

Energy Efficiency Business Opportunities in Ukraine:

**Report on the Mission of the
U.S.-Ukrainian Expert Working Group on
Energy-Efficiency Options for Closing the
Chernobyl Reactors**

March 1995



Energy Efficiency Business Opportunities in Ukraine:

Report on the Mission of the U.S.-Ukrainian Expert Working Group
on Energy-Efficiency Options for Closing the Chernobyl Reactors,
October 17 to November 18, 1994

M. Evans
J.W. Currie
N.V. Rapsoun
J.D. Duane
K.E. Nelson

March 1995

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Washington, DC 20024

FOREWORD

This report was prepared at the request of the U.S. Department of Energy (DOE). It was developed as part of DOE's effort to support the Government of Ukraine develop alternatives to the Chernobyl nuclear power plant. U.S.-Ukrainian cooperation toward that goal was initiated in April of 1994 during Deputy Secretary of Energy William White's visit to Ukraine. Subsequently, the United States and the other members of the G-7 countries have jointly agreed to assist Ukraine in closing the reactors. Battelle, Pacific Northwest Laboratory prepared this report to brief a DOE delegation to Ukraine, led by Deputy Secretary White from November 10-12, 1994.

Ukraine ranks among the least energy-efficient nations in the world as a result of its former system of centralized economic planning. At the request of DOE, the Pacific Northwest Laboratory (PNL)* in September identified a preliminary set of energy-efficiency opportunities which could save more power than is produced at Chernobyl. DOE requested this current effort to identify specific investment opportunities that might serve as an *initial* but significant response to the need to develop substitutes for the 1,800 megawatts (MW) of electric power capacity that remains operable at Chernobyl. It was not the purpose of this effort to determine ways to replace the entire output of Chernobyl, but rather to evaluate the feasibility of using efficiency as an alternative. That is, the opportunities identified in this report demonstrate the reality of energy-efficiency opportunities, and, we hope, illustrate real business opportunities for American firms.

The expert team visited seven major industrial facilities and asked three key questions. The team asked if cost-effective energy-efficiency options were present in the facilities, whether the firms were likely to survive the current economic crisis in Ukraine, and whether the firms had access to hard currency with which they could pay for products and services. The team identified four major industrial installations that satisfy these criteria. The firms include Severodonetsk Azot Manufacturing Association, Dniprovsky Iron and Steel Plant, Krivorozhstal Combinant and Lisichansk Petrochemical Plant. The opportunities at these enterprises, and the other firms we visited, are described in this report. We emphasize that these firms do not by any means represent the only energy-efficiency business opportunities in Ukraine, but could serve as hosts for initial projects.

The delegation also held discussions with regional and municipal authorities in Kiev, Lviv, and Odessa, and with national authorities responsible for energy efficiency. These discussions focused on devising integrated resource plans for energy production and consumption in the regions, and on establishing energy efficiency loan funds. DOE is currently formulating policy measures for supporting U.S. energy-efficiency business in Ukraine.

William U. Chandler
Director, Advanced International Studies Unit

* Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

ACKNOWLEDGMENTS

This report is based on the findings of a visit to Ukraine in October and November 1994 by Meredydd Evans and J.W. Currie of Pacific Northwest Laboratory (PNL), Jerry Duane of the U.S. Department of Energy, and Kenneth Nelson, President of Kentec, Inc. Nikolai Raptoun, Executive Director of the Ukrainian Center for Energy Efficiency and Ecology, coordinated the visit from the Ukrainian side and led the delegation on the visits to Ukrainian enterprises. The Ukrainian Ministries of Economy and Industry provided expertise, energy data and logistical support. We would particularly like to thank Viktor Parkhomenko and Mikhail Ruban from the Ministry of Economy for their advice and participation in our effort.

PNL would like to thank Deputy Secretary of Energy Bill White for his leadership in the effort to identify alternatives to operating the nuclear reactors at Chernobyl. We are also grateful for the leadership and support of Terry Lash, Director of the Office of Nuclear Energy, and Christine Ervin, Assistant Secretary for Energy Efficiency and Renewable Energy at the Department of Energy. We owe special thanks to Colette Brown, Brian Castelli, Warren Chernock, Jerry Duane, Elaine Guthrie, Greg Kats, Michael Moore, and Kristin Suokko of the Department of Energy. We would also like to express our appreciation for the cooperation of the Department of State and the Agency for International Development, especially that of Steve Miller and Robert Ichord.

CONTENTS

FOREWORD	iii
ACKNOWLEDGMENTS	v
INTRODUCTION	1
Current Opportunities	1
The Business Environment in Ukraine	2
Enterprises Offering Significant Opportunities	4
DNIPROVSKY IRON AND STEEL PLANT	5
Dniprovsky Facility Description	5
Dniprovsky's Organizational Structure and Financial Information	6
Dniprovsky's Markets and Exports	7
Dniprovsky's Energy Characteristics	7
Dniprovsky's Energy Efficiency Targets	8
Options for Developing Joint Business Projects with Dniprovsky	9
KRIVOROZHSTAL COMBINANT	11
Krivorozhstal Facility Description	11
Krivorozhstal Organizational Structure and Financial Information	11
Krivorozhstal's Markets and Exports	12
Krivorozhstal's Energy Characteristics	12
Krivorozhstal's Energy Efficiency Targets	12
Options for Developing Joint Business Projects with Krivorozhstal	13
LISICHANSK PETROCHEMICAL PLANT	15
Lisichansk Facility Description	15
Lisichansk's Organizational Structure and Financial Information	16
Lisichansk's Market and Exports	17
Lisichansk's Energy Characteristics	17
Lisichansk's Energy Efficiency Targets	18
Options for Developing Joint Business Projects with Lisichansk	18
SEVERODONETSK AZOT MANUFACTURING ASSOCIATION	21
Azot Facility Description	21
Azot's Organizational Structure and Financial Information	21
Azot's Markets and Exports	22
Azot's Energy Characteristics	23

Azot's Energy Efficiency Targets	24
Options for Developing Joint Business Projects with Azot	24
PETROVSKY METALLURGICAL PLANT	27
Petrovsky Facility Description	27
Petrovsky's Organizational Structure and Financial Information	27
Petrovsky's Markets and Exports	28
Petrovsky's Energy Efficiency Targets	28
Options for Developing Joint Business Projects with Petrovsky	28
ZAPOROZHSTAL COMBINANT	29
Zaporozhstal Facility Description	29
Zaporozhstal's Structure and Financial Information	29
Zaporozhstal's Energy Characteristics	30
Zaporozhstal's Energy Efficiency Targets	30
Options for Developing Joint Business Projects with Zaporozhstal	30
ZAPOROZHKOVS JOINT-STOCK COMPANY	31
Zaporozhkoks Facility Description	31
Zaporozhkoks' Organizational Structure and Financial Information	32
Zaporozhkoks' Markets and Exports	32
Zaporozhkoks' Energy Characteristics	33
Zaporozhkoks' Energy Efficiency Targets	33
Options for Developing Joint Business Projects with Zaporozhkoks	34

INTRODUCTION

The largest short-term opportunities for energy efficiency improvements in Ukraine lie in the industrial sector. Industry accounts for 70% of total energy consumption in Ukraine and individual enterprises can consume as much energy as entire cities. Industrial enterprises also have access to hard currency, which will facilitate financing of energy efficiency measures.

We identified four enterprises as promising business partners or potential purchasers of energy efficiency equipment and services. These enterprises include two metallurgical plants in the Dnipropetrovsk Oblast, and a chemical plant and petrochemical plant in the Luhansk Oblast. We believe that these plants have a good chance of surviving Ukraine's ongoing economic restructuring. The potential for savings at each plant is large because energy consumption is high and current industrial processes and practices are inefficient. The management teams at these enterprises supported the idea of energy efficiency improvements at their plants and are willing to cooperate with U.S. companies in this area. Each enterprise we recommend has access to large amounts of hard currency because of exports, which means that business is feasible.

Current Opportunities

Ukraine offers a significant energy efficiency market for U.S. companies. Several European and Ukrainian companies are tapping this market, despite the difficulties of working in Ukraine, but very few U.S. companies are involved. Every plant visited by the joint U.S.-Ukrainian team has contracts with other companies and institutions to buy energy efficiency equipment or services. These range from research on energy losses to purchases of controls and efficient turbines for cogeneration.

