profitably).

At this stage in Poland's development, control of energy prices may be desirable. A "typical" Polish family spends 20% of its income on energy in the forms of electricity, heat, and gasoline. This is a substantial burden, and immediate increases will cause severe hardship for many Poles. However, these controls are clearly causing misallocation of resources and poor planning for the future. The sooner controls are eliminated, the better it will be for the Polish economy in the long run.

- **Thermal Energy Pricing to Consumers** - Most district heating systems in Poland sell thermal energy to residential customers on the basis of the area to be heated, rather than on the quantity of heat used. The charge for thermal energy usually is included in the rent and is adjusted unilaterally by the district heating system to cover costs. This system has a number of problems:

  - Consumers have no incentive to conserve thermal energy. The most common means of controlling room temperature is to open windows. The Polish Foundation for Energy Efficiency estimates 25% of the thermal energy in the district heating systems is lost in this way.

  - Since the district heating system passes its costs on to consumers, there is little incentive for the plants to operate the system efficiently. In Warsaw, it is estimated that 1-1/2% of the water pumped into the system was lost by leaks. In a system the size of Warsaw, this loss is more than 1,000 gallons/minute of heated water. (In Łódź, a single company operated both the power plants and the district heating system. There, a great deal of attention is given to overall system efficiency).

  Few residences have meters, thus there is almost no way to charge consumers for the heat they actually use. In some residential complexes it may not be possible to isolate individual units for metering. Possible actions to correct this situation include: 1) requiring all new living units to have individual meters; 2) offering discounts to existing customers who install meters; and 3) separating the heating charge from rent and requiring regulatory approval to increase the charge.

3.5 Investment Policies

Poland should develop guidelines for investment in power generation and distribution facilities at several levels. At the **national level**, the Government should establish a framework of rules and incentives that will cause decisions at the lower levels to be made in the best long-run interests of the nation. Factors that should be considered include:

- nuclear power (both safety and cost issues);
- pollution levels;
- combined cycle cogeneration;

- common ownership of producing stations and district heating systems; and
- establishment of regional utilities.

Incentives, such as government loan guarantees, should be provided to encourage investment in the direction of national interest.

At the **regional level**, the Government should establish a more detailed framework, within national guidelines, to provide guidance on:

- electricity price structure;
- pollution control;
- scheduling to meet seasonal demand;
- planning to meet growth in regional demand; and
- incentives to maximize use of the most efficient facilities.

Finally, at the **local level**, guidelines should be established to provide detailed guidance for supplying energy to local residences and industry. Specific attention should be given to:

- pricing of thermal energy;
- penalties and rewards for energy conservation;
- cooperation with local governmental units to project future demand;
- waste disposal;
- pollution control; and
- prioritization of investments.

Electricity and thermal energy supplies are so vital to the Polish national economy that every effort must be made to make these system as efficient and reliable as possible. Massive investment over the next 10-15 years will be necessary to up-grade the systems so they can support the growth in the rest of the economy. The planning and prioritization of this investment is one of the most important tasks confronting Poland.

Currently, most plants have their own capital investment plans, with each facility planning substantial expenditures to replace old equipment and expand capacity. No plant appears to be making the difficult decisions to phase out antiquated facilities and to focus investment on those facilities that should operate long term. Thus, efforts such as the Industrial Energy Efficiency Project should be used to build an industry-wide awareness of the importance of energy efficiency and sound economic investment planning.

APPENDIX I

COMMENTS AND RECOMMENDATIONS - NITROGEN PLANT AT WŁOCŁAWEK

1. Observations on Energy Efficiency

Energy efficiency at this plant was the best observed by the Audit Team of any of the plants visited, although several important improvements are needed to keep the plant competitive in world markets.

Examples of areas which require energy-saving actions include:

- Improving the efficiency of the chlorine cells - the chlorine production process consumes the largest amount of electricity at this plant. In 1990, the specific energy consumption for chlorine production was 3,500 killowatt hours per metric ton.
- Recovering waste heat at the cracking furnaces of the VCM Plant.
- Using waste heat from a chlorination reactor to heat reboilers of the VCM/EDC purification towers.
- Modernizing the ammonia plant.

