PN-ABY-928
91236

PRIDE

Project in Development and the Environment

USAID Mission to the Czech Republic: Environmental Action Program—Investments

May 1994

Submitted to:
USAID/ENI
Submitted by:
PRIDE

AID Contract Number:
ANE-0178-Q-00-1047-00
AID Project Number:
398-0365

Sponsored by:
USAID/NE/DR/ENR
Operated by:
Chemonics International
and its associates

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USAID Mission to the Czech Republic: Environmental Action Program—Investments

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May 1994

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EXECUTIVE SUMMARY

Pursuant to the U.S. Government commitment under the Lucerne Agreement to support the Environmental Action Program (EAP) for Europe, a four-member PRIDE team carried out a project identification mission to the Czech Republic between 21 March and 8 April 1994. The purpose of the mission was to select a representative sample of promising environmental projects, primarily in the area of municipal district heating, and to assess their economic and technical feasibility and contribution to ambient air quality and environmental health improvements in the most affected regions of northern Bohemia and northern Moravia.

The mission was also to identify potential technical assistance interventions under the auspices of USAID, and to develop recommendations for enhancing the current process of project funding through centrally administered grants and low-interest loan programs. As a precursor to USAID's forthcoming Housing Guaranty Loan Program in the Czech Republic, our team was also asked to investigate municipal district heating projects that are likely candidates for funding by participating commercial banks.

Our preliminary evaluation of 12 projects indicated that rising pollution charges are the motivating factor behind requests for technical and financial assistance. This economic incentive has been quite effective in controlling emissions. However, this approach has led municipalities and industrial producers to focus on environmental projects that do not necessarily address the highest human health risks or represent least-cost methods to solving environmental problems. Indeed, many district heating plants have high stacks and are sometimes located outside of the town centers in less populated areas.

While controlling these sources may address some of the human health risks posed by local sources of air pollution, the optimal alternative from the human health perspective may involve a different set of measures, such as shutting down small inner-city coal-fired boilers and/or eliminating individual household furnaces in densely populated neighborhoods, and connecting these areas to the district heating systems. Inner-city boilers and household heating systems, which burn low quality coal, may be actually far worse than high stack plants because they emit at ground level and lack adequate pollution controls.

The project planning process in Ostrava steel was a notable exception to the prevailing practices we encountered. Thanks to ongoing assistance by the U.S. Environmental Protection Agency to Project Silesia, government environmental and public health officials have conducted a thorough assessment of ambient air quality and determined that coke oven emissions pose substantial health risks to the inhabitants. Their findings were instrumental in directing the efforts of local coke producers to investigate the most cost-effective alternatives for reducing risks from these ovens and to accelerate investments in pollution control.

At the issue of the mission, the members of the team concluded that the Czech Republic has several attributes that make it a prime candidate for further USAID technical assistance within the parameters established by the EAP's Project Preparation Committee. Support needs range from technical assistance for specific municipal district heating projects to "generic" assistance and training in the following areas:

- Establishment of procedures for incorporating human health risk reduction factors in the project identification, prioritization, and selection process.

- Evaluation of technology options for district heating (including power and heat cogeneration) and their relative benefits from environmental, public health, and economic perspectives.

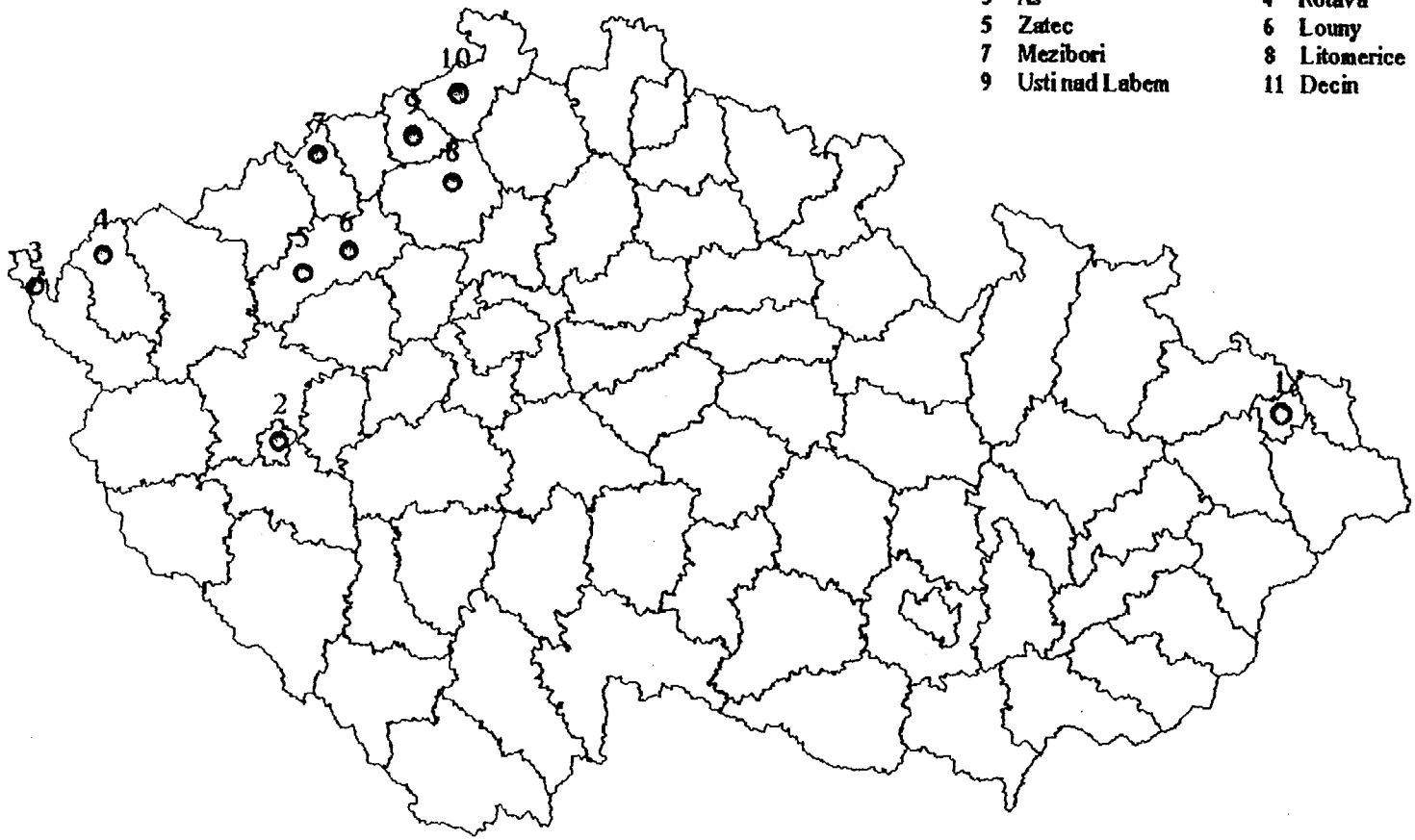
- Financial benefit/cost analysis for evaluating potential alternatives.

- Cost recovery and economic pricing of public services, particularly heat production and distribution.

- Development of financing plans and methods for securing funding from commercial sources.

As far as the process of central project funding is concerned, the team concluded that the projects funded by the Ministry of the Environment and the State Environmental Fund have definite environmental merits. However, there remains a need to further refine the criteria for project selection by incorporating health risk assessments and proposed cost recovery and financing in their evaluation in order to rationalize the fund allocation process. Other findings and recommendations are further elaborated in Section I of this report.

Czech Republic - Overview of Visited Places



SECTION I
CONCLUSIONS AND RECOMMENDATIONS

Our field visits targeted district heating projects in northern Bohemia and three coke plants in Ostrava (northern Moravia). The following discussion focuses primarily on proposals for environmental rehabilitation and upgrade of district heating projects, because they are of particular interest to three potentially complementary funding sources, namely:

- The Ministry of Environment grant program funded by the EU PHARE.
- The State Environmental Fund (SFZP), which provides financial assistance to municipalities and enterprises in the form of grants and/or low interest. loans
- USAID's forthcoming Housing Guaranty (HG) Loan Program.

With the exception of Litoměřice, where the district heating system is owned and operated by Severoceske Teplarny, a private sector company, heating utilities in the cities visited continue to be owned by the central government, though managed by the city administrations. The latter not only collect fees and charges related to distribution of heat, but also provide operation and maintenance services either directly or through a service contract with a private sector firm (e.g., Žatec). According to the sources contacted during our field visits, spin off and corporate reorganization of the district heating systems were scheduled to begin the second quarter of 1994, in conjunction with the second wave of "voucher privatization."[1]

In general, we see a definite need for technical assistance to certain municipalities to prepare plans for projects that reduce health risks through air pollution abatement and improved energy management. In addition to providing assistance to specific municipal district heating projects, we also see a need for "generic" technical assistance and training in the areas of (1) project identification, prioritization, and selection on the basis of human health impact, (2) evaluation of technical options and their relative benefits from the environmental, public health, and economic perspective, (3) financial benefit/cost analysis for evaluating the costs of potential alternatives, and (4) development of financing plans and methods for securing funding from commercial sources.

[1]Although the municipal officials interviewed referred to the forthcoming ownership transfer of housing enterprise assets as privatization, the move actually represents (at least initially) no more than a transfer of title of the shares of the new joint-stock entities to the municipalities, which are for the most part already operating and maintaining the heating plants and networks. The cities expect to receive between 51 and 100 percent of the shares, and will be authorized to sell part or all of their assets to private investors. Many municipalities have already organized in preparation for that eventuality, and have already named the future heads of the district heating systems. In some places (e.g. Pilsen), the local administrations have formed a holding company, with its own independent board of supervisors and managing directors, to manage the assets transferred by the state.