The potential market is large because Ukraine uses energy inefficiently, as do most other former socialist countries. This waste of energy hinders the nation's economic recovery. In the past, the state supplied energy cheaply to boost production. Today, much of Ukraine's energy comes from Russia and Turkmenistan, which are not willing to subsidize Ukraine's fuel purchases. Import prices have gone up significantly and are continuing to rise. The Ukrainian Government cannot afford to subsidize imports. As a result, it does not buy enough fuel and enterprises must find their own suppliers or cut production. Furthermore, Russia and Turkmenistan have reduced gas and oil shipments to Ukraine periodically because Ukraine does not always pay its energy bills. Thus, Ukrainian enterprises have two large energy problems: insufficient supplies and huge energy bills, both of which are related to lack of money to pay the real costs of energy. Today, even at partially subsidized prices, energy costs account for 30-70% of production costs at most large enterprises. Ukrainian enterprises are coming to realize that energy efficiency is important in order to stay in business.

One of the biggest transformations in Ukraine since the fall of the Soviet Union is the changing relationship between enterprise managers and the state. During Soviet rule, the industrial ministries such as the Ministry of Industry were essentially monopoly conglomerates which ran all the enterprises in their sector. Today, this is changing. While most enterprises are still nominally under the control of ministries, the management

knows that the ministries can supply little besides additional burdens. Many of the managers we interviewed said they wanted their enterprises to be privatized and that the state was counterproductive in its management of their affairs.

In October 1994, Leonid Kuchma, the new Ukrainian President, launched a major economic reform program. This year the government has begun large-scale privatization of industrial enterprises. Some housing and many small enterprises have been privatized, and privatization in these sectors will be accelerated. Enterprises will have more freedom to export their goods and earn hard currency: export licensing requirements were abolished by decree on November 1, 1994, although there are still some problems with the implementation of this decree. This means that enterprises can legally export most goods without the time-consuming process of obtaining licenses. Also, the government raised the official exchange rate to the level of the commercial exchange rate. This means that enterprises which export will no longer lose money because of unfavorable exchange rates when they are required to exchange hard currency earnings into kupons, the Ukrainian currency.

Perhaps the most positive indicator that the new government supports energy efficiency is that the first law which the new parliament passed was the Law on Energy Conservation. In addition, former President Kravchuk last spring issued a decree on corporatizing the power sector, excluding nuclear energy. The government is implementing this decree, and within 3 to 5 years, the power sector will be completely restructured and almost entirely privatized, if the reform proceeds as planned. By the second quarter of 1995, electricity prices will account for the full price of imported fuel, an aggressive price reform schedule. This must be done in conjunction with privatization for the prices to have a full impact on Ukrainian enterprises, but the government seems to understand this. Otherwise, the Ukrainian accounting system will allow enterprises to simply pass the increased costs onto their client ministries, thus shifting the subsidy and distorting the incentives for efficiency.

The Business Environment in Ukraine

One of the biggest hurdles which Ukrainian enterprises will have to overcome when adapting to a free market is getting rid of their antiquated accounting system. Ukrainian state enterprises use the Soviet accounting system, with a few modifications to comply with recent laws.

In this accounting system, capital is not considered a cost. It is basically a subsidy donated by the benevolent state. Most enterprises still believe the state will help them with their capital improvements, although the successful ones have come to understand that they must finance their own modernization plans. Production costs are calculated as the sum of expenses for materials, energy, salaries and routine repairs. The profit margin is a percentage of the production costs, and the exact percent is negotiated with the state. The profit is used for many expenses which we would consider production costs: taxes, wages, and social infrastructure, such as worker housing, schools and hospitals. Profits are also spent on capital investment funds, and it is these resources that the enterprises use to fund most energy efficiency measures. Prices for goods sold according to state contracts are simply calculated by adding production costs and profit. These prices must be declared and registered with the state, and obviously the state has a good bit of influence

over the prices declared, although in theory they are determined by the enterprises. The situation is somewhat different when goods are not sold to the state. If they are sold to commercial entities or any foreign entities, including Russian ones, then the enterprises have much more input on the prices and usually base them on some mix between market demand and production costs.

The bottom line of the state procurement system is that there are strong disincentives against efficiency. The lower the production costs, the less profit an enterprise earns. Thus the more energy the enterprise consumes, the more profits it receives. Also, many enterprises are worried that if they use energy more efficiently, their energy quota will go down, meaning that they must again cut production despite their investment. U.S. companies must be aware of these issues to successfully conduct business in Ukraine. Simple economic arguments are not always enough to convince Ukrainian enterprises to invest in efficiency.

Another major hurdle which enterprises will have to overcome relates to the social infrastructure they support and the large number of workers they employ. The enterprises we visited all pay for social infrastructure, such as schools and hospitals. The enterprise managers still feel that it is their duty to provide these services to their workers, but most would like to sell some of the enterprise holdings because they are so expensive to maintain. The Petrovsky plant tried to transfer ownership of its housing to the City of Dnipropetrovsk; in two years, the enterprise was able to transfer only two buildings and then gave up. The cities do not want the buildings because they are expensive to maintain. It is difficult to privatize them because, in the case of housing, the residents know that they will have to pay much more for utilities and maintenance and therefore are usually not interested in privatizing their enterprise-owned apartments. It is even more difficult to find buyers for stadiums, schools and hospitals. Energy efficiency will be important in decreasing the costs of maintaining and running these buildings so that they can be privatized or sold off.

While enterprises express some willingness to sell off their "social" property, they are usually unwilling to fire workers. They fear worker revolts if employees are fired en masse and management feels a paternalistic responsibility to take care of its employees. The Ministry of Industry supports keeping more employees on the payroll than is necessary. It is willing to subsidize it because labor at most enterprises makes up no more than 3 to 4% of production costs currently. However, labor costs are so low because in the last few years, wages have decreased and enterprises often do not pay full wages to the workers.

The third hurdle for enterprises relates to the quality of work at enterprises and the attitudes of employees. At Ukrainian industrial enterprises, maintenance is a low priority. Equipment is not serviced regularly so it is usually run until it completely fails, which means its useful life is much shorter than it should be. This is in part because in the past, equipment was subsidized by the state, with little direct cost for the enterprise. Maintenance and repairs, however, are paid for by the enterprise. Enterprise managers know that in today's economic climate they cannot expect the state to pay for modernization of their enterprises, but they have not yet been able to change the behavior of workers responsible for maintaining equipment.

Enterprises Offering Significant Opportunities

We recommend four of the seven enterprises we visited as initial partners for energy efficiency business arrangements. The four we identified are Dniprovsky Iron and Steel Plant, Krivorozhstal Combinant, Lisichansk Petrochemical Plant, and Severodonetsk Azot Manufacturing Association. The other three plants--Dniprovsky Iron and Steel, Petrovsky Metallurgical Plant, and Zaporozhstal Combinant--have great technical potential for energy efficiency improvements, but they were either not economically viable or management was not supportive of energy efficiency improvements.

In selecting the enterprises, we considered total energy consumption, and level of exports, which indicates access to hard currency. When we met with the enterprises, we evaluated the attitude of the management, their capabilities, and their vision. We discussed the financial viability of the enterprise, including the market for their products, their export potential, and the amount of state support they receive (which shows in part if the state feels this enterprise will survive). We discussed the condition and type of the equipment at the enterprise, which helped us understand whether the enterprise was competitive on the world market and how large a potential there was for energy efficiency. We toured each facility, which helped us understand the condition of the equipment, the level of maintenance and any major problems which existed in the production facilities. We also talked to the energy managers about energy consumption and the types of energy efficiency measures which they thought would be most effective. In general, we found the energy managers to be very knowledgeable and to have ready suggestions for improving efficiency.

In the next section of this report, we describe the enterprises we visited and the reasons for our recommendations on each one. The four recommended enterprises are described first, followed by descriptions of the three plants not recommended.

DNIPROVSKY IRON AND STEEL PLANT

Dniprodzerzhinsk, Ukraine

We spoke with the General Director, Yuri Borisov, and the Chief Energy Manager, Leonid Misura, as well as the chief accountant, the deputy chief engineer and the chief engineer of automatization.

Dniprovsky Facility Description

Dniprovsky Iron and Steel Plant is the fourth largest steel plant in Ukraine. The plant was originally built 105 years ago and has been reconstructed several times since. The enterprise makes several metal products, the main ones being cast iron, steel and billet steel.