Energy efficiency at the 125MW cogeneration plant can be significantly improved if the plant operates at a higher capacity factor. The Energy Audit Team recommended managers use spare capacity to provide heat for the city. A feasibility study has shown a one-year payback, so the plant is pursuing this idea. This scheme will allow the cogeneration plant to run at a higher capacity, improve efficiency, and form a cooperative with the city.

2. Decision-making Practices

The management of this plant does not completely understand all the implications of the concept of competition, although managers are trying to learn key principles quickly since they are dependent on exports for much of their revenue. There still remains a lack of personnel at the plant with adequate knowledge of financial management and analysis to formulate comprehensive long-term planning strategies. Similarly, economic evaluation capabilities for proposed projects are weak. (During the Audit Team's workshop in this plant, considerable time was spent reviewing a case study on economic evaluation).

An example of the effect of inadequate understanding of market-based principles on long-term business planning is the recent negotiation of a joint venture with a US company. Negotiations broke off partly due to lack of proper appreciation and understanding of how to assess risk in such a venture. Training is the only key to overcoming this particular problem.

3. Energy Management Practices

Wloclawek is by far the most modern industrial plant visited by the Energy Audit Team. Plant designs, instrumentation, automatic control systems, equipment, professional skills, and other factors are up to world standards.

Plant organization is comprehensive, and there is an energy management program in force at the plant which receives strong support from management and employees alike. The general power engineer responsible for this program and his supporting associates have done an excellent job in directing and coordinating various energy-saving projects.

This facility has established an effective framework for energy management at the plant and complex levels. Moreover, partly due to the effectiveness of the energy management program, there is widespread awareness of the importance of energy efficiency in determining overall plant competitiveness.

The plant is sufficiently modern and technologically sophisticated to have a computer-based economic model for cost accounting. This system should optimize plant production given specific energy consumption and other economic factors. A well-planned reduction schedule will increase the plant utilization factor and reduce specific energy consumption. Energy efficiency projects completed in the past are good indications that a strong energy management program has been in place.

Since this enterprise is among the most modern chemical plants in Poland, the plant has been encouraged to become a model for energy management programs in Polish industry. In this respect, Wloclawek must strive to achieve the highest levels of efficiency possible, both process and managerial.

4. Recommendations

1. Technical Assistance

Specific technical assistance projects that should be considered include:

- Integration of Cogeneration Plant with the Local District Heating System

  One of the severe drawbacks of the cogeneration plant as reported by the IRG Team is its extremely low utilization of the cogeneration facility (load factor: 20 - 25%). The IRG Team recommended ways be found to increase the thermal load of the plant so the cogeneration capability can be fully utilized. Integration of local district heating plants with the cogeneration plant was also suggested during the April 1991 meeting.

  During August 1991, a preliminary study was conducted by Energoprojekt of Warsaw (the process design group). This feasibility study explored the economics of combining the thermal load of the district heating plants of the city of Wloclawek with the thermal demand of the chemical complex. The results of this study had not been thoroughly evaluated as of December 1991.

Since there are several cogeneration facilities in Poland in similar situations (e.g., Nitrogen Works at Kędzierzyn), such integration, if proven successful, can serve as a model for other district heating plants and industrial cogeneration sites.

- Combined-Cycle Cogeneration Plants

  The optimal long-range energy policy solution for Poland involves the use of coal; it appears to be a viable choice for Poland's long-term electric power requirements. For the near future, it is advisable for Polish industrial facilities to adopt combined-cycle, gas-turbine cogeneration plants.

2. Training

Training in economic analysis techniques to supplement the staff's technical knowledge would be useful. 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 projects.

3. Financial Requirements

Financing of energy projects including large capital projects can be achieved through joint ventures with U.S. companies once plant personnel understand how energy projects are financed in a competitive power market oriented economy. They also need a better understanding of how the income stream gets divided for a project based on the various risks involved. Several U.S. companies have expressed interest in this plant.

Another idea for financing capital projects is to contact significant Polish communities in U.S. cities. Many people in these communities are willing to invest in "mutual funds" whose proceeds are invested in Poland. The investments in Poland can be on a "share-the-benefits" basis. For example, the fund might purchase:

- Improved burners for certain boilers;
- Conversion of district heating system water pumps to variable speed control; or
- Computer-based load management systems.

The fund would receive a share of the economic benefits of the investment for a period of time, say 50% for 5 years.