A. Assessment Summary

The projects reviewed ranged from those in the early "good idea" stage to those in the final stages of implementation. Sophistication of the technical proposals from an engineering perspective was varied, and we were pleased to note that most proposers had competent engineering staff or access to external contracted engineering expertise to perform feasibility studies or carry out technical work on a long-term basis. There were of course exceptions to this rule, particularly in smaller towns, where local needs receive less attention from city technical staff. Further, most of the proposals reviewed lacked detailed environmental and financial feasibility analyses, which clearly indicates the need for technical assistance in these areas.

A1. Technology Selection

Where the district heating network was in poor shape, boilers at individual buildings were the preferred solution. Where the network was in better shape, the preferred solution was either gas or coal central boilers. From our perspective, fluidized bed combustors (FBC) are the preferred coal technology. However, this option was seldom considered by the grant applicants. Thus, it appears that the choice between coal and gas usually depended on the size and sophistication of the district heating utility. Large facilities with more engineering experience were more likely to consider adopting FBC than were smaller ones. In general, however, fuel conversion from coal to natural gas is perceived as the safer, low risk solution, though it often loses in a cost comparison to FBC where a plant has on-site coal handling facilities.

Cogeneration remains an open issue. The driving factor is the price at which electricity can be sold to the electric utility. At CK 1 per kwh, cogeneration may not be economical. The break-even point is probably between CK 1.30 and CK 1.50 per kwh. Secondary information (which could not be substantiated) indicated that current power purchase contracts with CEZ, the state utility monopoly, have ranged between CK 0.67 and CK 1.67 per kwh.

A2. Recommendations for Project Specific Support

At the issue of our mission, the team concluded that future USAID technical assistance within the PPC framework would be very beneficial in the cases of Decín, Žatec, Meziboří, and the Ostrava coke ovens. A summary of our findings, with our project-specific recommendations, follows. Further recommendations related to "generic" environmental health and other aspects begin on page 44.

Recommendations

Decín. The city of Decín is following an aggressive program of gas conversion. Unfortunately, the plan calls for immediately converting a relatively good unit, delaying the conversion of the Zelenice plant, which is very poor condition because gas lines have not reached it. The study for improvement in Decín was done by Brun & Sorensen, a Danish

firm, whose services are provided under the auspices of the Danish Environmental Protection Agency. The study did not consider the option of upgrading Zelenice to burn coal cleanly. Further, there was no assessment of the cost of repairing a new coal plant that has never been brought on line, or of upgrading its emissions controls. We recommend that USAID provide additional engineering support to (1) reexamine the possible use of coal in Decín, (2) investigate the technical and engineering feasibility of cogeneration projects, (3) advise on cost recovery and service projects, and (4) assist in the preparation of financing plans and in obtaining outside financing (see also human health assessment below).

Žatec. The district heating plan for Žatec involves consolidating the heating at a modernized plant and phasing out heating at smaller plants with poor emissions controls. The town is proceeding with a feasibility study by a Czech engineering firm, which will examine both coal and gas burning options. Technical assistance by USAID can complement this effort, particularly in technology selection and assessment of clean coal technology options. The town does not have the needed funds at this time to continue the engineering study through an implementation and financing plan. USAID could provide this extension to the feasibility study (see also human health assessment below).

Meziboří. The city has the most fully developed district heating plan reviewed and has made the most progress in implementing it. Only one plant remains to be addressed. The city has yet to determine whether this plant should be used for district heating only, or for combined heating and power generation. The decision is a close one and rests in large measure on the prices for electricity sales to the distribution company. As noted further below, assistance in the evaluation of cogeneration options is needed in other cities as well.

Ostrava. The management of the facilities visited and Hutní, the metallurgical consulting engineering firm, have the design and engineering capabilities necessary to complete the work. There is, however, need for assistance in evaluating the costs and effectiveness of proposed solutions (see Conclusions and Recommendations Related to Human Health, below). Furthermore, in view of the uncertainties governing the steel sector in the Czech Republic and current excess capacity in the Ostrava region, the long-term viability of certain facilities should receive particular attention.

EPA is providing substantial technical assistance in Ostrava. As a result, an evaluation of costs and effectiveness of controlling emissions from coke ovens is well underway. Any additional technical assistance provided by USAID must be coordinated closely with ongoing efforts. Building on the results of existing analyses, there may be a need for additional technical assistance in the following areas:

- Coordinate with EPA to evaluate the costs and effectiveness of specific proposed engineering solutions to reduce emissions from individual coke oven batteries.

- For the most cost-effective projects, evaluate the economic feasibility and financing capabilities in more detail.

- Follow this evaluation with technical assistance in preparing financing plans and in securing external capital for the proposals that are most promising in terms of cost-effectiveness and economic feasibility.

- Evaluate other proposals for iron ore sinter plants, which could not be reviewed during our visit to Ostrava.

B. Human Health Assessment

Our preliminary project evaluation indicates that projected increases in pollution charges are the motivating factor for requests for technical and financial assistance. Current pollution charges will more than triple by 1998 and may cause facilities to shut down if they are unable to reduce their emissions. This economic incentive appears effective at motivating emission controls. However, it has led to a focus on environmental projects that do not necessarily address the highest human health risks or represent optimal approaches to solving environmental problems.

In Ostrava, however, both factors are taken into consideration. Coke ovens have been identified as the major source of health risks to local inhabitants, and emission charges are accelerating investments in pollution control at these plants. Based on a good understanding of health risks and engineering solutions, efforts are underway to identify the most cost-effective alternatives to reduce risks from coke ovens and obtain financing for implementing them.

In northern Bohemia, in the towns with problems related to low-level emissions from district and household heating sources, the activities focus on reducing emissions from district heating plants to comply with emission limits and minimize pollution charges. The proposed solutions do not necessarily address the most serious heating-related problems with the least-cost solutions. Because many district heating plants have high stacks and are located outside of the town centers in less populated areas, controlling these sources may address only a small portion of the human health risks posed by local sources of air pollution.

From the human health perspective, the best alternatives may consist of shutting down small coal-fired boilers and/or eliminating individual household furnaces in densely populated neighborhoods and city centers, and connecting these areas to the district heating systems. Smaller inner-city boilers and household heating systems may pose significantly greater human health risks than high-stack plants located at the edges of towns, because they tend to burn low quality coal, have no pollution controls, and, by emitting at ground level, subject many people to pollutant exposure.

In Chapter 4, we evaluate each of the projects reviewed with respect to these pollutant and human exposure factors. In our opinion, project proposals for the towns of Žatec and Decín offer the most promising possibilities to address potentially high-risk sources. The Žatec proposal includes plans to eliminate 17 small coal burning boilers in the center of the city and densely populated neighborhoods by extending the district heating distribution

system linked to the main plant. This would significantly reduce low-level emissions that affect much of the town's population. In Decín, the Zelenice district heating plant deserves attention due to its state of disrepair and associated high emissions of SO_2 and particulate matter, its low stack height, and its location in a densely populated residential area in the city center. However, the current plans for the town call for addressing lower risk heating plants first, suggesting that funds may not be available to address the Zelenice plant. Technical assistance for controlling pollution from heating sources appears to be needed in helping the town set priorities based on the relative costs and benefits of options.

With these general findings in mind, we recommend the following for follow-up activities and technical assistance in the Czech Republic.

B1. Northern Bohemia District Heating

Technical assistance in human health risk evaluation should focus on assessing the relative risks of various heating sources (e.g., district heating plants, small local boilers, individual furnaces), setting priorities for risk reduction, and developing low cost solutions that address major health risks. In our opinion, future technical assistance should target two cities for pilot demonstration activities. From a human health perspective, Decín and Žatec appear to have the most potential case as studies. The efforts should involve:

- Preparation of detailed analysis of the engineering, human health, and economic aspects of technological options that could address low-level pollution emissions from local heating sources.

- Incorporation of human exposure assessment into the analyses, so that technical options for optimal human health risk reduction at least cost can be identified.

- Close cooperation with the MOE, SFZP, municipalities, and local consultants to transfer know-how to Czech experts and to provide effective and consistent technical assistance to the two pilot towns.

B2. National Level

While projects funded by the MOE and SFZP have definite environmental merits, a need remains to further refine the process of project selection to ensure that limited resources are spent to achieve the greatest risk reduction. This is particularly important at a time of reduced state assistance to local governments. To rationalize the fund allocation process, we recommend the following assistance to the staff of the ministry and the fund:

- Develop and implement approaches for considering human health risk factors in selecting projects for technical and financial assistance. This could include assistance in refining the general criteria and approach currently used for project selection, and/or modifying the application forms for assistance requests.

- Incorporate human health risk assessment into the technical and economic evaluation of control options and establish procedures for considering a range of human health risk factors (e.g., pollutant characteristics and ambient concentrations, and human exposure characteristics) in formulating least-cost solutions for optimal health risk reduction.

Assisting the MOE and SFZP in developing and implementing approaches to sort and select projects by their potential to improve environmental health would lead to a more efficient allocation of resources. While the ministry's environmental policy draft and the fund's statement of priorities indicate the intention to allocate funds with such considerations in mind, this is not taking place due to a lack of staff resources, expertise, and information.[2]

To reinforce the policy and accelerate its implementation in project evaluation, USAID should consider providing limited assistance in this field. We recommend that USAID sponsor a pilot evaluation of a subset of selected projects, using local consultants and U.S. experts. During the course of the evaluation, USAID and its consultants would work with the staff of the Ministry of the Environment and State Environmental Fund to: (1) develop a human health-based approach and methodology for project evaluation, (2) implement the methodology on a subset of projects, (3) sponsor a workshop to critique the approach based on its pilot application, (4) revise the approach and methodology for broad application, and (5) modify application forms to request data necessary for implementing the approach.

Below, we summarize our preliminary ideas on an approach for evaluating air pollution control projects. A similar approach could be used for other applications. The goal is to quickly evaluate projects according to their potential contribution to health risk reduction. Both the general steps involved and the information needs and sources are identified below.