In 1991, this company began a major modernization program, financed with its own profits. The enterprise has bought three continuous casting machines. During our visit, one machine was functional, the second was being installed and a third was to be delivered in mid-November. The equipment for these machines was manufactured in Ukraine and Russia. The enterprise is also purchasing new converters from an Austrian company and is eliminating several old plants, including an open hearth furnace and a blast furnace (four blast furnaces will remain). It also plans to modernize a plant which makes rails for railroads. The enterprise began the modernization because it saw the economic problems ahead and wanted to adapt to new markets. The modernization program will cost \$116 million, of which \$82 million has already been paid. Another payment was due the day after we visited the plant, but the director said he would not be able to make the payment because the government was taking over two-thirds of his hard currency earnings because of the difference between the official and commercial exchange rates. These rates were unified in late October 1994. The director was enthusiastic about the unification of exchange rates. The enterprise has set up a system to ensure payments on the equipment, through a Cypriot insurance company, which the enterprise will then repay later.

After the modernization, the plant will annually produce 2.8 millions tons of cast iron, 5.5 million tons of steel (up from a current capacity of 3.5 million tons), and 4.5 million tons of billet steel. The director felt that the modernization would increase the competitiveness of his products, although when we asked him where his new markets would be for the expanded production, he did not demonstrate that his enterprise had completely analyzed the market potential. Currently, the plant is running at 70% of capacity because of a shortage of raw materials (primarily coke), and a shortage of electricity. In 1993, the plant ran at 82% of capacity.

There are 23,000 employees at the enterprise, 17,500 of which are involved in metallurgical production. The remainder work in other businesses the enterprise owns. Employment has not changed despite the drop in production.

Dniprovsky's Organizational Structure and Financial Information

The plant is owned by the state, although the director openly ridiculed state management (in the presence of his bosses from the Ministry of Industry). The director said that he would be very happy if the state privatized his enterprise and that if the state would only leave him alone, most of his problems would be solved.

Yuri Borisov clearly stated that Dniprovsky's accounting system, like that of all other enterprises, was irrational and that even if he gave us financial data about his plant, they would not correspond to Western accounting principles. He did have his Chief Accountant provide us with all the information she could. The director was familiar with market economics and Western marketing practices. He has travelled extensively abroad.

The total revenue of the plant is 6.5 trillion kupons (\$144 million)¹ annually, which includes both the "profits" and production costs. The enterprise made a profit of 3.7% from January-October 1994. This estimate seems much more realistic than the 20 to 30% profit which most enterprises claim to make. The director said, however, that regardless of what his books say, he knows his enterprise has debt. Because of the strange accounting system used in Ukraine, the debt does not show up in the enterprise's accounting balance.² The accountant said that the enterprise has no large hard currency debts, but it does have debts from unpaid gas and electricity bills. The energy manager confirmed that the enterprise was behind on energy payments. This is the only enterprise which admitted not paying all its energy bills; according to the Ministry of Power and Electrification, virtually all major enterprises owe back-payments for electricity and gas.

The "profit," as elsewhere in Ukraine, is used to cover some operating expenses. 22% of the profit goes to pay profit taxes; 61% of it is used to pay for the modernization and the rest is for social purposes, such

¹The exchange rate used to calculate the enterprises' profits and revenues in this report is 45,000 kupons to the dollar, which was the exchange rate for most of 1994. During the fall of 1994, the kupon was seriously devalued; on November 18 it was sold at a rate of 140,000 to the dollar, although since then it has stabilized at a level of 130,000 to the dollar. We chose the lower exchange rate because the enterprises gave us their earnings from January to October 1994, when this rate was in effect. It is important to note that most of these profits and revenues are in kupons and cannot easily be spent on foreign purchases.

²Until October 27, 1994, when exchange rates were unified, enterprises were required to exchange much of their hard currency earnings into kupons at an unfavorable exchange rate. Exporting goods did allow enterprises to purchase foreign equipment through the government at this same official exchange rate. Thus, there is no simple system to list costs and revenues at Ukrainian enterprises. The accountant said that this enterprise had no substantial debt. Without a detailed audit, it would be difficult to understand how much debt, if any, the enterprise had incurred.

as financing vacation resorts, kindergartens, collective farms and other worker benefits, plus a portion of workers' salaries.

Production costs are primarily due to energy (70%), followed by raw materials (20%). Salaries account for only 3% of production costs, and the rest is for depreciation of equipment and miscellaneous expenses.

Dniprovsky's Markets and Exports

The plant exports almost 70% of its products: 30% to CIS countries, 12% to China, 3% to the U.S. and Canada, 3% to Western Europe and 22% to other countries primarily in the Middle East and Eastern Europe. Thirty percent of the products are sold within Ukraine, most of which are sales required by the Ukrainian government at set prices (the reformed version of quotas).

The enterprise is actively trying to expand its markets, particularly in the U.S. and Canada, and the director was planning to sign several sales contracts at the end of 1994. Dniprovsky has a marketing department with four employees; the director is also heavily involved in marketing. He would like to decrease sales to China because he feels that the plant's Chinese market is unstable. Also in September 1994, the enterprise decreased the export price of its billet steel from \$195 per ton to \$170 per ton in response to decreased demand, despite increasing production costs. These price reductions are putting pressure on the enterprise to cut costs. In fact, Dniprovsky is the only enterprise which we visited in which the management was immediately in favor of the idea of energy efficiency improvements.

Dniprovsky's Energy Characteristics

Seventy percent of total production costs are due to energy at the Dniprovsky Iron and Steel Plant. The energy manager provided us with a break-down of energy consumption, listing fuel and power used at each shop within the enterprise for one day. According to the enterprise's projections, energy consumption will decrease by 25% and the use of raw materials by 20% after the modernization is complete.

The peak electric demand of the enterprise is 225 MW at full capacity. The plant's power consumption in 1990 was two billion kWh. In 1994, annual power consumption will be about 1.2 billion kWh, accounting for the plant's drop in production. The peak capacity on December 22, 1993, was 160 MW and the peak on June 22, 1994, was 150 MW,³ indicating that the shape of the load at the enterprise is rather flat. This is important because Ukraine will soon adopt new tariffs which charge higher rates for peak electricity consumption.

Fifty percent of the power consumed is used at the oxygen plants. The rest is used primarily in the water supply shop and in heat exchangers at the cogeneration plant. The cogeneration plant produces 10% of

³ In the former Soviet Union, December 22 is used as the day with the highest peak and June 22 as the day with the lowest peak.

the electricity consumed at the plant. It burns natural gas and blast gas. Currently, there are ten boilers at the cogeneration plant and one more is under construction. Honeywell has installed controls at the cogeneration plant. The power factor at Dniprovsky was surprisingly low at 0.5 to 0.6, offering an opportunity for efficiency improvement.

At full capacity, the heat consumption at the enterprise is 7.5 million GJ per year. No more than 15% of the heat produced is used to heat buildings; the enterprise does not supply residential buildings with heat. The management was not able to tell us the current heat capacity.

Dniprovksy's Energy Efficiency Targets

There are many other opportunities for energy savings at Dniprovsky. The electric motors and drive systems are inefficient and consume a large portion of the electricity at Dniprovsky. More efficient motors and variable speed drives could save much energy. Likewise, the steam lines at Dniprovsky waste enormous amounts of energy because of poor insulation and the lack of quality steam traps. In addition, steam leaks are common. Better maintenance would help prevent this waste.

The enterprise's new continuous casting plant has large heat collectors on the melting vessels, but all of the heat recovered is vented to the atmosphere. This could be improved with better instrumentation and control. Similarly, operation of the cogeneration plant could be substantially improved with automatic boiler controls, improved control valves and better insulation. The enterprise has already purchased some controls for its cogeneration plant from Honeywell.

When dealing with energy conservation opportunities, however, it is important to note that Ukrainian operating and maintenance philosophies are not consistent with those used in U.S. plants. For the most part, Ukrainian industry tends to install equipment and run it until it fails and must be shut down for repair or totally replaced. Very little preventative maintenance or continuous upgrading is done. This is a long-term problem that must be addressed. The new continuous casting unit, for example, was computer controlled, with monitor screens showing temperatures and status of equipment. Although familiar with the system's capabilities and how to use them, the plant's staff did not participate in the design. It is doubtful that the workers could easily modify the program to adapt to new conditions or, perhaps more importantly, recognize opportunities to expand the scope of the computer's application to solve new problems. When we visited the continuous casting facility, it was not operating. The engineers on site explained that this situation was very common. In fact, the plant usually only has between two and 10 meltings before it has to shut the equipment down. Thus, it never runs for more than a day before it must be shut down. In the U.S., similar plants can run for a month or longer continuously. One problem is with the refractory materials, which are of poor quality and quickly lose their ability to insulate. The resulting shutdown wastes energy because the furnaces must be completely cooled and then reheated. This replacement also wastes long periods of time. If the enterprise purchased high quality, foreign refractory materials, it would save energy and could produce more metal with less down time.