APPENDIX II

COMMENTS AND RECOMMENDATIONS - CEMENT PLANT WIERZBICA

1. Observations on Energy Efficiency

The plant design at Wierzbica is based on "Wet Process" Soviet technology and is noted for its inherently higher energy consumption per unit of product. Consequently, the inefficiency of the process combined with other energy practices causes the plant to use energy inefficiently.

The IRG Energy Audit Team recommended more efficient burning of coal in the kilns be the main target of the Energy Efficiency Improvement project. Gas analyzers for the kiln exhaust gas are necessary to ensure the best combustion efficiency is obtained when coal is burned in the kilns. In addition, infrared thermometers can be used to locate defective fire brick insulation in the kilns.

Serious consideration should also be given to exploiting kiln exhaust gas (190-220 °C) as the heat source for the dryers. In addition, waste heat can be used in hot water heating for building and domestic use. These multiple uses would increase overall energy efficiency while decreasing the absolute amount of energy consumed.

Only one major long-term option was recommended by the Audit Team - to build a new plant with the latest, most efficient "dry process" technology.

2. Decision-making Practices

Wierzbica management is sensitive to production expense issues, including energy costs. A monthly seminar is organized in conjunction with a local polytechnic university (Radom), with the topics of these seminars closely related to operating problems. The seminars are informal, although most of the chief engineers and operators are required to attend and participate in the discussions. More formal training would also be useful, however, particularly in economic analysis, investment prioritization, and long-term strategic planning.

3. Energy Management Practices

Management staff and engineers were extremely helpful and cooperative during audit activities and meetings. Based on Team members' observations and plant engineers' input, a strategy was formulated that has the potential to help save energy and progress toward more energy-efficient operations.

4. Recommendations

1. <u>Technical Assistance</u>

There is only one long-term option recommended by the audit team: Building a new plant with the latest "dry process" technology.

According to the Cement Data Book by Walter H. Duda, the average thermal energy needed to produce one kg of clinker for the wet and dry processes are:

800 kcal/kg dry process
1,300 kcal/kg wet process

The Cement Plant Wierzbica requires 1,694 kcal/kg of clinker, which is more than twice the Western dry process requirements, and 30% more than that of the Western wet process.

It is not clear whether the raw materials and technical labor force exist in the area that would facilitate the implementation of this long-term option. The short-term and medium-term energy efficiency options must be examined carefully, and, wherever possible, implemented.

2. Training

As in all the plants, there is a strong need for economic evaluation training, since few people at the plant have had any experience in understanding profit and its relation to risk.

3. Financial Requirements

It is not clear that the market potential exsits for a new plant based on a dry process, or that the plant would attract sufficient capital investment to build new facilities. Nonetheless, potential savings warrant further examination of this option.

Privatization was mentioned by management during the plant visit. However, before privatization becomes a realistic option for Wierzbica, local subsidies (housing, education, some community services) must be removed. Similarly, tax and legal frameworks for private enterprises must be established.

The fact that the chief power engineer and his associates have been conducting a program for plant load optimization is a sign that energy management issues are treated seriously. Technical engineers also investigated and evaluated different control options to reduce specific energy consumption, another indication of strong managerial support for energy management practices.

APPENDIX III

COMMENTS AND RECOMMENDATIONS - STEEL PLANT AT OSTROWIEC

1. Observations on Energy Efficiency

Operation and technology practices used at the Steel Plant Ostrowiec (SPO) are far from energy efficient by Western industrial standards. However, when energy prices are raised to world levels, the Steel Plant will find it more difficult to compete on the world market without improving energy efficiency. This realization has sent a strong message to management that energy efficiency improvements should be a high priority.

Plant load optimization is the most urgent and cost-effective energy efficiency improvement option recommended. The proposed project will utilize a personal computer as a central information processor (plus one back-up), and impulse sensors to transmit the KW demand signals; installed cost of this system was quoted at $22,660. The payback period is two months at current electricity and fuel prices. Funding for this project was available through the A.I.D. Emergency Energy Program.

Combustion gas analyzers are needed on five steam and nine hot water boilers; in addition, the heating furnaces need a gas analyzer to improve combustion efficiencies. Reduction of excess air on all boilers and combustors represents a major energy improvement opportunity in all plants visited.