Steps:

1. Describe current air pollution sources and their emissions in the relevant geographic area. Include major sources outside the immediate geographic area that impact air quality.

2. Describe the current ambient air quality situation, based on available monitoring data for major pollutants.

3. Describe meteorological conditions (e.g., prevailing wind direction, occurrence of inversions), as well as terrain conditions (e.g., river valley).

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[2]The environmental benefits of projects are typically evaluated in terms of the quantities of emissions reduced. This is only one indicator of risk reduction. Other equally important risk factors include the release characteristics (e.g., stack height and pollutant concentration), location, and human exposure conditions.

4. Describe human exposure characteristics in terms of population densities in the area and exposure routes (e.g., inhalation, ingestion from deposition on soils and plants).

5. Assess the relative contribution of the sources to ambient air pollution and human health risk in the geographic area.

6. Estimate emissions reductions with the proposed changes relative to total emissions from all sources.

7. Estimate the potential impact of emissions reductions on ambient air quality in the area and associated human health risk reduction.

Information Needs and Sources:

1. Baseline information on location, fuel, and emissions of large and medium sources of air pollution (available from the Czech Hydrometeorological Institute, the Czech Environmental Inspection Station, or State District Offices).

2. Data on ambient air quality from Czech Hydrometeorological Institute database or from municipally owned stations.

3. Data on meteorological conditions from the Czech Hydrometeorological Institute.

4. Number of inhabitants for each Basic Settlement Unit (*Zakladni sidelni jednotka*) within the relevant geographic, derived from census data.

5. Map identifying sources and affected populations, as well as areas heated by central heating systems (if any) and coal burning households.

The methodological details needed to implement this approach would depend to a large degree on the time, resources, and data available to the ministry and fund. At one end of the spectrum, a qualitative assessment could be made of each step outlined above in the course of a site visit and discussions with municipal representatives familiar with the project. At the other end of the spectrum, a more quantitative assessment could be made using a geographical information system (GIS) and air modeling and risk assessment methods. An intermediate method that uses readily available information in a GIS database, without extensive modeling and risk calculations, could be a relatively inexpensive way to meet the needs of MOE and SFZP. In any case, the objective would be to consider a range of human health risk factors in evaluating projects to ensure that limited resources are allocated efficiently to achieve the greatest reduction in human health risks.

C. Economic and Institutional Aspects

In view of the pending ownership status of district heating systems and current service pricing distortions (due to subsidies and lack of adequate projections of operating costs), we were not able to provide precise financial evaluations or analyses of financing options for the proposed projects. There were other reasons as well:

- Although the proposed projects demonstrated merits from the technical and environmental health risk points of view, their economic viability could not be determined, within the time constraints of this mission, owing to uncertainties regarding future pricing flexibility, access to cleaner fuels (e.g., natural gas), costs of equally benign alternatives (coal washing, fluidized bed combustion, or simply use of cloth bag houses), or costs of other options for household heating (e.g., natural gas central heating at apartment blocks).

- While eligibility for funding under the EU PHARE program and SFZP may continue, we could not be sure what will happen under the HG Loan Program if the commercial bank requires recourse from the municipality, and if the latter is willing to grant guarantees if it did not wholly own the assets of the district heating utility.

- The profitability of the combined heat and power generation projects proposed by some cities was based on speculative assumptions that (1) the state will continue to provide consumer subsidy to households, and (2) CEZ, the power generation and transmission monopoly, will be willing to purchase cogenerated power from the district heating system at certain prices, even though no such assurances from the utility have been provided.[3]

With these caveats in mind, and except where specifically noted in our individual project evaluations, most of the proposals reviewed could be feasible and credit-worthy under the following circumstances:

- Gas supplies and prices remain stable up to double their current levels.

- The state consumer subsidy continues, enabling the district heating systems to recover capital investment and recurrent costs.

- In combined heat and power generation, distinct heating systems will be able to sell electricity at an average price of CK 1.30 to CK 1.50 per kilowatt/hour.

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[3]The price of heat delivery to customers in the service area of a district heating system is usually determined by the utility, based on a rate design formula mandated by the ministry of finance. During our field visits, we noted heat delivery prices in the range of CK 200 per gegajoule (Žatec) to more than CK 340 (Meziboří). However, while commercial consumers paid these prices, the government subsidizes household consumers by reimbursing them directly for the difference between the local market price, and the official support price of CK 139 per gegajoule.

Our recommendations for future technical assistance in the economic, financial and institutional areas, revolve around three areas:

- Cost accounting in district heating operations, and economic pricing of steam and hot water delivered to households and businesses.
- Benefit/cost analysis of alternative district heating technologies, including combined heat and power generation options.
- Project financing and accessing financial markets.

USAID technical assistance can be supplemented, as needed, with training in organization and management of district heating services. We also see a need for advising various central government grant-making organizations on methods to improve inter-agency coordination and rationalization of project identification and selection.

C1. Cost Recovery

In the cities we visited, we noticed that district heating system accounting systems are to a large extent uniform and conform to cost accounting methods dictated by the Ministry of Finance. However, it appeared that costs were not consistently reported in the various cities. For instance, while system rehabilitation costs appear to be capitalized in Žatec, other cities, such as Meziboří (and possibly Decín) tended to record these as operation and maintenance costs. While this is understandable given the need to recover as many costs as possible early on, the practice leads to high production costs and prices, and thus higher subsidies from the central government.

The present cost recovery system allows for a profit margin 5 to 8 percent (a low rate compared with prevailing interest rates), and depreciation of plant equipment at annual rates between 8 and 20 percent, based on historical costs and depreciation methods used. As a result, cash flow tends to be modest, leading us to doubt whether the current pricing system will allow for sufficient cost recovery and debt coverage once the district heating companies resort to external financing. Although Severoceske Teplarny, a private district heating company, is capable of raising funds commercially, it has been forced to abandon earlier plans for building a fluidized bed combustion plant because of its inability to recover costs and achieve an acceptable return under the current system.[4]

Accordingly, we recommend (subject to Czech government approval) that future technical assistance missions further investigate the current cost recovery system. This is

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[4]Headquartered in Most, northern Bohemia, Severoceske Teplarny owns the heating system in the district of Teplice, as well as heating plants and networks in Litomerice and Louny. The company also leases and operates two city district heating systems, and is presently seeking to obtain service contracts for the systems in Litvinov, Chomutov and Louny. Severoceske Teplarny, which became a joint stock company after the first wave of voucher privatization, is 25 percent owned by municipal governments, and the rest is in the hands of private investors. Its annual profits (before tax) amounted to CK 138 million, on total sales of CK 1.2 billion.

important, because central government subsidies to municipalities, fuel suppliers, and consumers are likely to be phased out and focused mainly on major environmental cleanup and energy conservation efforts. In addition, should municipalities decide to access the financial markets (including the HG loans), it will be essential that their proposed projects not only be technically and environmentally sound, but credit-worthy and capable of generating sufficient funds through user fees and charges to cover ongoing operational costs and debt servicing requirements. Technical assistance and training in the areas of cost recovery and economic pricing of heat delivery and other utility services can be provided under the forthcoming HG Loan Program.

C2. Financial Benefit/Cost Analysis of Alternative Courses of Action[5]

While fuel conversion from brown coal to natural gas at the district heating level would greatly contribute to reducing air pollutants, there may be definite advantages, in certain instances, in adopting lower cost, readily available, appropriate technologies.[6] This is particularly the case when a district heating system has access to better quality coal with lower sulfur and ash content, or when relatively inexpensive retrofitting can substantially lower environmental risks.[7]

In other instances, we saw the need to compare the option of increasing local heating plant capacity and network expansion with the option of building central heating facilities in municipally owned apartment blocks. For instance, in Decín, the cost of building a generation plant for heating 1,000 apartment units is approximately CK 60 million, compared with CK 15,000 per dwelling converted from coal heating to natural gas. The difference of CK 45,000 per unit does not necessarily favor household-level conversion, since other factors

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[5]We distinguish here between financial benefit-cost analysis, which is to be performed to compare among alternative technologies with similar pollution abatement benefits, and *economic benefit-cost analysis*. The latter, which takes into account opportunity costs and other externalities, should be performed in connection with environmental risk analyses to assess the current impact of pollution on the community and the ecosystem, and to rank, among other things, the anticipated results of pollution abatement measures in various facilities on public health risk reduction. Please refer to the findings and recommendations related to human health considerations.

[6]At the district heating system in Žatec (operated under contract by Severoceske Teplarny), the local manager believes that, based on report from Slovakia and Germany, where low quality lignite is being used in fluidized bed combustors (FBC), this option may economic. However, he did not have any data to substantiate his claim. From our perspective, the FBC technology has three great advantages: (1) coal constitutes only 1 to 3 percent of the bed, with the incombustible bulk serving to store and even out the heat; (2) the process emits considerably fewer NO_x than existing U.S. standards permits; and (3) the boilers can be built in a wide range of sizes. They are also particularly suited for combined heat and power generation.

[7]See, for instance, our analysis for the district heating system in Litoměřice, where Severoceske Teplarny, which owns the local district heating plants, is proposing to install bag houses to reduce ash emissions and has forced the local coal supplier to provide them with lower sulfur coal. The same company was also considering fluidized bed conversion technologies as an alternative to fuel conversion, but abandoned that alternative after determining that they could not generate sufficient cash flow to service the debt required.

such as fuel consumption and other costs of production enter into the equation. Nonetheless, we may need to consider all the factors involved before opting for a course of action.[8]

Although we found sophisticated expertise in the cities of Decín and Usti and among the staff the district heating company Severoceske Teplarny, municipal staff continue to need further technical assistance in financial benefit/cost analysis and the preparation of feasibility studies, particularly in smaller cities. The staff tend to rely on the assistance of district-level engineering services and, in two cases (Aš and Rotava), the advice seems to be taken at face value, without further investigation.