Dniprovsky also has two oxygen plants, one completed in 1964 and one in 1983 which together consume half of the power at Dniprovsky. Both could be made more efficient by improving compressors and motors as well as making modifications to the separation columns.

Options for Developing Joint Business Projects with Dniprovsky

The enterprise management would be willing to accept hard currency loans to pay for energy efficiency improvements. The enterprise would also be willing to exchange its product for new equipment, selling its metal through an intermediary. The general director felt that it would be difficult for the enterprise to provide large amounts of capital for a project because the enterprise has substantial commitments for modernization. It may be able to invest some of its own capital, particularly in a year when it has made the bulk of the payments for the modernization. The maximum payback time which Dniprovsky would be willing to accept is 3.5 to 5 years.

Dniprovsky seems to have a strong chance of surviving Ukraine's current economic downturn. The management is looking toward the future with competitiveness in mind. It is interested in finding innovative ways to cut costs, and in developing new markets. Most of the enterprise's products are exported, which shields it somewhat from the economic problems in Ukraine. We recommend this enterprise as one which U.S. companies should consider for investment and other business arrangements.

KRIVOROZHSTAL COMBINANT

Kriviyy Rih, Ukraine

Our visit was hosted by Vladimir A. Nechiporenko, Chief Engineer. We also met with the chief energy manager.

Krivorozhstal Facility Description

This is one of the largest metallurgical plants in Ukraine. At full capacity, the plant employs 37,000 people, produces 10% of all metallurgical output of the former Soviet Union and 25% of Ukrainian output. The annual output, at full capacity, is 12 million tons of pig iron, 12 million tons of structural steel, and 10 million tons of other steel products.

Current employment is 25,000 people, and employment has not changed although the plant is operating at only 50% capacity. As with other enterprises, Krivorozhstal owns not only the production facilities but the surrounding community infrastructure as well. The plant owns apartment buildings, schools, a 1,000-bed hospital, a 26,000-seat stadium and the football team. Approximately 15% of the employees supports the community infrastructure leaving 21,000 to 22,000 people working in production operations.

The plant has two blast furnace workshops with a total of nine furnaces, one open hearth furnace, three steel cast workshops, and ten rolling mills. Krivorozhstal's main products include wire, semi-finished pipe, structural steel, and small shaped steel of various dimensions.

The plant has a major renovation program under way and appears to have considerable support from the government. In December 1993, the plant let a contract worth approximately \$130 million to a West German firm for a casting mill. The contract was structured under a credit line with a German bank. The casting mill is currently under construction. The enterprise recently signed a second contract with a Dutch company to install a process for using coal dust as a substitute for coke. The Ukrainian government has guaranteed both contracts.

Krivorozhstal Organizational Structure and Financial Information

The plant is state-owned. The plant managers would like to completely privatize the enterprise and have suggested this to the Ukrainian government. Krivorozhstal's proposal is for roughly 20% foreign ownership of the enterprise.

At the current operating capacity of 50%, the reported "profit margin" is 20%. At full capacity, the profit margin was reported at 25%. Raw materials and energy expenses comprise about 85% of total current production costs.

Krivorozhstal's Markets and Exports

Krivorozhstal exports 50% of its products, but only half of which does it export directly. The rest it sells first to the government, and thus it does not earn hard currency from the sale. Most of Krivorozhstal's exports outside the former Soviet Union are to China, the Middle East, Turkey and Eastern and Central Europe. The products producing the greatest sales revenue are structural steel and cast iron. In general, the management would like to orient the enterprise more toward end-use products and consumer goods. Currently, the plant produces building materials for residential homes and single-car garages, along with a full range of industrial products.

Krivorozhstal's Energy Characteristics

Krivorozhstal uses several forms of energy, including electricity, natural gas, coke gas, blast gas, and fuel oil. The consumption of electricity and natural gas has decreased recently, resulting in lower output. The chart below describes the amount of electricity and gas consumed:

<u>% of Capacity</u>	<u>Electricity</u>	<u>Natural Gas</u>
50%	250 MW/hour	170,000 m ³ /hour
100%	450 MW/hour	250,000 m ³ /hour

There are three cogeneration plants with an installed electric capacity of 250 MW, all of which are in the industrial facility. About 90% of electricity use is for drive power. There are about 60,000 electric motors at the plant, half of which have a demand of greater than 50 KW. Most of the motors are very old. There are 24 large substations with 2 to 3 transformers at each. These transformers are also antiquated.

At full capacity, the enterprise consumes 400 tons of steam per hour. The plant has 250 km of steam lines, most of which are poorly insulated. Virtually all steam lines are above ground. The largest line is 400 mm in diameter. One steam line runs for four kilometers from the cogeneration plant to the first point of use. Only 20% of the condensate for the entire complex is returned. Three water treatment facilities are required to provide make-up water.

Krivorozhstal's Energy Efficiency Targets

Management has done little to implement energy efficiency measures at the plant. The focus for the future is on modernization and energy supply. The energy manager fully understood the potential opportunities in energy efficiency. He feels that upgrading steam turbines is a top priority. His second priority is to install new controls on the boilers.

The third area he mentioned, and one which we believe has great potential, is in decreasing heat losses from steam lines by insulating them and installing more steam traps. The enterprise does not appear to use steam

traps: either there are none or they are by-passed because they operate poorly. This could be an important source of savings because of the amount of steam lines at Krivorozhstal.

Other suggestions that the energy manager discussed include installing more efficient motors and drive systems as well as meters and gas analyzers.

Options for Developing Joint Business Projects with Krivorozhstal

The management at Krivorozhstal is interested in energy efficiency. The enterprise would consider sharing investment costs and savings. It would also entertain the idea of purchasing energy efficiency equipment with hard currency or in exchange for its products. The enterprise has a capital investment fund which it could use to pay for energy efficiency investments. In theory, Krivorozhstal is open to any mutually profitable energy efficiency improvements.

In summary, this plant seems to have support from the Ukrainian government. The management appears to understand what needs to be done to succeed and is open to new approaches that will improve the economic position of the enterprise. The energy savings potential seems significant. We believe that this is one plant which American companies should consider.

LISICHANSK PETROCHEMICAL PLANT

Lisichansk, Luhansk Oblast, Ukraine

We met with Yevgeny N. Bakulin (the Chief Engineer), the chief energy manager, and an accountant.

Lisichansk Facility Description

The Lisichansk refinery is relatively new. It was built in 1976 using foreign technology, mainly from Germany and Czechoslovakia. It is reportedly the largest refinery in Europe. The enterprise accounts for 40% of Ukraine's total refinery capacity. The refinery has the capacity to process 16 million tons of crude oil per year, but currently the plant is running at half capacity because of the lack of crude. The enterprise's production level was very unstable in 1994 and from January to April, the plant was completely closed much of the time. Since April, the refinery has run continuously, but at a decreased and fluctuating level. The company has recently upgraded its processes so that recovery (yield of desirable products) is at 67%, up from 35%, which means that the refinery needs less crude oil to obtain the same volume of products. In the near future, the enterprise would like to increase the level of recovery to 75%. This will require an investment of \$30 million.

In addition to gasoline, the refinery produces ethylene (which is sent to Azot where it is made into polyethylene), propylene, polypropylene, asphalt, and vacuum still bottoms. The enterprise built the asphalt plant with the help of an Austrian company. Lisichansk's polypropylene plant was built six months ago by an Italian company, Technimont. It is a turnkey facility, which means that the Italians built the entire plant and then turned it over to the Ukrainians. The polypropylene plant was supposed to pay for itself in four years, but is now shut down because of a lack of raw materials. Similarly, an ethylene plant, which a West German firm built, is not operating because of raw material shortages. The enterprise is using most of its available raw material to produce diesel and gasoline. Another unit at the enterprise is also inoperable because of an explosion earlier in the year; the enterprise managers did not mention this despite several questions on why production had dropped so much.