Bottom cycle waste heat recovery on all furnaces represents a very large opportunity for energy efficiency improvement. This is true for steel operations throughout Poland. The economic advantage of this type of heat recovery is that the heat source costs nothing, and the recovery equipment is not as expensive as that of the topping cycle.

2. Decision-making Practices

Energy decision-making processes for the Steel Plant have been prioritized in the organization so that the Power Department reports directly to the Technology Department. This will assure the plant's energy management program will receive much stronger support from management and keep the energy efficiency drive alive, making it an important part of the plant performance indices.

The staff at Ostrowiec have shown much improvement in evaluating projects using economic techniques since the initiation of the Industrial Energy Efficiency project in April 1991.

3. Energy Management Practices

At the beginning of the April 1991 audit, management practices in the plant did not encourage employee involvement in energy conservation issues. Managers and supervisors appeared reluctant to express their views and to identify energy-saving opportunities in the presence of their bosses.

However, the energy management team at the plant is now committed to measuring the benefits of the instruments being installed in their plant as a result of the Audit Team recommendations. The plant has shown great achievements in energy management since International Resources Group's April 1991 audit. The Power Department took full responsibility implemented a variety of programs in a timely manner; results are evident.

The following specific projects were implemented with funding and/or technical assistance from the IRG Energy Audit Team and the Industrial Energy Efficiency Project:

- On-line Load Management and Optimization System (OLMO)

  The Team was pleased to see the OLMO system was commissioned and produced the short-term payback as predicted within the time frame given. The plant has reduced its electric demand by 9,000 KW, saving $10,000/month.

- Off-line Gas Load Management

  This program is in the process of commissioning, and the potential for savings is very impressive.

- Reorganization

  Before the reorganization, the Power Department was under the Energy section of the Technology Department. After the reorganization, the Power Department was moved directly under the Technology Department. This direct linking proved the management had placed extra emphasis on the energy management program within its organization.

- Integration of District Heating Plant

  Management is studying options for supplying thermal energy to the local city district heating system. This will utilize capacity that otherwise may sit idle.

4. Recommendations

1. Technical Assistance

Specific technical assistance projects to be considered include:

- OFF-LINE GAS LOAD MANAGEMENT

  This program was in the process of being commissioned when the Team visited in October 1991. Potential savings are impressive.

- INTEGRATION OF DISTRICT HEATING PLANT

  A feasibility study should be started to find out the potential costs and benefits. IRG will follow up if possible.

- BOTTOM CYCLE - WASTE HEAT RECOVERY

  Waste heat recovery on all furnaces represents a very large opportunity for energy efficiency improvement.

2. Training

Training in economics and strategic planning is essential to enable management to establish an effective priority system for implementing energy-saving projects.

3. Financial Requirements

Ostrowiec is working on privatization, but is proceeding very slowly as is privatization in general throughout Poland. There are several reasons for this, but a very important cause seems to be that the ordinary Pole has little discretionary capital and is extremely reluctant to part with what he/she has. To make privatization attractive several things are needed:

- Create a "share" of something that the ordinary Pole can understand.
- Make the price of a "share" within comfortable reach.
- Assure liquidity of the "share".
- Reduce the perceived risk of investing.

APPENDIX IV

COMMENTS AND RECOMMENDATIONS - NITROGEN WORKS AT KĘDZIERZYN

1. Observations on Energy Efficiency

The Kedzierzyn Nitrogen facility (ZAK) is the second largest chemical production complex in Poland. The coal-fired cogeneration plant within the complex is over 30 years old and has a capacity of 123 MW.

While the plant is trying to improve efficiency, it is an uphill climb owing to the age of the equipment, the fact that the plant is burning coal of much poorer quality than it was designed for, and the fact that the facility does not have adequate instrumentation to measure efficiency.

2. Decision-making Practices

The Department of Technology and Energy at ZAK is in charge of researching and executing projects that will improve the energy efficiency of the plant. Moving some of the decision-making down in the organization will help to get more people involved in coming up with low cost/no cost ideas for energy efficiency improvement and will also help in getting them implemented. The staff has shown improvement in evaluating projects.

3. Energy Management Practices

A fairly strong energy management program exists at the Nitrogen Works in Kędzierzyn; high-level managers support and are committed to the program. The energy committee consists of the Vice Director of Production, Director of the Department of Technology and Energy, heads of each production department, Director of the Office of Design, the Director of the Department of Automatics, and other relevant individuals.