C3. Project Financing

This is perhaps the most important area of institutional support in which USAID can provide assistance. Most local government officials and district heating general managers have no experience in this field.[9] With their limited ability to mobilize local resources and their reliance on state (income tax) revenue sharing for 70 to 90 percent of their operational budgets, the majority of Czech municipalities are uncertain how to fund their ambitious environmental projects. Although two cities have already floated bonds, access to financial markets is confined to short-term commercial banking loans, obtained generally against collateralized municipal assets.[10]

At present, we see few options for funding district heating upgrade projects other than state grants and interest-subsidized bank commercial loans. In the longer run, however, once the assets are transferred to the municipalities and the ownership status of the prospective companies is determined, several alternatives may become available. These options, as well as the prerequisites for success and mechanisms for their implementation, are discussed below:

Grants and other subsidies. We recommend that increased portions of these state contributions be channeled to finance two types of initiatives: (1) projects in highly polluted areas with the greatest potential benefits for environmental health risk reduction, and (2) energy conservation measures, particularly insulation of public housing and municipal buildings, as a means to lower demand for heat and consequently to lower emissions.

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[8]Such analysis apparently was performed in Decín. The local housing enterprise, which administers the district heating system, found it more economical to convert dwellings in certain neighborhoods to natural gas.

[9]Many cities are already exploring the possibility of accessing the municipal bond market but are unsure how to proceed. Pilsen, a major industrial city in western Bohemia, appears to be seriously considering floating a Eurodollar bond, and has already begun preliminary talks with Chase Securities, a subsidiary of Chase Manhattan Bank. City officials appear to be having second thoughts because of the high cost of obtaining a debt rating from Standard & Poors.

[10]Information based on interview with Mr. Michael Schaeffer, a USAID consultant, during a meeting in Prague on March 21, 1994.

We also suggest that SFZP and the MOE, which also administer EU PHARE grants, work closely in this area with the Czech Energy Agency (at the Ministry of Industry and Trade), which currently implements a similar program of energy conservation. Furthermore, to spread the limited grant moneys among competing claimants, we recommend that SFZP and the MOE earmark part of their subsidies for matching grants, in proportion to funds generated by the municipalities internally or secured from commercial sources. This will encourage municipalities to actively mobilize their own resources, while effectively decreasing their overall cost of capital and, hopefully, the financial burden of debt repayment.

Subsidized loans. This category of funding should be maintained to ease the burden of debt servicing, particularly in smaller, economically depressed areas in northern Bohemia and Moravia. However, given the small pool of funds available, it may be preferable to earmark these funds for the rehabilitation and upgrade work in the most affected communities as well as for cost-effective, energy saving initiatives that could lead to substantial pollution abatement and, consequently, measurably reduce environmental health risks.

Municipal bonds. Given the uncertainty about the future ownership status of municipal district heating systems, we are not sure that this instrument can be used directly by the prospective heating companies. Should some of them remain majority owned by the municipalities (which seems to be the most likely scenario), it may be possible for cities to loan funds to the company. However, it will be essential that local governments not overburden themselves with debt and that they ensure a sufficient stream of cash flow generated by the district heating companies to reimburse the debt. This will depend again on service pricing and adequacy of the cost recovery system.

The forthcoming HG Loan Program should serve as a venue to channel technical assistance and training in municipal finance and cost recovery (including rate design and development of user fees and charges), particularly for district heating company personnel. To these ends, we recommend that future USAID advisory missions work closely with the ministry of finance to ensure that proposed cost recovery solutions are in compliance with government regulations.

Commercial loans. As noted earlier, commercial loans (excluding state subsidized programs), are of short duration and invariably contingent on the availability of acceptable collateral (usually real estate). We do not view this as an adequate means to fund long-term projects unless, of course, the short-term debt is used for bridge-financing purposes and future funding has been readily identified and secured.

We believe the prospective district heating companies will not immediately qualify for commercial loans unless they are able to provide external guarantees. The proposed technical assistance under the HG Loan Program should prove beneficial to both the heating companies and commercial banks. Introducing new concepts of long-term commercial financing, based on the borrower's ability to generate funds rather than assets, will encourage the municipally owned utilities to lower their costs, improve their efficiency and profitability, and, eventually, become self-sustaining.

Non-recourse project finance. Once established, the heating companies may seek to fund large system conversion or rehabilitation projects by requiring interested suppliers to provide project financing at their own risk, or by bringing in a financial institution to share the risks.

This option may not be cost effective in the case of smaller district heating utilities from the supplier perspective. However, in the cases of Decín or Pilsen, the volume of work could be very attractive to a consortium of engineering firms, equipment suppliers, and lending institutions. Although both cities are receiving technical assistance from other sources at present, officials in both places expressed interest in receiving additional support in securing external financing. The additional technical assistance will build upon work being done by (1) familiarizing local officials and district heating managers with non-recourse project financing and the range of other potential financing options, and (2) helping them prepare the engineering specifications and financial documentation necessary to qualify them for external financing.

Cost sharing through cogeneration. Several municipalities favored the development of combined heat and power generation to lower heating costs through sale of cogenerated electricity to CEZ, the national electric generation and transmission monopoly.[11] While the economics of this option are doubtful at present in light of the absence of regulations governing power purchases from independent producers, the option is potentially viable under certain pricing scenarios presented to us in Pilsen, Decín, and Meziboří.

The draft environmental policy program prepared by the MOE calls for supporting combined heat and power production and for developing an independent regulatory body for the electrical sector. The Ministry of Industry and Trade, which supervises the electric power sector, has similar plans in the works. However, no information was available to us on future prospects, and none of the cities contemplating cogeneration options had any indications (other than speculations and tentative agreements) of the price of bulk power sales to the distribution utility. Thus, we can only suggest that the government is predisposed to that option. Should cogeneration receive the green light from the government and a policy be developed, cogeneration may become a cost effective alternative.

The availability of power sale agreements between the district heating companies and an electric utility will greatly facilitate cogeneration project financing, because of the financial strength and stability of the electric utility. However, the heating companies will still have to put their houses in order first, so to speak. We see here a definite need for technical assistance and training in the areas of cost recovery and recommend that a future USAID mission help the cities of Pilsen, Decín, and Meziboří assess the benefits and costs of heat generation (alone) versus cogeneration, and work closely with their staff to estimate production costs under the options considered.

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[11]It is our understanding that CEZ has been broken up into a power generation and transmission company, and eight regional distribution companies. Initial unfruitful attempts to reach officials at CEZ to discuss power purchases from cogenerators and other subjects were followed up because of time limitations.

Lastly, it may be useful to explore the possibility of cost sharing between district heating companies and electric distribution utilities. Depending on the costs of purchasing from CEZ versus the heating company, the regional utilities may find it advantageous to cofinance the development of heat and power generation plants in exchange for future sales agreements. However, we should emphasize that the legality of power purchases or sales from or to utilities other than CEZ could not be ascertained during this mission.[12]

Build-operate-transfer and variations on the theme. Other financing options, which are being increasingly used in the power generation sector, particularly in China and southeast Asian countries, are the so-called build-operate-transfer (BOT) and build-own-operate (BOO) schemes. These mechanisms allow service providers (be they privately or publicly owned utilities) to access external financing sources, with little or no upfront expenditure. The structuring of BOT and BOO projects resembles a concession-type arrangement, where a utility (or sometimes a transportation agency) contracts with a private concern for construction, operation, and maintenance of part or all of a service delivery system. These types of project include power generation, wastewater treatment, and water systems. The investing company finances the initial capital investment costs and pays the working capital required for operation and management. In exchange it receives revenues from the services (or, rarely, directly from the consumers) for providing these services.

BOT projects have a maturity date that corresponds to the time investors need to recoup the capital initially invested and earn a rate of return on these investments. After this maturity date, the capital structures revert to the service provider. Under BOO arrangements, the private investor generally retains ownership of the infrastructure but may, subject to mutual agreement, transfer it to the service provider under certain contractual conditions.

From the perspective of municipally owned district heating systems, the BOT/BOO alternatives offer several rewards. These include:

- Construction, rehabilitation, or expansion of heating systems in accordance with government environmental regulations.
- Off balance sheet financing, which represents budgetary savings on capital and recurrent costs.
- Introduction of new managerial methods and technologies.

These arrangements can be complex, however, because of stringent contractual requirements regarding performance by the private investor and commitments by municipal district heating systems with respect to compensation and financial guarantees (take or pay clauses). Other potential difficulties include:

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[12]In addition to uncertainties related to the price of power purchased from cogenerators, the Czech Republic is currently adding 2,000 2MW of nuclear power. Some of the excess capacity that will be produced will be exported to western European countries under long-term contracts. We do not know how this will affect the disposition of CEZ and the distributing utilities to buy power from district heating producers.

- Negotiation of length of BOT concession.
- Quality of service.
- Service pricing and inflationary cost clauses.
- Condition of installations at the end of the contract, in the case of BOTs.

Furthermore, from the investor's perspective, the development costs of BOT/BOO may be high. In the case of large projects, potential investors may have to spend years and substantial amounts of money on project design, engineering studies, financial evaluations, and legal negotiations. While we do not think this type of project financing is appropriate for most cities we visited, we believe that, in the case of medium and large size metropolitan areas (Decín, Pilsen, and Usti), BOO and BOT schemes should be seriously considered as an alternative to outright debt. Technical assistance in these instances can be provided either through the private sector component of EP3, or through USAID's CDI project. Technical assistance should include:

- Assisting the three cities mentioned above in investigating financing alternatives, including BOT and BOO schemes.

- Helping them prepare the documentation necessary to approach external financing sources.

- Matching prospective district heating utilities with potential U.S. construction and engineering firms, equipment suppliers, and investors.