The plant's supply of crude oil is not stable. The oil pipeline which serves Lisichansk comes from Russia and Russia has periodically restricted Ukrainian crude supply because of non-payments. Ukraine pays \$90/ton (\$12.85/barrel) for Russian crude. The Ukrainian government buys the crude from Russia and then sells it to the Lisichansk refinery. In return, Lisichansk must sell an equivalent share of its products to the state, although the state is not Lisichansk's sole supplier.

The Russian Gazprom would very much like to obtain this enterprise in exchange for Ukrainian gas debts. The Ukrainian Government is strongly opposed to such a move and views this enterprise as important to Ukraine's national security. In fact, the refinery supplies much of Ukraine with oil products and its closure could have a major impact on the Ukrainian economy.

Employment now stands at 5,000 people and it has not decreased despite the drop in production. About 2,000 employees are involved in industrial activities. This enterprise employs relatively few industrial workers because the refinery operation is highly automated. The remaining 3,000 workers support the social infrastructure. The management estimated that labor costs were only 1.5% of total costs.

In addition to operating the refinery and associated plants, the enterprise also owns a sausage making plant and a brick making plant. The brick plant is a joint venture with a Yugoslavian firm and produces 10 million bricks/year. The sausage plant produces 1.5 tons of sausage per day. The enterprise would like to get more involved in making consumer goods, which is where the management sees the greatest profit. The management mentioned that it would like the enterprise to make polypropylene-based carpets, and estimated a one-year payback on this project. Films were also mentioned as a growing consumer market. All of these expansions will require capital, and there will be additional raw material costs associated with making more products. Late in 1994, the management organized an investment planning commission. The scope of the commission includes both internal cost savings investments, such as energy efficiency, and expansions to new markets and products. Currently, the enterprise claims that it does not have sufficient money to buy crude oil, so devoting capital to improvements is difficult.

Lisichansk's Organizational Structure and Financial Information

The Lisichansk Petrochemical Plant is a joint-stock company in which the state owns all the shares. There are plans to put the shares up for bid, but this has not yet happened. The firm is in the process of corporatizing, and when this is complete, it will be privatized. Privatization and the new reform program will allow more flexibility in both raw material purchases and sales, but presently the state still maintains control over oil supplies and access to products.

The plant's current profit margin is 17%. Management claims that most years, the enterprise earns 600 billion kupons in profits, but it is not clear what this means, given the hyperinflation which Ukraine has experienced in recent years. The managers would not tell us the enterprise's current annual profits, or the annual revenues. They claimed that profits and revenues are too difficult to calculate because some of the revenues are in rubles, some in kupons, some in dollars, and some exchanges are on a barter basis. Twenty-two percent of the profits are used to pay taxes. Most of the rest is spent on social infrastructure, with a smaller amount allocated for capital investments in the plant.

Ninety-five percent of production costs are for raw materials, primarily crude oil. Labor makes up only 1% of production costs, and energy payments for electricity and natural gas make up most of the rest.

The management explained that the enterprise currently has major contracts for equipment purchases with Italian and German firms, but no major contracts with any American companies. Later we found out that Lisichansk has a contract with Honeywell for control systems. Overall, we found that this enterprise was less open than the others, particularly about financial information.

Lisichansk's Market and Exports

The firm works according to contracts. Other organizations supply the refinery with crude oil, which it then processes. Instead of monetary profits, the enterprise gets to keep a certain percentage of the processed product, which it can sell to whomever it likes. Its main contracts are with the Ukrainian State Committee on Oil and Gas, the enterprise's parent organization, but it also has contracts with other organizations, including commercial organizations and Russian entities.

The management said the enterprise has no exports outside of the former Soviet Union, because it has no contracts with entities outside the former Soviet Union. Lisichansk does sell its "profit" abroad and appears to have access to a large amount of hard currency: its offices were among the nicest we have seen anywhere in Ukraine. The plant has made several major purchases of foreign equipment, including control systems. The managers claimed the volume of exports was a commercial secret. They said that they did have a market for their products abroad. They were able to tell us some of their export prices: today they charge \$170 per ton of gasoline and \$800 per ton of polypropylene.

The firm has an export license for polypropylene and can get one-time licenses for other products, although this may be a sensitive area because under Ukrainian-Russian intergovernmental agreements, Ukrainian enterprises are restricted from exporting oil products which they make with crude bought at discounted prices. In fact, it is unclear how much, if any, of the crude which Lisichansk obtains is bought at discount prices.

Lisichansk's Energy Characteristics

The plant has a 110 MW cogeneration plant fueled with natural gas, or No. 6 fuel oil as a reserve, and it purchases power from the grid. The cogeneration plant is currently generating no more than 40 MW (28 MW on the morning of our visit, 36 MW the previous morning) because of "technical problems" and about 50 MW are being purchased from the grid. At times, the cogeneration plant is down entirely. At full production, the plant needs 90 MW of power.

Lisichansk's maximum steam demand is 250 tons per hour, with current use at 100 tons per hour. Half of that amount is for heating multi-family apartment buildings. Process steam is primarily used for blowing systems. About 1/3 of the condensate is returned to the power house, but it is often contaminated, and when this happens it must be dumped. The plant has thousands of steam traps and about 9,000 electric motors, about half of which are above 50 horsepower. The enterprise does its own rewinding, which averages 120 motors per year.

Because of the lack of crude oil for feed stock, the enterprise has closed several facilities for repair, including a cracking plant and two turbines at the cogeneration plant. This further decreases the demand for energy.

Lisichansk's Energy Efficiency Targets

The areas with the greatest potential for energy efficiency improvements include improving heat recovery and heat exchange, improving the efficiency of motors and drive systems, and installing steam traps. Steam traps are particularly attractive for the enterprise because of the large number of steam lines on the premises and the poor quality of the few traps which are in place. One high pressure steam line is 400 cm in diameter and 3 km long. In general, lines are not well insulated. More than 70% of the electricity is used to run motors and drives. The largest electric user is the catalytic cracking facility.

There are also many opportunities to save energy through additional metering and control. Electricity metering is inadequate and heat metering almost non-existent, according to the chief energy manager. Honeywell has already installed control systems at the enterprise. The energy manager would also like to undertake other upgrades, including:

1. Installing a new 50-MW gas turbine (combined cycle)
2. Improving metering for hot water, chemically treated water, and steam
3. Reducing water jacket heating of process lines with high efficiency electrical heat tape.

The enterprise is already planning to buy 37.5 MW turbines for the combined cycle plant. It will probably buy the turbines from a German firm, which on the day of our visit, finally agreed to take payment in oil products. The payback time on this investment is estimated at two years, at a cost of \$200 per kilowatt of installed capacity.

Options for Developing Joint Business Projects with Lisichansk

Although the management recognizes that there are many opportunities for energy efficiency improvements, it prefers to invest in new products and new markets. The managers said that even a one-year payback on an energy saving project would not necessarily be a suitable investment.

The enterprise does have a fund for capital investments, financed through profits. The investment planning commission makes decisions on investment projects, including energy efficiency investment. Thus an important step in any major contract award is to obtain approval from this board. In general, the Lisichansk Petrochemical Plant repays foreign equipment purchases with oil products. A third party may be involved to sell the products and pay the foreign supplier with the revenues. The managers of this enterprise clearly has much experience in working with foreigners. They are also very astute negotiators.

Because Lisichansk has strong support from the Ukrainian government and produces products for which demand is increasing, both in Eastern Europe and beyond, we feel this enterprise will survive the current economic downturn. It is also likely to play an important role in Ukraine's economy in the future. This enterprise should be kept in mind as a potential customer for U.S. equipment vendors. We also feel it would make a good business partner, particularly for companies which have experience in the emerging markets of Eastern Europe.

SEVERODONETSK AZOT MANUFACTURING ASSOCIATION

Severodonetsk, Luhansk Oblast

At this facility, the team met with Alexey R. Bukarov (Deputy Chief Engineer), Valery I. Krivokhin (Chief Energy Manager), Valery N. Bondarev (Technical Department Head), Viktor Korobets (Deputy Head of the Department for Foreign Economic Relations) and the chief economic planner.

Azot Facility Description

Severodonetsk Azot is the largest single energy consumer in Ukraine. The enterprise was originally built in the late 1930s, although it was destroyed and rebuilt during World War II. Many of the plants at the enterprise, including the ammonia and cogeneration plants⁴ date from the early 1950s and as a result are in poor condition. Some of the other production facilities, particularly those which produce consumer goods are newer and in slightly better shape. In the past few years, Azot has purchased equipment from companies in Japan, Austria, France and Germany. For example, eight years ago Azot bought U.S. technology for producing acids from Monsanto.