Energy measurements in the plant are taken by the results engineering group in the Department of Automatics. Energy balances, energy audits, verification, documentation, energy information management, plant load, and fuel optimization information are the responsibilities of the Department of Technology and Energy, which is associated with the cogeneration plant.

4. Recommendations

1. TECHNICAL ASSISTANCE

Specific technical assistance projects that should be considered include:

- NEW NITRIC ACID AND FERTILIZER PLANT

This project is needed not only for the sake of energy efficiency, but also for eliminating a serious air pollution source. Two stacks are emitting yellow flue gas that contains 2,000 ppm of NO_x and which can be seen miles away.

- NEW COGENERATION PLANT

The existing power plant is too old to justify investment in any permanent energy efficiency or desulfurization measures. It may be optimal to build a new cogeneration plant with all new combustion controls and flue gas cleaning facilities. This project has been included in a World Bank study.

- GAS-FIRED COMBINED-CYCLE COGENERATION PLANT

The long-term energy policy for Poland will be centered around coal. In the long term, coal gasification appears to be a viable option for future Polish electric power plants. However, in the near term, the IRG Audit Team recommends Poland adopt the use of combined-cycle gas turbine cogeneration power plants.

The primary justifications for this policy are:

- Combined-cycle gas turbines can be converted to burn coal gas when necessary at a later time;

- Combined-cycle gas turbine plants have the highest fuel efficiency of all other fossil fuel-fired plants and produce the most electricity per unit of fuel;

- Poland already has the district heating systems in place to take advantage of the thermal energy outputs from these cogeneration plants;

- The technologies for gas-fired combined-cycle cogeneration power plants have existed for years, and risk is minimal; and

- The Kędzierzyn facility is located in the Silesian coal mining region and has the economic advantage of being near the mine mouth. In addition, a coal storage/handling facility and an ash management program already exist. These programs will be helpful when the turbine fuel is switched from natural gas to coal gas.

Currently, all natural gas is imported from the former USSR. However, the World Bank is cooperating with the Polish authorities on developing domestic resources. Alternative sources of imported gas, Norway and Algeria, are also mentioned in Poland.

At present, the Nitrogen Works sells hot water to the local district heating network. There is an existing district heating plant at Blachownia, only 11 km away. The boilers at Blachownia and the Nitrogen Works are both very old and need to be replaced soon.

One proposal is to build one combined-cycle gas fired cogeneration plant to replace both the cogeneration plants of Blachownia and the Nitrogen Works. In addition to the

economic benefits of high efficiency (both energy and labor), the environmental benefits of this project are significant: over 1.5 million MT of coal per year will not have to be burned in this highly polluted area.

The management of the Nitrogen Plant is very interested in looking into this proposal further in conjunction with the fluidized bed combustion boilers study.

2. Training

Training in economic analysis and strategic planning are again needed to understand what financial institutions require for financing energy projects. One of the key factors is how costs should be split between electric energy and thermal energy. This can be very complicated and not easy to comprehend. Usually, electricity is valued at 2 - 3 times the energy in steam.

3. Financial Requirements

Kędzierzyn is in the process of being privatized, although the transition has been slow. At the present time, the Kędzierzyn management cannot give further details about the privatization other than to indicate that the plant is disengaging from a number of local obligations which it subsidizes.

The management is excited about the prospect of becoming a private enterprise and understands operations must remain very competitive on an international scale attract investment money. However, management also recognizes it will not be easy to remain competitive with old technology and equipment.

Several U.S. companies have expressed interest in the opportunities represented by both the Kędzierzyn and Włocławek Chemical plants.

APPENDIX V

COMMENTS AND RECOMMENDATIONS - COGENERATION PLANT NO. 2 AT LÓDŹ

1. Observations on Energy Efficiency

The technology and equipment at the Lódź cogeneration plant are very old. There is little instrumentation, monitoring or control of pollutants, and no automatic control systems at this plant. However, the plant is responding rapidly to the new emphasis on energy efficiency in Poland.

The Audit Team observed the boilers were operating at excess air levels in the range of 26 - 42%, while efficient operation runs between 12 - 20%. The plant has leaks and steam trap failure on high pressure steam lines. Although the insulation in the plant appeared to be in good condition, there were a number of instances of places, particular pipe joints, where the insulation had deteriorated.