Subsequent assistance may be provided in developing the terms of reference and requests for proposals, developing bid evaluation criteria, evaluating bids, and negotiating contracts.

For smaller projects, we recommend investigating other variations to the BOT and BOO alternatives described above. In the Philippines, for instance, the government-owned National Power Corporation (NPC) is presently soliciting offers for lease-rehabilitate-operate-transfer (LROT) and build-lease-operate-transfer schemes (BLOT). Under these options, the power utility maintains its ownership of the generation plants but purchases power (in bulk) from its lessees over a predetermined period. By doing so, NPC is guaranteed a supply of electricity without investing upfront in construction or rehabilitation, and the plants are operated and maintained by the lessees in accordance with the terms of their contracts.

The LROT and BLOT options are quite appropriate in the context of the small cities of northern Bohemia. As we noted previously, the Most-based Severoceske Teplarny heating company is already operating several district heating companies under contract with a number of small cities. Introducing these schemes in such places as Aš and Rotava has two potential benefits: (1) they will enable the cities to rehabilitate their systems without using the limited budgets at their disposal, (2) a company such as Severoceske Teplarny can supply qualified staff to supplement local operators and ensure proper and efficient operation of district heating facilities. Future technical assistance in this respect may include working closely

with the staff of the MOE (including SFZP) to identify cities that are likely candidates for such schemes. They should then:

- Meet with officials from the cities to explain the LROT and BLOT concepts and solicit their opinion.
- Based on the feedback obtained, develop models for requests for bids from qualified companies.
- Develop evaluation criteria for prospective bids.
- Draft model contracts that could be followed by district heating systems.

SECTION II
BACKGROUND AND PURPOSE OF THE MISSION

This first USAID mission to the Czech Republic in support of the Environmental Action Program (EAP) for Europe was carried out from 21 March to 8 April 1994. It falls under the Project Preparation Committee component of the EAP and is a result of the commitment of the U.S. Government to identify environmental project opportunities in Central and Eastern Europe (CEE) and assist local institutions in pre-investment analysis of activities to improve environmental health in the region. The mission had four objectives:

- Assess the economic and technical feasibility of municipal infrastructure projects aimed at improving ambient air quality and environmental health in selected cities of northern Bohemia and northern Moravia.

- Select a sample of promising environmental projects, primarily in the area of municipal district heating, which could benefit from additional technical assistance under the auspices of USAID.

- Support municipal infrastructure projects that are likely candidates for funding under USAID's forthcoming Housing Guaranty Loan Program in the Czech Republic and meet EPA criteria.

- Develop recommendations for enhancing the current process of project identification and funding at the Ministry of the Environment and the State Environmental Fund.

A. The Environmental Action Program

The EAP for Central and Eastern Europe was established, at the meeting of ministers of environment in Lucerne, Switzerland (in April 1993).[1] The Lucerne agreement is designed as a partnership among Western countries and the countries of CEE and the New Independent States (NIS) to improve environmental health in Europe. The EAP recognizes that, despite extensive efforts by CEE governments, severe environmental problems remain. Further, the urgency of the needs and the limitations of grant financing for environmental investments require that foreign donor resources be more focused, and leveraged with those of the aid recipient governments, to maximize their impact.

[1]The Lucerne meeting was intended to follow up on the United Nations Conference on Environment and Development (UNCED) of 1992. It was based on the perception that, despite the efforts of the CEE countries, more urgent efforts are needed to deal with the critical environmental problems of the region. For further information, please refer to the *Environmental Action Programme for Central and Eastern Europe*, Washington, D.C.: World Bank, 1994.

The EAP's principal priority is environmental health. Numerous studies in the last several years have identified poor air quality as the primary cause of major environmental health threats in the region. The EAP specifically cites the following pollutants as critical:

- Airborne dust from household furnaces, small-scale enterprises, power and heating plants, and metallurgical and other plants;
- Lead and other heavy metals in air and soil, often from smelters and transport;
- Sulfur dioxide and other gases, especially in combination with dust.[2]

A1. Structure of the EAP

The EAP is designed to deal with critical environmental problems by supporting ongoing efforts in institutional strengthening, policy reform, and capital investments in pollution abatement. To these ends, the Lucerne Agreement created two interrelated entities. The first is a "Task Force" to provide assistance in policy formulation and development of National Environmental Action Programs (NEAPs). The membership of the Task Force includes the signatory countries, international financial institutions (IFIs), and environmental NGOs, with the Organization for Economic Cooperation and Development (OECD) serving as its secretariat. The second is a "Project Preparation Committee," (PPC) to coordinate the efforts of donors in identifying, selecting, and preparing projects for possible funding through IFIs. The PPC consists of active donors and IFIs. There is no secretariat as such, but there are four environmental investment advisors, provided by individual PPC members, to the World Bank and the European Bank for Reconstruction and Development.

A2. PPC Criteria

While the Lucerne Agreement was specific in focusing on activities aimed at improving environmental health in the region, it did not include the means of financing investments in such projects. Rather, the funding for these investments is expected to be obtained from domestic and international capital markets. Therefore, the success of the PPC initiative is contingent upon the ability of sponsoring governments to devise the means to make the selected projects credit-worthy, and to assure their access to credit markets.

A3. USAID Missions to Support the PPC

At the Lucerne Conference, the U.S. Government pledged $10 million, over a period of three years, to support the PPC process. To channel this assistance, USAID has established a number of mechanisms for providing technical expertise and other resources to

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[2] Other important health threats arise from agriculture-based, non-point source pollution of water, food, and water from toxic chemicals and heavy metals. The destruction and degradation of natural resource systems, loss of biodiversity, and degradation of wetlands, marine ecosystems, and similar habitats also pose serious economic and quality-of-life problems. The agreement recognizes that in addition to these region-wide problems, specific areas and localities may have other, equally serious environmental health threats.

CEE and NIS countries. In addition, the U.S. EPA works closely with USAID and is an active participant in the Task Force and the PPC.

To initiate the PPC process, USAID fielded project identification missions to Poland, Estonia, and the Czech Republic, and is planning follow-up and new missions to the region during 1994. These missions serve both general EAP as well as specific PPC objectives, which include the following:

- Stimulate host country efforts in setting up the domestic processes for both NEAP and PPC activities, and identify areas within the host country institutions where assistance could further the EAP/PPC process.

- Explain the PPC investment criteria and USAID technical assistance available for project preparation, and work closely with host government counterparts on establishing enhanced processes for identifying and evaluating PPC projects.

- Identify and evaluate projects that fit the PPC criteria in terms of environmental health improvement and economic viability.

- Provide a preliminary assessment of a sample of projects to gain a better understanding of the technical and fiscal issues involved, determine the commitment of the sponsoring entity, and ascertain how USAID assistance could best be utilized.

B. PPC Issues in the Czech Republic

The Czech Republic has several attributes that make it a prime candidate for USAID technical assistance within the framework of the PPC. Indeed, the Czech Government has shown considerable interest in promoting the EAP process, and the Ministry of the Environment has drafted a new National Environment Plan that incorporates the priorities outlined in the EAP. The ministry has compiled a list of projects for PPC review and is actively soliciting proposals from local government units.

B1. Financial Environment Favorable to PPC Activities

The stable economic situation in the Czech Republic is promoting the development of orderly financial markets. Inflation and interest rates are declining, and activity is growing in the equity and debt markets, including a modest volume of secondary trading in municipal bonds. While outstanding issues of privatization and regulatory reform may present serious impediments, the macroeconomic conditions and regulatory framework are hospitable to the development of credit-worthy environmental projects.

Of particular importance in that context is the forthcoming USAID Housing Loan Guaranty Program. The program, scheduled to be initiated next Fall, aims (among other objectives) to increase the involvement of the banking sector in municipal finance by channelling relatively inexpensive funds to local government units through local banks. The

latter will make commercial loans available for municipal projects related to residential infrastructure, including environmental infrastructure, at competitive interest rates. These loans offer the possibility of favorable financing for certain PPC projects that were identified during our mission.

B2. Follow-Up USAID Efforts

From the perspective of the U.S. Government, PPC activities represent an extension of its ongoing efforts to improve environmental conditions in the Czech Republic. The United States presently has extensive programs in northern Bohemia (Teplice, Usti, and Pilsen) and northern Moravia (Upper Silesia Project, in Ostrava).[3] These programs, which focus on environmental problems, including measurement of environmental risk and better energy management, have clearly identified low-level emissions as a principal health threat. These emissions can be from industrial processes, such as coke ovens in Ostrava, or, most importantly, from the widespread coal-fired residential and district heating facilities. This presents an opportunity to focus follow-up efforts on a specific sector in that country, thus allowing USAID to maximize results from the limited technical assistance available.

[3] In addition, much of the work done by USAID and DOE in southern Poland is directly relevant to the context of the Czech Republic, and some of the solutions formulated there are directly relevant to northern Bohemia and northern Moravia.

SECTION III
OVERVIEW OF CURRENT ENVIRONMENTAL PROBLEMS AND POLICIES

In a recent speech before Parliament, the Czech health minister, Ludek Rubas, declared that average life expectancy in the republic is six to seven years shorter than in other European countries and the mortality rate of men in the work force is twice as high. According to Mr. Rubas, life style was responsible for 60 percent of these deaths, while low-quality environment and health care accounted for 20 percent each.[1] Contributing factors include chronic and acute exposure to pollutants, high-fat diets, smoking, stress, and safety hazards in the work place and on the road. In the highly industrialized mining districts of northern Bohemia and Moravia, practices associated with coal extraction, industrial production, and power and heat generation, combined with poor solid and wastewater management, are the root cause of many public health risks and environmental damages. The net effect of these practices, which are prevalent in many CEE countries, include:

- Severe air pollution, with high levels of sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), volatile hydrocarbons (C_xH_y), lead, suspended particulates, and other hazardous chemicals in the ambient air, emanating from emissions from power and district heating, industrial plants, transportation, and household coal heating. Other contributors to air pollution include ammonia, fluorine, chlorine, phenol, hydrogen sulfide, and arsenic.