When we toured the facility, it looked run down, but not in complete disarray. We saw extensive rust on staircases and other nonessential equipment, corrosion on pipes and leaks from steam pipes. Our guides told us that there were problems with contamination of water at the plant and leaks of harmful substances.

Azot produces ammonia-based fertilizers and other chemical products. The enterprise has two large ammonia plants, each with a capacity of 2 million tons per year, and a urea plant with an annual capacity of 800,000 tons. It also manufactures polyethylene, organic acids and various catalysts as well as several consumer goods, including plastic tubs, buckets, luggage, cleansers and glue. The enterprise is currently running at 57% of capacity due to natural gas and electricity shortages.

Azot's Organizational Structure and Financial Information

The enterprise is owned by the state, under the umbrella of the Ministry of Industry, although it may soon become a joint-stock company, which is the first step towards privatization.

The management seems to be mixed in terms of vision and ability to respond to market conditions. The Chief Engineer and Head of the Technical Department were committed to the old, socialist way of doing business. For example, when we asked the Chief Engineer why Azot did not export more if its products were as competitive as he claimed, he said that it was unpatriotic to export too much. The Deputy Head of the Department of Foreign Relations and, to some extent, the Chief Economic Planner, however, both seemed to understand market economics and the need to produce goods for a market, not a state plan. They were excited about the recent reforms regarding exchange rates, exports and privatization. This

⁴The cogeneration plant is actually owned by Donbasenergo, the regional electric utility. It is common in Ukraine for regional electric utilities to own the cogeneration plants at chemical enterprises.

enterprise had a large marketing and contracts department, with a staff of 35, four of which worked solely on international issues, which indicates that the management understands the importance of marketing.

The Ministry of Industry allows the enterprise a 15 to 20% profit margin. Each product line has a different negotiated profit margin which ranges from 5% to 50%. When products are in high demand, the profit margin increases. For goods sold to the state, Azot adds the profit margin to production costs and this establishes the product price. In Ukraine, "profits" are often used to cover operating expenses. 50% of the profits at Azot go to taxes, 25% to social programs and 25% to salaries. Except for a few small projects, virtually nothing is saved for reinvestment. When the facility was running at full capacity, the management said that it used 18% of profits for capital improvements.

When asked about production costs, the management explained that energy and raw material costs are 70% of the total, labor is 10%, and other production maintenance costs are 10%. Natural gas is the main feed stock, which is very expensive in comparison to other inputs, thus explaining the high raw material costs.

At full capacity, the enterprise has 17,500 employees, with 5,000 of the employees involved in social programs. Employment now stands at 12,100, of which 3,000 are involved in social programs or nonproduction activities. The enterprise owns several vocational schools, health clinics, a hospital, day care centers, a cultural center and theater, and resorts for workers.

Azot's Markets and Exports

Azot directly exports 17-18% of its products outside the former Soviet Union. 30% of its products are sold to other former Soviet republics and approximately 50% are sold in Ukraine. In Soviet times, the enterprise exported 19-20% of its products to 28 primarily socialist countries. Azot no longer exports to as many countries as in the past, however the volume of exports has gone up in 1994 in comparison with 1993 and eventually, the enterprise would like to export 35-40% of its goods for hard currency. Since 1951, Azot has had a "monopoly" on the export of several chemical products from the USSR and now Ukraine.

Sales within Ukraine currently amount to a third of Azot's total sales revenues. Production and sales have dropped substantially in recent years. In fact, much of the total drop in production has been caused by lack of demand (at full cost) within the domestic market. Still, half of the fertilizers used in Ukraine are made at Azot.

In discussing current and future export markets, Azot's management said that the enterprise's methanol was high quality and that its urea was suitable for world markets.⁵ It is important to note that fertilizer

⁵Until recently, the U.S. Department of Commerce had an anti-dumping order against urea from the former Soviet Union because the USSR sold urea abroad below cost. This seriously restricted exports to the U.S. The order appears to have been rescinded this year. Nonetheless, the situation needs to be carefully examined when structuring any business deals which involve import of urea to the U.S.

specifications are not likely to be very tight. Urea and methanol make up 30 to 40% of Azot's exports and ammonia another 25%.

Azot and other enterprises find it difficult to determine whether exporting is profitable because of changing and confusing exchange rates. The fluctuation of the exchange rate makes price negotiations difficult for them. The enterprise currently exports at the following rates:

Urea	\$148/ton
Methanol	\$430/ton
Ammonia	\$176/ton

The foreign relations department in this enterprise conducts continuous research on the world market and international prices for the products which Azot sells. The department calculates export prices by comparing this information with Azot's production costs. In order to break into new markets, such as the United States, Azot has at times sold below cost but it feels that this is profitable in the long-term. The enterprise also sometimes has an incentive to sell even if it is losing money with unfavorable exchange rates because its allowance for purchasing equipment abroad is in part set by the amount of hard currency earnings it exchanges at unfavorable rates. While it is troubling to see that the enterprise may export at a loss, in general, Azot seemed to have a much better grasp of international marketing and business than most of the other enterprises we visited.

Azot's Energy Characteristics

Currently, Azot lacks natural gas both to supply the energy necessary for operations, and as a raw material for its ammonia plant. At full capacity, the plant consumes 12 million cubic meters of gas per day, but currently only consumes half that amount.

At full capacity, Azot uses 3.2 billion kWh per year and has a peak demand of 375 MW. Current electrical use is 2.4 billion kWh per year with a peak demand of 220 MW.⁶ The enterprise has only one boiler house. It burns natural gas as well as waste gases, and has oxygen and NOx analyzers on the boiler stacks. Power comes from the electric grid and from a cogeneration plant that is owned by the regional utility.

The cogeneration plant has an electrical capacity of 80 MW, half of which Azot consumes. The cogeneration plant makes 140 bar steam and sends it to a steam turbine. Part of the 140 bar steam is also reduced through a valve in order to meet Azot's demand for 17 bar steam. The cogeneration plant also supplies heat and hot water for all of Severodonetsk. The plant burns natural gas, with fuel oil as the reserve.

⁶It is not possible for Azot to consume 2.4 billion kWh annually if its peak demand is only 220 MW. This discrepancy is probably the result of decreasing energy consumption, whereby the megawatts describe current peak demand and the kilowatt hours describe the accumulated usage from the past year, including periods when peak demand was higher.

One of Azot's large energy consumers is an air separation plant, which produces nitrogen. Although built in the 1970s and modified in 1987, it is inefficient and uneconomical. It has five 10 MW compressors with a total power demand of 50 MW. The management would like an entirely new air separation plant.

Azot's heat consumption has been halved in recent years. Sixty percent of the heat comes from Donbasenergo's cogeneration plant and 40% from Azot's own boilers, which generate 39 bar steam. The energy manager did not know the plant's condensate or make-up water rates, but estimated that about 35% of condensate was returned.

Azot's Energy Efficiency Targets

Approximately 20% of Azot's total costs are directly related to energy consumption. Energy figures do not include natural gas used as a raw material for the ammonia plant, or natural gas by-products manufactured and consumed at the plant.

The energy manager has the capability to record and analyze use of energy, but has no control over how energy is used in various shops. Further, the shops are not held accountable for their use of energy. Better controls would improve the energy efficiency of the plant.

The enterprise has 20,000 motors and an outdated shop which rewinds about 500 motors per year. One of the best opportunities for energy efficiency improvements at Azot is in motors: both replacing inefficient motors and drive systems and implementing an efficient rewind program.

There is also much which can be done to use steam more efficiently. Steam pipe insulation is generally in poor condition. Most lines are loosely wrapped with "blanket" insulation that is falling apart. In some places, the pipes have no insulation at all. The energy manager estimated that 20% of the steam lines need new insulation, but this is probably low based on our observations. The main purpose of existing insulation may be protection against burns. The energy manager said that the enterprise has 15,000 to 20,000 steam traps, although we did not see steam traps on the main steam distribution lines. There were some steam leaks, but not as many as we might have expected considering the amount of steam piping.

Options for Developing Joint Business Projects with Azot

The management of Azot agreed in principle to share costs with U.S. companies and return the investment and profits to those companies in dollars. It would consider a simple payback period of up to 4.5 years. The enterprise has asked a Swiss company to study its urea process, and will pay the company in urea. In general, Azot prefers to pay with its products, through an intermediary, rather than in hard currency.