The plant was responsive to suggestions regarding energy efficiency, and with the help of equipment purchased under the Industrial Energy Efficiency Project, is making improvements in overall energy efficiency.

2. Decision-making Practices

The plant encourages all employees to make energy efficiency improvement suggestions. A number of energy saving incentives are included as a part of the energy management program.

The management of the plant, however, needs some further training in economic decision-making practices, both to make decisions regarding energy efficiency investments, as well as to develop a comprehensive long-term strategic plan for the facility. Although the plant management already has a strong understanding of many of these issues, it would help if they received further training.

3. Energy Management Practices

The Lódź plant had a strong energy management program, which receives a high level of support from the plant management. Initiatives include:

- A portion of annual profits are set aside to provide incentive bonuses to employees;
- Bonuses are awarded for energy-saving suggestions that are put into practice; (Employees can earn up to 20% of their annual wages in bonuses.)

In addition to specific incentives, management requires all employees to attend seminars and training sessions on cost- and energy-saving issues. Moreover, every five years, each employee connected with operations must pass an examination which includes questions on energy-saving techniques.

The Thermal Power Company of Lódź has made several key steps related to long-term strategic planning. Of all the plants visited, Lódź has the best understanding of strategic planning.

4. Recommendations

1. Technical Assistance

Specific technical assistance projects that should be considered include:

- PREPARING A LONG-RANGE PLAN

  The Audit Team recommends preparation of a comprehensive long-range strategic/economic plan be a pre-condition for World Bank support of all major investments in this plant. It may be productive for the World Bank to support the development of long-range strategies for all enterprises in Poland eligible for foreign investments.

- REBUILDING ELECTROSTATIC PRECIPITATORS ON ALL BOILERS

  The plant is discharging seven times the permitted quantity of ash into the air. Management has developed a proposal to replace or rebuild the electrostatic precipitators on all nine boilers at a total cost of $23 million; the Audit Team suggests alternatives be examined before commitment of this substantial investment.

  As an interim measure, Plant No. 2 is exploring the injection of SO_3 into the flue gas to improve precipitator efficiency. This measure has the potential of increasing the precipitator efficiency by 15%, which would bring the plant emissions almost into compliance with regulatory limits. Use of higher quality coal in addition would probably bring the plant into compliance. This alternative is likely to be much less expensive than replacing or rebuilding all the precipitators.

- INSTALLATING OF AUTOMATIC CONTROLS ON BOILERS 4-6 AND 7-9

  The benefits of automatic controls include improved boiler efficiency, fewer interruptions of operations due to faster response conditions, and reduced need for labor.

- MODIFYING THE WATER PUMPS

  The Audit Team recommends modifying the water pumps responsible for pumping hot water to the district heating system, so that water flow can be controlled by varying the pump speed rather than throttling water flow at the pump outlet.

2. Training

The personnel at Plant No. 2, although relatively knowledgeable, would benefit from additional training in economic project evaluation. Training should include calculating:

- return on investment;
- net present values;
- discounted cash flow; and
- Sensitivity.

Training key personnel to use these techniques will help the Thermal Power Company to analyze alternatives and prioritize project options. Resources should be devoted to additional formal training in strategic planning to improve their ability to develop strategic plans.

APPENDIX VI

COMMENTS AND RECOMMENDATIONS - LĘG THERMAL POWER PLANT AT KRAKÓW

1. Observations on Energy Efficiency

Although the management at Łęg was concerned about energy losses and monitored operations in order to minimize losses, no formal energy management program had been established to address energy savings issues throughout the plant. Following the initial meeting with the plant in February 1991, low-cost and no-cost energy savings projects were initiated almost immediately. When the Audit Team arrived in April 1991, many of these projects were already underway. Examples of these project include repair of steam pipe insulation, steam leaks, and broken windows.

- Individual initiatives directed at improving energy efficiency include:

  - Daily analysis of heating value of coal;
  - Monitoring and evaluation of steam losses;
  - Calculation of fuel consumption per unit of electrical or thermal energy produced; and
  - Development of control parameters for turbines and boilers.