- Acid rain, also caused by soft coal combustion.

- Surface, groundwater, and soil contamination, resulting from mining and agricultural runoff of nitrogenous fertilizers, pesticides, and toxic organics and metals.

The Czech Republic at a Glance

Formerly part of Czechoslovakia, the Czech Republic emerged as an independent republic on January 1, 1993. The country has an area of 30,450 square miles and a population of approximately 10 million. It rests on the Bohemian Plateau, which stretches west to the German border and east to Slovakia. Mountains, including the Bohemian, Sudetes, and Carpathian ranges, rise along the plateau's edges, primarily to the north and east. The central part of the plateau consists primarily of rolling hills, farmland, and fertile river beds. The Republic's primary rivers include the Elbe, Vltava, Morava, and Oder. The country's highest point is Snezka, which rises 5,256 feet in the Sudetes Mountains.

Coal is the most common natural resource in the Czech Republic, particularly brown coal and lignite. Increased excavation and use of coal has wreaked environmental havoc on the Republic's air and water quality, which has subsequently affected the health of the population. Magnesite, iron ore, and a few nonmetallic minerals are also common in parts of the Republic.

[1] *Prognosis* (Prague), March 15, 1994, p.2. The declaration made before the Parliament of the Czech Republic on March 2, 1994.

Surface water is also greatly affected by discharges of untreated municipal and industrial wastewater with high concentrations of biochemical oxygen demand (BOD), and total suspended solids.

- Poor solid waste handling, including the presence of metals, organics, radioactive contaminants and other hazardous wastes at an undetermined number of sites.

- Unsanitary work conditions, leading to on-the-job exposure to chemical and other hazards.

Interestingly, while the Czech Republic as a whole rates well on average among CEE countries in terms of emission of total suspended particulates and sulfur dioxide, the industrial regions of northern Bohemia and Moravia are choked by pollution. Within these regions lie much of the Czech heavy industry (chemicals, steel, and cement), and a large number of inefficient, coal-burning power generation and district heating plants, which emit huge quantities of hazardous gases, suspended particulates, and hydrocarbons.[2] Among the most damaged areas are the cities of Usti, Most, Decín, and Ostrava, which were visited during this mission, Sokolov (the supplier of coal to the nearby towns of As and Rotova, which was also visited) and the capital, Prague.[3] Although water and soil conditions have had their toll on the environment, our mission, as noted earlier, concentrated on ambient air quality conditions in the north of the country, owing to their severe impact on public health.

Needless to say, the cleanup costs are staggering. To that end, the Czech Republic has passed a series of laws to accelerate the process, and has imposed charges on industrial and municipal polluters. These charges are scheduled to more than triple by 1998, before additional fines are assessed or facilities are closed. Meanwhile, municipal governments across the country have begun evaluating options to remedy these situations.

A. Resource Constraints

Unfortunately, the Czech national and local governments are faced with a multitude of problems. Despite the success of the first wave of privatization, the country still has to contend with a slowly emerging market economy. The economic reforms have led to substantial reduction of central government subsidies for municipal infrastructure, despite the obvious need for repairing and upgrading municipal infrastructure and service delivery

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[2]According to a report by Resources for the Future, the average percentage reduction in Total Suspended Particulates (TSP) needed to meet the European Union's standards for ambient concentrations is only 5 percent, versus 40-49 percent in Bulgaria, Hungary, Poland, and Ukraine. In the case of SO_2, the Czech Republic needs to reduce its emissions by 26 percent, compared to 12 percent in Hungary and 32 to 70 percent in the other three states. For further information, please refer to A.J. Krupnick et al, "Assessing the Health Benefits of Improved Air Quality in Central and Eastern Europe," *Resources,* No. 113, Fall 1993.

[3]During air inversions in January 1982 and February 1987, the 24-hour SO_2 concentrations in the city of Prague exceeded 3,000 micrograms per cubic meter, more than 20 times the limit admissible in any 24-hour period.

systems.[4] Despite good intentions and realistic environmental rehabilitation plans, the governments are likely to be overwhelmed by pressure to preserve jobs.[5] Unemployment, particularly in northern Bohemia and Moravia, is almost double the national average of 3.5 percent.

Faced with these constraints, industrial concerns and local government units have a number of options with limited funding capability at their disposal. In addition to the modest subsidies allocated by the central government to the highly damaged, economically depressed areas through the so-called "burial fund," many are applying for grants from the State Environmental Fund (known by its Czech initials as SFZP) and the EU-funded PHARE Program. Although Czech local governments have little ability to generate funds other than fees and charges authorized by the central government, two cities have already floated municipal bonds by pledging real estate assets; and two other cities—Prague and Pilsen—are seriously considering issuing dollar-denominated debt instruments for the Euromarket.[6] Further, over 160 municipalities have expressed interest in borrowing the necessary capital from the forthcoming Housing Guaranty (HG) Loan Program. In their response to official government announcements and advertisements about the HG Program placed in the Czech press at the end of last year, approximately 40 city governments indicated that the amounts borrowed will be used to rehabilitate the current air pollution control devices in their district heating systems, reconfigure them, or convert current heat generating processes from coal to natural gas.[7]

B. Current Ambient Air Quality Conditions

The northern regions of Bohemia and Moravia are among the most damaged areas in CEE countries. They are part of the Silesian coal belt, which also encompasses southern Poland and southeast Germany. These two Czech regions, which release approximately 1 percent of the world's total SO_2 emissions, also cause substantial transboundary pollution.

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[4]G.T. Kingsley and J. Tomankova, "Candidate Infrastructure Projects Proposed by Czech Municipalities," Working Paper, 6283/43 (prepared under USAID Project No. 180-0034). Washington, D.C.: The Urban Institute, February 1994.

[5]Faced with budgetary constraints, the Czech government decided on March 23 to lower its allocation from Kc 1 billion to Kc 400 million to deal with unemployment in northern districts. The day before, approximately 30,000 labor union members demonstrated in Prague's Old Town Square, ostensibly to protest raising the retirement age. Observers believe, however, that the demonstration reflected discontent in the ranks of "a movement bewildered at its own inability to influence social policy." (*Prognosis*, April 1, 1994, pp. 2, 5)

[6]The city of Prague has already received a triple B (low-level investment-grade) rating from Standard and Poors and is preparing to issue up to $150 million in bonds. Pilsen has had some preliminary discussions with Chase Securities, a subsidiary of Chase Manhattan, but does not appear to be ready yet.

[7]*Ibid.*, p. 3.

B1. Trends

In 1991, total emissions of SO_2 in the Czech Republic amounted to approximately 1.8 million metric tons, compared to about 2.3 million in 1982. According to the Ministry of the Environment, the decline in emissions began in 1984, with a dramatic fall in 1990, chiefly because economic restructuring affected industrial production following the Velvet Revolution.[8]

This trend is, however, not followed by significant improvement in the ambient air quality. Annual average concentrations of SO_2 and particulate matters in northern Bohemia and northern Moravia still exceed World Health Organization limits. These conditions are further worsened during winter inversions.

The Czech Economy

The Czech Republic has been very successful in containing inflation. Following the introduction of the value added tax in January 1993, prices jumped approximately 8.5 percent, but subsequently stabilized at approximately 1 percent per month over the remainder of the year. According to government reports, the consumer price index increased by 18.2 percent over the 12-month period ending December 1993. Official and OECD forecasts anticipate an inflation rate of about 10 percent for 1994. The main causes of price increases this year are likely to be linked to further government deregulation, wage increases, and the removal (or modification) of price ceilings in such areas as rental rates, heating, and electricity.

The stabilization of inflation has had a positive impact on interest rates, particularly in the interbank market where various short-term rates decreased by slightly over 2 percent in the last quarter of 1993. Longer-term commercial rates and yield on bonds (including two municipal issues) have already dropped, and may continue their decline in the short run. The OECD predicts, however, that unemployment will run at 8 percent in 1994-1995, while wage growth will hold at 5 percent per year during the same period.

The Czech Republic has exercised monetary and budgetary restraints and fared well in international trade, registering only a modest deficit in 1993, thanks to its success in expanding its markets in the West and in Asia. Heavy industry and the mining sectors, on the other hand, have been hard hit by the dismantling of Comecon and saturated global demand for metallurgical products. Given the structure of these regions and the critical state of their environment, the financial costs of redressing their economies are heavy. In the Ostrava region, which has a population of nearly 1 million, the approximate cost of economic reconstruction is estimated at more than CK 250 billion. Such a massive amount cannot be supported by the state and the domestic banking system. The restructuring of the big industrial groups is highly complex, and their privatization will probably necessitate large-scale downsizing of the labor force. The possibility of loans from international financial institutions is somewhat doubtful, since the government is very hesitant to guarantee them.

[8] *Environmental Year-Book of the Czech Republic, 1993*, p. 87.

Between September 1992 and April 1993, the country experienced three severe episodes of air pollution (including smog) due to high atmospheric pressure over Central Europe followed by unfavorable dispersion conditions.[9]

Concurrently, in a number of places at 1,000 meters above sea level, a winter inversion brought about a massive accumulation of harmful air pollutants. On December 16, 1992, the average concentration of SO_2 reached 370 micrograms per cubic meter in northwest Bohemia, almost two and a half times the maximum average daily concentration limit. This was followed by further deterioration the next day, when recordings exceeded 600 micrograms in the Chomutov and Teplice regions. Other regions in northern Bohemia, northern Moravia, and Silesia experienced similar severe episodes during the period in question, and reached their highest during the second week of February 1993, when SO_2 daily concentration reached 900 micrograms per cubic meter in the Teplice region, and 500 in Most. In the Ostrava region (northern Moravia), the highest daily concentration reached 440 micrograms per cubic meter at one point during that period. However, a more serious problem in that region is posed by drifting dust and, in the city of Ostrava, by a high concentration of NO_x.