Azot claims to have paid for all of its foreign purchases on time and continues to have friendly relations with its foreign suppliers. The enterprise is interested in attracting American investments to improve the plant's energy efficiency, and would be willing to repay these investments in hard currency.

In summary, we recommend this enterprise as a business partner. We feel it will survive in the long-term, in part because of its forward thinking marketers and financial planners.

PETROVSKY METALLURGICAL PLANT

Dnipropetrovsk, Ukraine

The delegation met with Vasili Derevyanko, Director of the Petrovsky Metallurgical Plant.

Petrovsky Facility Description

This plant was originally built 107 years ago, although it has been rebuilt several times. It has three blast furnaces, three converters, and three rolling mills (which include shapers). It has the newest rolling mill in Ukraine, built in 1987. The main shaped products include steel for welded pipes, plows, mining products, piping, channels, and car axles. The plant has a capacity of 2.2 million tons of cast iron, 1.8 million tons of steel and 2 million tons of rolled metals.

The director would like to completely modernize his plant by building a new continuous casting plant. He has a modernization plan which has been approved by the Ukrainian Cabinet of Ministers. This would cost \$160 million if all Western equipment were used for the modernization. If Petrovsky used Ukrainian products, it could modernize the plant for \$50-\$60 million. This project exists only on paper: there is no financing and there are no plans to find financing.

Currently, the plant wastes 20% of the metal produced because of the outdated technology. With the continuous casting equipment proposed for the modernization, that rate would go down to 2% waste. This in turn would significantly improve the energy efficiency of the plant.

This plant is currently working only at 35% of capacity. Employment has gone down, but at a much slower rate. At full capacity, the plant employs 10,000 people, today 8,700 people work there. In fact, current employment is even lower than this because many workers are on reduced schedules or have not been paid for some time. About half of the employees work in non-steel making processes: the enterprise also owns a 500-bed hospital, a health clinic, kindergartens, and a stadium with a capacity of 27,000. The director is trying to transfer ownership of this property, particularly worker housing, but in two years he has only been able to transfer one residential building to the City of Dnipropetrovsk.

Petrovsky's Organizational Structure and Financial Information

The state owns the plant, although the workers have leased it from the state. This is a form of restructuring which Ukraine has tried in recent years, with limited success.

Regarding production costs, we were told that labor makes up only 3% of production costs today, although in 1990, it accounted for 10% of the costs. Energy makes up 40% of the cost of cast iron and only 7% of the cost of shaped steel. The rest of the costs relate to raw material purchases and depreciation of the equipment.

The director said the state gave the enterprise a 19% profit in the first 10 months of this year. This equalled 400 billion kupons or \$8.9 million. One third of this "profit" is used for salaries,

one-third for social expenditures, and one-third for technological upgrades and new equipment. Revenues from January through October 1994 were 10 trillion kupons, or \$222 million.

Petrovsky's Markets and Exports

Half of Petrovsky's products are sold in Ukraine, 30% in other countries of the former Soviet Union, and 20% to countries outside the former Soviet Union. These countries include China, Hong Kong, Thailand, and Singapore. More than 30% of revenues were obtained from exports to countries in the "far abroad" (outside of the former Soviet Union). The average price for the products sold abroad is \$200 per ton.

Within the domestic market, this enterprise is an important supplier of plows, car axles, mining equipment, bridge parts, and semi-finished sheets for tubes. The director claimed that Petrovsky is the only enterprise in the former Soviet Union which produces certain types of plows.

The director was not sure what his market would look like after modernization. He was clearly from the old system and had little idea of what a free market would mean for his enterprise.

Petrovsky's Energy Efficiency Targets

The Petrovsky plant could use many energy efficiency improvements, including metering devices, and controls, improvement of boiler plant efficiency and gas analyzers at the boiler plant. However, most shops in the Petrovsky enterprise are not economically viable in our view. One possible exception to this is the new shaping mill. This shop could use more efficient motors and drive systems, of which there are many.

Options for Developing Joint Business Projects with Petrovsky

The director originally was not in favor of the idea of small energy efficiency projects, as opposed to modernization. With further discussion, he came around to the idea and said he would be willing to cooperate on such projects. He would prefer to pay for equipment and services with metal. The enterprise does have an investment capital fund which it can use to finance equipment purchases. The maximum payback time he would be willing to accept for an investment would be two to three years.

We discussed investment guarantees with the director and he indicated that aside from helping to obtain a government guarantee, he would be willing to use some of the enterprise's property as a guarantee.

This enterprise will have a difficult time surviving. The government is clearly not supporting this enterprise. Thus, we do not recommend this enterprise for U.S. investment.

ZAPOROZHSTAL COMBINANT

Zaporizhzhia, Ukraine

The delegation met with Igor Dyschlevich, Chief Engineer.

Zaporozhstal Facility Description

Zaporozhstal was built in 1933, under Stalin's rule. Much of the plant was constructed in the middle to late 1940s with the assistance of American engineers and technology. The plant's infrastructure is very old and includes 5 blast furnaces, 9 open hearth furnaces, and 6 rolling mills. About half of these facilities are currently operating. The management recognized the problem of obsolescence but did not reveal a vision or game plan for resolving the problem. There are renovation plans in place and the plant has received many proposals from foreign companies for modernization, but the Ukrainian government has refused to support or guarantee any of the projects. The management said that in comparison with other Ukrainian steel enterprises, the technology and equipment at Zaporozhstal is outdated. The managers estimate that modernization will cost \$1.8 billion. Production figures were available on a wall chart in the meeting room and the trend has been steadily downward since 1956.

The plant produces sheet metal, thin strip metal, stainless steel, metal for automobiles,⁷ and an array of other products. Annual output includes 4 million tons of cast iron, 5 million tons of steel, and 3 million tons of rolled steel.

At full capacity the plant employs 19,000 people, about 15% of whom support the community infrastructure which includes apartment buildings and a hospital. The plant is currently operating at 53% of capacity and employment is 16,800 workers. We had great difficulty getting consistent estimates of production costs.

The enterprise is located in downtown Zaporizhzhia, a large Ukrainian city. It is a major source of pollution and thus environmentalists and local citizens' groups have targeted the enterprise, complaining about the emissions from the enterprise.

Zaporozhstal's Structure and Financial Information

The Ministry of Industry owns Zaporozhstal. About 50% of its sales are to the Ukrainian government. The plant management told us that orders from the government must be filled first. Of the remaining sales, about 40% are within Ukraine and 10% are direct sales to countries which are not part of the former Soviet Union. The management said that the state exports some of the products purchased from the plant, but it has no idea what that figure is.

⁷A Ukrainian car, the Zaporozhets, is manufactured in Zaporizhzhia. Zaporozhstal supplies metal for the cars.

When asked to describe who Zaporozhstal's customers would be in the next three to eight years, what products the plant would be selling, and what share would be exported, the management team was not able to answer clearly. The chief engineer said that he would really like to modernize the plant and that without modernization, Zaporozhstal could not survive.

Zaporozhstal's Energy Characteristics

There is one cogeneration plant on the site. It is very old, but appeared to be well maintained and run. The installed electric capacity is 17 MW. Peak demand for electricity at full plant capacity is 230 MW.

Zaporozhstal's Energy Efficiency Targets

Some of the largest energy losses are from the plant's steam lines. The enterprise has roughly 40 to 50 km of steam lines. About 20% of condensate is returned. The enterprise has installed less than 150 steam traps at the entire plant. The energy engineer told us that 20 to 30% of the insulation on the steam lines should be upgraded. However, a short tour of part of the facility suggested that the percentage is much higher. All control systems are old and obsolete.

There are 20,000 electric motors at the plant and about 60% of these are less than 50 horse power. The plant rewinds about 1,500 motors annually and is not currently purchasing motors.

The energy manager told us that his first priority is to replace the enterprise's steam turbines. His second priority is to replace the cogeneration plant boilers. The next priority addresses oxygen production. The existing facility is designed to produce 50,000 m³ of oxygen per hour. Given that the enterprise is operating at only 53% capacity, this is much more oxygen than the enterprise needs. The plant is searching for a way to solve this problem.

Options for Developing Joint Business Projects with Zaporozhstal

The future of this enterprise seems uncertain. There are energy savings opportunities but we cannot recommend this plant as a high priority for American energy efficiency companies.