2. Decision-making Practices

Plant management and professional staff had limited experience with applying techniques for economic evaluation and strategic planning. Thus, operations at the Łęg plant will benefit substantially if key managers receive formal training in strategic planning.

3. Energy Management Practices

The Łęg Thermal Electric Power Station was well managed, and the facilities were neat and relatively clean. There were no obvious signs of neglected maintenance, and the insulation throughout the plant was well maintained after the initial visit.

4. Recommendations

1. <u>Technical Assistance</u>

Specific technical assistance projects that should be considered include:

- ADD STEAM BOILER/STUDY DEMAND SITUATION

  Łęg plans to add a large steam boiler of a similar size as the present Boilers No. 1 - 4 with an extraction turbine. The boiler will be equipped with devices to control emissions of SO_3 and NO_x.

The Audit Team recommends the projected future demand situation be carefully defined before support is given to the proposed expansion. The resources may be used more productively to upgrade the existing facilities.

- EQUIP FOUR LARGE BOILERS WITH AUTOMATIC CONTROLS

  At present, all adjustments to operating conditions are done manually. Essentially all data needed for automatic control are available in the control rooms; however, additional instruments and electronics are needed to automate this system effectively. A rough estimate of the cost is $200,000 per thermal block.

- CONTINUE DEVELOPMENT OF A GAS-TURBINE UNIT

  Continue the development of a gas-turbine topping unit to one of the thermal blocks and equip with automatic process controls.

  A preliminary study of a completely automated combined-cycle cogeneration block has been made and looks promising. The proposed project would involve some of the equipment manufacturers in financing.

2. Training

Training of key personnel to use economic techniques to evaluate projects would be helpful to management, ultimately improving management ability to analyze investment alternatives and prioritize project options.

3. Financial Requirements

The plant is working on privatization and has had one offer for a joint venture. The management plans to allow employees to own part of the plant by putting in a portion of their salary for stock. However, privatization proceeds very slowly, as previously mentioned in the Ostrowiec Financial Requirements.

APPENDIX VII

COMMENTS AND RECOMMENDATIONS - WOLA DISTRICT HEATING PLANT AT WARSAW

1. Observations on Energy Efficiency

The boilers at Wola are operating at very high excess air levels. For example, the measured excess air levels in Boilers No. 2 and No. 4 were more than 50%; these are inherently inefficient because of antiquated burner design. The plant is well aware of the changes that are needed, but presently lacks the capital to pay for them.

2. ENERGY MANAGEMENT PRACTICES

Wola does not appear to have a formal program to emphasize energy saving. The Production Manager is responsible for *ad hoc* energy management activities. Activities to date include:

- Energy consumption measurements;
- Fuel oil consumption monitored daily;
- Electricity consumption is monitored monthly;
- Thermal energy production is monitored daily;
- Energy consumption per boiler is calculated and analyzed; and
- Data is correlated regularly to compare overall plant performance with goals.

3. Recommendations

1. Technical Assistance

- LONG-RANGE STRATEGIC PLANNING

  In cooperation with other plants supplying the Warsaw District Heating System, Wola appeared to have given much attention to the development of a long-term strategic plan. The Audit Team recommends resources be devoted to additional formal training in strategic planning to improve upon corporate capabilities in this area.

  If developed in cooperation with other plants in the Warsaw District, a comprehensive strategic plan could guide the investment of resources and help assure the most efficient (and profitable) supply of thermal energy to the District.

2. Training

The personnel at Wola, as in most plants, appeared to have little understanding of techniques commonly used in the U.S. to evaluate projects. These methods include calculating:

- return on investment;
- net present values;
- discounted cash flow; and
- Sensitivity.

Training key personnel to use these techniques would help the Wola District Heating Plant to analyze investment alternatives and prioritize projects.

APPENDIX VIII

COMMENTS AND RECOMMENDATIONS - BLACHOWNIA COGENERATION PLANT AT KĘDZIERZYN

1. Observations on Energy Efficiency

The boiler efficiency at Blachownia is below design value, primarily due to combustion conditions, air leakage around the pre-heaters, poor quality fuel, and unreliable controls. There are few opportunities to improve energy efficiency in the turbine area of the plant, since although fairly old, the turbines run well.