Total Emission of Main Pollutants in the Czech Republic During 1991 (metric tons)

SO_2	1,775,560.70
NO_x	724,979.20
CO	1,101,920.10
C_xH_y	227,159.60

Source: *Environmental Year-Book of the Czech Republic, 1993*

B2. Public Health Impact

Mr. Rubas' declaration before parliament illustrates well the government's concern about the strong inter-relationship between environmental, dietetic, and other life-style influences, though the relationships are difficult to ascertain with precision. Czechs, in general, tend to smoke heavily and eat fatty foods. These habits, combined with bad environmental conditions, further increase the likelihood of the incidence of respiratory illnesses, cancer, hypertension, and heart disease.

[9]Pollutant concentrates are reduced by atmospheric mixing, which depends on such weather conditions as temperature, wind speed, and the movement of high and low pressure systems and their interaction with the local topography. Normally, temperature decreases with altitude. But when a colder layer of air settles under a warm layer, producing a temperature or thermal inversion, atmospheric mixing is retarded and pollutants may accumulate near the ground. Inversions can become sustained under a stationary high-pressure system coupled with low wind speeds. Periods of only three days of poor atmospheric mixing can lead to high concentrations of hazardous materials in high-pollution areas and, under severe conditions, can result in injury and even death. An inversion over Donora, Pennsylvania in 1948 caused respiratory illness in over 6,000 persons and led to the death of 20. Four years later, severe pollution in London took 3,500 to 4,000 lives.

Exposure to air pollutants at any level increases health risks, and public health damage is roughly proportional to exposure.[10] Studies conducted under the auspices of the Teplice Program, performed in cooperation with the U.S. EPA, have found that average life expectancy in that district is two to three years below national average for males, and one to two years for females.[11] Some 82 percent of air pollution in the Teplice region is caused by coal combustion. Dust particles in that area tend to be so minute that they could easily pass from the lungs into the blood stream. These emissions also contain, in addition to SO_2, NO_x, and particulates, high concentrations of arsenic and mercury, and carcinogenic polycyclic hydrocarbon (PAU) levels that were four to five times higher than in large U.S. cities.[12]

Other studies carried out in the past decade have also shown a strong correlation between mortality among 0-1 year-old infants and high concentrations of particulates. In the Ostrava region, data obtained by molecular dosimetry showed that PAU emissions from coke-producing plants have higher genotoxic potential than tobacco smoke.

B3. Root Causes

Between 1948 and 1989, the mining and burning of lignite coal multiplied almost seven-fold, reaching approximately 100 million metric tons per year in 1989. Hard coal, on the other hand, increased from approximately 10 million tons per year to less than 25 million during the same period. On the eve of the Velvet Revolution, solid fuels (mainly coal) were the main source of commercial energy in former Czechoslovakia, accounting for 1,702 petajoules, or 62 percent of total energy consumption. Consumption of petroleum products (including natural gas) stood at 916 petajoules (34 percent), and electricity at 114 petajoules (4 percent).

The reliance of northern Bohemia and Moravia on poor-quality brown coal with high sulfur and ash contents accounts for most of the air problems currently experienced in these regions.[13] This mostly surface-mined source of energy is used in industrial production and power generation. It is also a cheap fuel for coal burning, low-stack household heating, small-scale industry, and district heating plants, which are significant contributors to atmospheric pollution.

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[10]Exposure to SO_2 and particulates greater than 1,000 micrograms per cubic meter (0.4 ppm) during a 24-hour period causes measurable increases in mortality among patients with heart or respiratory illnesses. Levels above 250 micrograms per cubic meter (0.1 ppm) seem to worsen the health of such patients. Chronic or long-term exposure to 100 to 250 micrograms per cubic meter increases coughing and vulnerability to respiratory illness such as asthma, emphysema, and bronchitis, particularly among children.

[11]*Environmental Year-Book of the Czech Republic, 1993,* op. cit. p.279. Earlier statistics from 1988 have shown that men's life expectancy in Most and Sokolov, two highly polluted cities in North Bohemia, was approximately six years lower than in the rest of Czechoslovakia.

[12]*Ibid.*, p. 279.

[13]Czech coal contains up to 40 percent ash and 1 to 15 percent sulfur per weight. Power plants in the United States use a higher-quality coal with ash content between 5 and 10 percent, and 5 to 4 percent sulfur.

The inefficient use of energy under the previous Czech command economy has been well documented. Although Czechoslovakia was relatively advanced in its industrialization prior to World War II, much of the damage occurred in the fifties and sixties with intensification of energy use (almost double the rate in Western Europe). Much of the damage was caused by a policy that promoted the growth of heavy industry by subsidizing the prices of inputs for industrial production, particularly energy prices, which reflected neither the costs of environmental remediation nor the rising costs of coal extraction. Other factors affected energy intensity of industrial production as well:

- Low energy prices, particularly for coal, led to over-consumption by industrial and individual consumers alike. Consequently, both paid lip service to energy conservation.

Energy Efficiency

Energy intensity in the former CEE planned economies is among the highest in industrialized countries. The energy required to make steel in the CEE is estimated to be two to three times greater than in Western Europe, owing to the prevailing use of older, less efficient technologies. For example, the hearth process, which accounts for over half of steel production in the CEE and former Soviet Union, is virtually out of use in the rest of Europe and accounts for less than 8 percent of U.S. output.

Energy consumption in the Czech Republic is approximately $7.4 billion and represents over 25 percent of GDP. Surveys cited by T.J. Sherwood, of USAID's Capital Development Initiative project, have reported that savings in the range of 15 to 50 percent are achievable in the ferrous metal sector, and 30 to 33 percent in the chemical and building sectors. Overall savings of 21 to 33 percent are obtainable in the economy as a whole. These savings can translate into annual savings of $1.5 to $2.3 billion, which exceed annual direct foreign investments in that country and represent 6 to 8 percent of current GDP.

- Lack of incentives for improved efficiency, technological innovation, and resource preservation. The government's economic plans emphasized quantitative outputs regardless of resource usage. Any fines assessed for environmental violations were usually incorporated into the state enterprise's budget as a regular cost of doing business.

- As state finances declined in the eighties, the enterprises had little funds to invest in new machinery. Similarly, power generation plants, particularly district heating plants (often built as a "temporary measure until more elaborate systems are constructed") became outdated. This led, in turn, to increased maintenance costs and noticeable decreases in efficiency.

- Absence of local government autonomy. The affected communities had limited authority over polluters in their jurisdiction and were not, in general, compensated by either the abusers or the state for environmental degradation within their boundaries.

During the seventies and eighties, the government began to express concern about environmental problems, and in fact enacted elaborate environmental protection laws about the same time as their Western European counterparts. However, industry failed to invest in pollution prevention or control, since the penalties tended to be less expensive than

remediation or rehabilitation. For its part, the government did not enforce its own regulation and continued to promote the use of local coal as a means to maintain economic independence, preserve jobs in the mining sector, and conserve foreign exchange.

C. Post-1989 Policy Directions

Following the Velvet Revolution, the newly established Ministry of the Environment developed the so-called *Rainbow Program, Environmental Recovery Program for the Czech Republic,* which was subsequently approved as a policy document by the state government. The program represented the first systematic attempt to define the basic problems and propose the development of the necessary regulatory and institutional frameworks to address them. Since then, over 15 laws and legal measures have been passed. Two government bodies, the Czech Environmental Agency and the State Environmental Fund, SFZP, were also established during the intervening period (see box on the following page). In addition, the former federal government adopted a plan that called, among other things, for:

- Phasing out subsidies to energy sources.
- Closing industrial and power generation plants based on out-dated technologies.
- Desulfurization by coal washing methods.
- Using clean coal technologies (e.g., fluidized bed combustion).
- Flue gas desulfurization.
- Indexing air pollution charges to the industrial price index.
- Public participation and establishment of an environmental impact assessment process.
- Linking pollution charges to marginal cost pollution abatement.[14]

C1. Performance

Government initiatives and increases in funding levels for environmental protection have paid off.[15] Improvements in air quality were achieved, as noted earlier. This was due, in part, to closing inefficient power plants, as well as to lower emissions from heavy industry plants that decreased their activity as a result of economic restructuring and the ongoing European recession.[16] Furthermore, fuel conversion from coal to natural gas

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[14]Cited by J.L. Schnoor in "The Czech Republic: Environmental Problems in Eastern Europe," a case study published under the auspices of USAID's Environmental and Natural Resources Policy and Training project, June 1993.

[15]Between 1989 and 1992, government spending on the environment rose from CK 3.6 billion to CK 10.8 billion, almost a five-fold increase over environmental expenditures under the previous regime. This represented a rise from 0.7 percent to approximately 2.3 percent of GDP.

[16]Between 1989 and 1992, the absolute values of emissions of SO_2 in the Czech Republic decreased by 23 percent, emissions of NO_x were lowered by 24.2 percent, and solid substances by 25.6 percent. These pollutants decreased only slightly, however, in the most affected regions, except for NO_x levels, which actually increased in the capital, Prague (due to increased vehicle traffic). Noticeable air quality improvements were registered in localities that began converting to natural gas.

among district heating utilities and households, combined with increased fuel prices and use of an increasing proportion of higher quality coal, have contributed to lower emissions from low stacks. Although funding for these activities and state subsidies remain modest (in comparison with the magnitude of the problems), some municipalities have already begun plans for fuel conversion and extension of natural gas lines in city neighborhoods.[17]

Important measures since 1989, however, include expanding the air quality monitoring system and undertaking pilot activities in environmental risk assessment to guide public health and environmental planning. The most noteworthy of these activities is the ongoing Project Silesia, under the auspices of the Ministry of the Environment in Ostrava, in cooperation with the U.S. EPA and local public health institutions.