ZAPOROZHOKS JOINT-STOCK COMPANY

Zaporizhzhia, Ukraine

The delegation met with Valery Rubchevsky (the Vice President), Yuri Chernyshov (the Head of the Technology Division), as well as the head accountant, the head economic planner, and the chief energy manager.

Zaporozhkoks Facility Description

Zaporozhkoks produces coke and related chemical products, such as coke gas, blast gas and coal tar. The enterprise has four cokers which have the capacity to produce 2.76 million tons of coke per year.

The plant is currently running at 50% of capacity, which management claims is because of the lack of coal. Zaporozhkoks gets 99% of its coal from the Donbass region of Ukraine, which has seen declining production for over a decade now. The enterprise is trying to purchase supplies from Russia and Poland, but this coal is too expensive for the plant, given the demand for its products.

The enterprise is planning a major project to expand the scope of its production. The management would like to install new equipment to make 70,000 tons of gasoline and 20,000 tons of methanol per year from the high temperature conversion of coal gas. It has completed feasibility studies for the project, but is waiting for approval from the state. The plant would use its own capital for the project. Valery Rubchevsky also said that before Zaporozhstal use its own capital, the management would first like to better understand the market for these goods both in Ukraine and abroad first. The managers do know that there is a demand for methanol in Western Europe and a large market for gasoline in Ukraine. They were expecting government approval of the project in November 1994 and planned to purchase the equipment one year later. They have established a tender commission to select the equipment. They will purchase two compressors abroad for the methanol process and the rest of the equipment in Ukraine. The total cost of the project is about \$30 million. It was not clear whether this project would be economically viable in a free market.

Zaporozhkoks is also planning to produce other products, unrelated to the coke process. The enterprise is building a brick factory and a cement plant, both of which will use waste ore as a raw material. These facilities will be complete next year. The plant is also building a covered coal storage area and a natural gas treatment facility to produce diesel and other fuels.

The enterprise employs 3,000 people, of which 2,000 are employed in production operations. The rest work at schools, a health clinic, a cattle farm, greenhouses and other facilities owned by Zaporozhstal. Employment has not decreased with the decline in production, supposedly because the production processes do not allow incremental decreases in the labor force.

Zaporozhkoks' Organizational Structure and Financial Information

The enterprise is on the road to privatization: it is a joint-stock company, but the state currently owns most of the shares (the enterprise itself owns 12% of the shares). Ideally, the management would like Zaporozhkoks to be owned by a mix of the state, employees, and private shareholders.

When we asked the managers where they would like Zaporozhkoks to be in ten years, they said that Zaporozhkoks' main product would still be coke, which the enterprise will continue to sell primarily to Zaporozhstal. The management does envision selling more products abroad and expanding the number of products which Zaporozhkoks produces.

Management's four biggest problems or concerns are:

1. Securing the supply of raw materials in order to run the enterprise at full capacity
2. Manufacturing new kinds of products and extending the sphere of production
3. Increasing environmental protection measures and energy efficiency
4. Installing automatic controls.

Coal and energy purchases make up almost 90% of Zaporozhkoks' production costs. Coal as feed stock accounts for 68% of production costs, energy for 20%, and labor and other raw materials for 2% each. The enterprise makes a profit of 25-30% at full capacity. The accountant said that the enterprise has a profit margin of 20% and in the first nine months of 1994, the enterprise's profits equalled 312 billion kupons (\$7 million). After paying a 22% profit tax, Zaporozhkoks uses 55% of its remaining profits for a development and investment fund, 26% for social expenditures such as schools, 13% for workers' salaries and 5% for insurance. Four-fifths of workers' salaries are paid for with the profits.

Zaporozhkoks' Markets and Exports

The management of Zaporozhkoks does have an understanding of the importance of developing a market for its goods. The enterprise has a marketing and finance department with six employees, who work on advertising and invite firms to visit the facility. The department did not seem to be looking for new markets very aggressively. Over the past 3 to 4 years, Zaporozhkoks' markets have actually decreased because of the drop in production. The enterprise used to sell many of its products to Poland, Hungary, Bulgaria, Cuba, Germany and the other Soviet republics. Currently, it sells about 1% of its products to Russia, and the rest within Ukraine. These sales in Ukraine are required by the Ukrainian Government because coke and the other products of this enterprise are considered national priority products. The management says the enterprise cannot even export outside of the Zaporizhzhia region because its main product, coke, does not ship well. This also means that Zaporozhkoks has limited access to hard currency.

While the enterprise understands the need to look for new markets for the products it currently produces, it is extremely limited by state requirements. Zaporozhkoks is required to sell 99% of its coke and 75% of total products to Zaporozhstal. Given the difficulties that face Zaporozhstal, this does not bode well for Zaporozhkoks.

Zaporozhkoks' Energy Characteristics

20% of the energy which Zaporozhkoks consumes is used in the main processes and the rest for auxiliary functions, which indicates a large potential for energy efficiency savings.

Part of the fuel is supplied by blast gas from Zaporozhstal and the rest comes from coal gas. Steam and hot water are also obtained from Zaporozhstal. Thus if Zaporozhstal closed, not only would Zaporozhkoks' main purchaser disappear, but it would also lose an important energy supplier. The enterprise's electricity comes from the grid.

Zaporozhkoks' Energy Efficiency Targets

Zaporozhkoks is undertaking several small projects to improve energy efficiency, although much of the money which the enterprise supposedly spends on efficiency seems to go towards research instead of actual efficiency improvements. The enterprise does have a contract with a new Ukrainian energy services company called Khartron, under which Khartron is designing and manufacturing a fully automated control system for some of the existing processes.⁸

When we toured the facility, it looked run-down and little attention seemed to be paid to housekeeping measures. There were several leaks in steam pipes and the insulation on these pipes was shoddy. We noticed that at least one of the slot-type coke ovens was on fire and the door had burned off. We also drove through a major leak of contaminated water.

The drop in production has made operations even less efficient. Normally it takes 13 hours of heating to convert coal to coke. Because the enterprise is running well below capacity, it is using 35-hour cycle times. This allows the enterprise to keep the coke batteries on all the time, which is essential for them to function properly, however, it wastes large quantities of energy.

The maintenance philosophy at Zaporozhkoks seems weak: the workers generally only fix essential equipment and let most maintenance problems go until the equipment is completely broken. Thus, there should be many opportunities for improving efficiency through better maintenance and housekeeping, especially in the coke oven area. Leaking doors, gas offtake lids and coal charging lids would be primary targets. Improved control to reduce excess air to the coke ovens would also be a logical target as would

⁸According to Zaporozhkoks, Khartron was formerly involved in the space industry. Recently, an article in *The Ukrainian Times* (Nov. 15-23, 1994) wrote that Khartron formed a joint venture with Westinghouse to modernize Ukrainian nuclear reactor safety systems. It is unclear how involved and knowledgeable Khartron is in the area of energy efficiency.

replacement of worn-out valves and steam traps. The enterprise could also improve its efficiency through better pipe insulation: most of the steam pipes had poor insulation, or no insulation at all in places.

The company's vice president said that the firm does track its use of energy and that it would be interested in energy efficiency projects which pay for themselves. Nonetheless, he did mention that the large project to produce gasoline and methanol had to take precedence, and he was concerned that if the company spent too much on efficiency, it would not have enough money left over for major process improvements.

Options for Developing Joint Business Projects with Zaporozhkoks

Zaporozhkoks does have an investment fund which it uses to pay for energy efficiency improvements. Despite limited hard currency earnings, the enterprise is purchasing equipment from a German company called Mann GH and, in the past, the plant has purchased equipment from the United States. Zaporozhkoks can use its own profits to pay for equipment, but it needs government approval before the sale is finalized.

The management does not have specific requirements for the maximum payback time which it would accept; rather investment decisions depend on several factors, including the overall importance of the investment to the future of the enterprise. Nonetheless, the management seemed to favor very short payback times (one year or less), so as not to tie up capital which it could use on modernization.

The enterprise management agreed in principal to the idea of sharing costs and savings with a foreign firm, but emphasized that the enterprise staff have little experience working with foreign firms, so this might not be the best option.

We cannot recommend this enterprise for investments at the current time because of our concern that it will not survive in the long run. The vice president told us that he felt the enterprise was viable, even without Zaporozhstal. When we asked the head accountant the same question, she said that her enterprise could not survive if Zaporozhstal went under. Given how important Zaporozhstal is as a client and a supplier, it is hard to believe that the accountant is wrong. If the enterprise does expand its clientele in the next year, it should be reexamined for investment potential.