2. Energy Management Practices

The housekeeping at Blachownia, however, was in extremely poor condition. Yet the managers and administrators of this facility were obviously competent and capable. The Audit Team therefore concluded that there is a fundamental need for more direct communication between management and the workforce, to guide the operating personnel toward quality and excellence in all activities.

3. Recommendations

1. <u>Technical Assistance</u>

- CONDUCT STRATEGIC ANALYSIS OF BLACHOWNIA

  The Audit Team recommends a broad strategic analysis of Blachownia's future be undertaken before any long-term investment commitments are made. Points that should be considered include:

  - Plant age. Almost every instrument and piece of equipment must be replaced if the plant is to be economically viable in a competitive environment.

  - Blachownia presently supplies steam to a small nearby chemical plant, but none to the City District Heating System. Given that demand equals less than 50% of Blachownia's present capacity, the analysis must consider whether the future operation of Blachownia is economically justified.

  - The large chemical plant on the other side of Kędzierzyn-Kozle has its own power generating plant and supplies steam to the local District Heating System. The analysis should evaluate whether both the chemical facility and Blachownia are required to meet local energy needs.

2. Training

The Audit Team recommends Blachownia institute a mandatory training program, supported by incentives and penalties, directed toward establishing high standards of performance among the entire workforce.

An extension of this training should focus on energy-saving opportunities and should include recognition for a variety of energy-saving activities, and provide monetary awards to employees who make significant individual contributions to energy conservation in the plant.

3. Financial Requirements

Since capital is short and very expensive, a program similar to the one described in the Łódź plant might be appropriate.

APPENDIX IX

RECOMMENDATIONS FOR A LONG-TERM ENERGY EFFICIENCY PROGRAM

A. NEED FOR TECHNICAL ASSISTANCE

There is a need to update and modernize technology and equipment throughout Polish Industry, before Poland can compete in world market. However, priorities must be established and an implementation strategy formulated for accomplishing these tasks. A study to evaluate technical assistance and investment priorities is recommended.

B. TRAINING PROGRAM

There is a need to establish training seminars for plant managers to assist them in the development of energy efficiency programs, and to improve skills in the areas of economic project analysis, investment project evaluation, and long-term strategic planning. Finally, managers need further training to evaluate new instrument and automatic control systems.

C. FINANCIAL ASSISTANCE PROGRAM

A general consensus exists that Poland has a need for private venture capital investment. However, private power generating ventures will not gain popularity and have an impact until the electric power price structure and other institutional obstacles are resolved to the satisfaction of western investors.

Similarly, until the energy price situation stabilizes in Poland, many energy-intensive industries may have difficulty in attracting foreign capital investments. Consequently, public sector assistance, from bilateral sources such as the Agency for International Development, and from multilateral sources, such as the World Bank and the European Bank for Reconstruction and Development, will be fundamental sources of financial assistance for the region.

International donors interested in smaller, technical assistance projects would be ideal for providing financial assistance in the area of feasibility studies, technical and economic training, etc. Donors interested in larger infrastructure projects would be well suited to provide loans/grants for the major energy efficiency capital investments required in Polish industry. In particular, the replacement of antiquated processes and plants should be a priority of this type of donor project.

D. DEVELOPMENT OF PRIVATE ENERGY SERVICE ENTERPRISES

At this stage, energy cost issues and governmental regulations relating to energy enterprises are not clear enough to encourage shared saving enterprises or joint ventures. However, vendors and manufacturers of pollution monitoring and control instruments, steam traps, waste heat boilers, turbine generator sets, and measuring and

automatic control systems are currently in a strong position to move in and set up joint ventures with local firms.

Moreover, energy measuring and auditing services are likely to develop from existing state run organizations. A market definitely exists for the services of this type of enterprise. One example is Energopomiar of Gliwice. Energopomiar is a forty-year-old institute that has been active in servicing the electric power industry since the 1950's. In September of 1991, Energopomiar was privatized, with the intention of offering technical and consulting services to the power industry throughout Poland as a commercial for-profit enterprise.

The International Resources Group Audit Team worked closely with Energopomiar during its Poland mission, providing further exposure of Energomiar's presence to this market. Through this mission, several equipment vendors from the U.S. were introduced to Energopomiar, and are considering making Energopomiar a local service agent for their products. Johnson-Yokogawa and E2 Technology are arranging technical seminars to train Energopomiar personnel to provide this type of service.