C2. New Phase in Environmental Policy

Late last year, Minister of the Environment Frantisek Benda released the draft of a new environmental policy for the country.[18] The document, which has not yet received official government endorsement, aims to update the Czech government's environmental agenda in light of political, economic, and social developments between 1990 and 1993. It also reflects the ministry's adoption of priorities highlighted during the Lucerne Conference of 1993 and recommendations adopted by the signatories of the agreement.

Institutional Framework

The development and implementation of government environmental policy is vested in the Czech Ministry of the Environment and its regional satellite offices.

Water, soil, and ambient air quality monitoring is performed by the ministry's Hydrometeorological Institute, which is in charge of tracking pollutants in the country. The environmental inspection agency and its regional offices monitor emission reports submitted by enterprises and local government units. The agency is responsible for (1) setting local emission limits, (2) enforcing environmental regulations, (3) issuing environmental permits, (4) determining and collecting pollution charges, and (5) assessing fines against violators. The charges and fines collected by the agency are remitted to the State Environmental Fund (SFZP), which provides financial assistance, in the form of grants and low-interest loans, in support of environmental remediation projects. The resources of the fund amounted to approximately CK 3.5 billion last year, and were (or will be) allocated in approximately equal proportion between grants and loans.

The environmental departments at the municipal level are responsible for the provision of sanitation, heating (in collaboration with housing departments), and land-use services, as well as monitoring and enforcement (including fine assessment). However, the authority to review and approve projects resides in district level environmental departments that are part of the Ministry of the Interior. The decisions of the district-level departments can be appealed to the regional offices of the Ministry of the Environment.

[17]In 1992, the SFZP Fund received 824 applications for funding environmental projects in the Czech Republic. Over 50 percent of the proposed projects were for air quality protection. The SFZP approved 154 of these proposals, of which 84 were related to air pollution abatement. According to the *Environmental Year-Book*, the SFZP-funded projects contributed to annual emission reductions of 3,554 metric tons of SO_2.

[18]*The State Environmental Policy of the Czech Republic* (draft document), Prague, December 1993.

C2a. Highlights of the Proposed Policy

The draft MOE document, which proposes to redefine the government's policy goals, seeks to "stimulate the behavior of the population, the business community, and the public sector" and to establish "a framework for the solution of high priority problems." It also aims to mobilize local resources and develop a timetable for gradually implementing the following objectives:

- Address the risk aspects of toxic pollutants and their effect on public health and the ecosystem.
- Decrease activities leading to irreversible changes in the natural environment.
- Enforce the principle of careful management of renewable and non-renewable natural resources.
- Integrate environmental considerations in all aspects of economic and social activities.

The draft policy document places particular emphasis on the need to select cost-effective technical solutions that are economically viable and/or susceptible to generating public support and increasing taxpayer's willingness to bear the costs of environmental remediation. The document views environmental policy as an inseparable component of growth-oriented national economic restructuring that should (1) mobilize local resources and optimize societal investments in the environment and (2) promote the use of technically advanced, energy-saving, and environmentally benign technologies and low-waste production processes. Furthermore, the proposed policy reiterates the government's long-standing principle of the "polluter pays" to encourage enterprises (including electric utilities and municipal district heating systems) to mitigate the impact of their activities by using low polluting fuels, expanding energy conservation measures, or retrofitting industrial and power generation plants.[19]

The draft policy document seeks also to shift from command-and-control measures to market-based economic stimulants, requiring less extensive administration and "achieving the same environmental effects at a much lower cost."

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[19] *Ibid.*, pp. 4-7. Although the government is committed to the principle of "the polluter pays," the draft policy document notes that state budget assistance will be required to finance (1) programs that are in the public interest, (2) environmental cleanup costs in circumstances where the party responsible cannot be readily determined, and, most importantly, (3) remediation of inherited environmental damages. The document foresees that environmental protection costs will be in the range of 1.7 to 2.0 percent of GNP. However, it considers spending above these levels wise, even at the risk of incurring additional debt, should it be necessary to address urgent environmental hazards to "avoid acute risks of irreversible damage" to public health or the ecological system.

C2b. Air Quality Goals and Proposed Measures

Although the draft document states no specific targets for air quality ambient conditions, it emphasizes that the Czech Republic will aim to conform to the norms in the European Union and to bring Czech laws and policy instruments into further harmony with those of Western Europe, in accordance with the Lucerne agreement. The objectives and measures of the proposed policy are summarized below:

Objective	Proposed Measure
Smog prevention	Formulate a national program for heating conversion. (target date: 1995)
Protect public health against acute consequences of short-term exposure to critical air pollutants.	Provide for country-wide conformity with emission limits. (target date: 2005)
Improve ambient air quality to eliminate the long-term public health risks, and prevent irreversible damages to the ecological systems and the global climate.	Develop programs for decreasing overall emissions of volatile organic substances, solid particles, and heavy metals.
Gradually limit transboundary pollution, in compliance with international obligations.	Progressively reduce specific emissions from mobile sources.

In the energy sector, where power and heat generation represent the greatest source of airborne pollution, the draft environmental policy recommends an ambitious set of measures to promote energy conservation and efficient use of non-renewable resources. It includes the following steps:

- Establish an independent regulatory agency for the power sector (1994).
- Develop rules and regulations, including incentive instruments for energy use rationalization.
- Create a nuclear safety inspection and management systems (1995).
- Fully incorporate the cost of environmental externalities into the cost base and pricing of energy resources (1998).
- Limit energy export.

- Support projects aimed at decreasing energy consumption.
- Promote combined heat and power generation (e.g., cogeneration), environmentally benign technologies (e.g., fluidized bed combustion systems), and other appropriate modern technologies.
- Support renewable and secondary sources of energy, particularly biomass.[20]

[20]*Ibid.*, pp. 10-11. The Czech government has started a coal washing demonstration project and there have been discussions on using flue gas desulfurization techniques on large coal-fired power plants. Unfortunately, the cost of this process appears uncompetitive in comparison with fuel conversion to natural gas. Some of the cities we visited are seriously considering, however, switching to fluidized bed combustion units, and one proposal actually called for the manufacture of FBC boilers in the Czech Republic under a licensing arrangement with a Japanese manufacturer.

SECTION IV
PROJECT SELECTION CRITERIA

A. Methodology

Our approach to selecting projects for preliminary review was to work within the institutional framework of the Czech Republic to ensure that future technical assistance provided by USAID in support of the EAP would be consistent with national environmental objectives and complement existing efforts. To that end, the members of our team met with officials of the Ministry of the Environment (MOE) and the State Environmental Fund (SFZP), and with USAID staff and consultants preparing the forthcoming HG Loan Program.[1] In these meetings, we discussed EAP objectives and outlined our proposed project selection approach. Next we narrowed the lists of environmental projects obtained from these three sources by applying the following criteria:

- Projects must be located in northern Bohemia and northern Moravia, which, along with Prague, are the most affected areas (the so called "hot spots").
- Only air quality improvement projects are to be included, in view of the fact that the government and other external funding sources are already dedicating substantial resources to other project types.
- Proposed activities must have significant human health benefits, as indicated by potentially high existing risks to individuals or populations and opportunities for substantial risk reduction.
- Proposed technological solutions are appropriate compared to other potential alternatives.
- Projects must be economically feasible in terms of (1) cost-effectiveness of proposed solutions, (2) adequacy of capital budgets and financing plans, and (3) ability of the entity initiating the project to recover capital investments and recurrent costs over the life of the project.

In our review and evaluation of projects submitted by various municipalities and enterprises, we took into consideration the priorities of the programs sponsored by MOE, SFZP, and the HG Loan Program. Due to our interest in activities that could be financed under the HG Loan Program, we paid particular attention to municipally owned district heating rehabilitation projects aimed at limiting low-level emissions to the air and/or bringing existing plants into compliance with national emission limits.

[1] The HG Loan Program will be administered by five to six commercial banks under the auspices of a Czech joint-stock company owned by the Central Bank and the ministries of economy and finance.

A1. Ministry of the Environment

The MOE's priorities for supporting environmental improvement projects are: (1) protection of human health and (2) water quality. The ministry has identified three geographic "hot spots" where immediate environmental improvements are needed—northern Bohemia, northern Moravia, and Prague. In northern Bohemia, the ministry is currently focusing its efforts on air quality issues, including transboundary transport and wastewater treatment issues, through support from EU PHARE and in cooperation with Germany. During our meeting, the deputy minister and his staff emphasized that there is an immediate need to address low-level air pollution problems in that region. In northern Moravia, the comparative risk analysis conducted as part of Project Silesia, with the assistance of the U.S. EPA, identified the coking and steel industries as a high priority for pollution control. The ministry's pollution abatement priorities in Prague are in the areas of air quality (district heating, power generation, and transportation), potable water supply, and wastewater and solid waste management.

After discussing the priorities of the ministry and their overlap with EAP priorities, the ministry provided us with files on 26 potential projects submitted for funding by various municipalities and corporate enterprises.

A2. State Environmental Fund

The SFZP priorities for providing grants and subsidized loans for environmental projects are very broad. They include water quality, air emissions reduction, nature conservation, waste management, pollution monitoring, and new pollution abatement technologies. In the area of water protection, the fund emphasizes as priorities drinking water, water quality in lakes and rivers, and local problems. For air pollution, environmentally benign technologies and combustion processes, as well as controlling emissions of particulate matter, flue gas, and ozone depleting pollutants, are given high priority.[2] Waste management activities noted as priorities include municipal, industrial, and hazardous waste disposal and remediation of old waste sites.

The fund also favors projects involving local monitoring systems linked to the state monitoring network. While the SFZP is required to evaluate projects by their potential to improve environmental quality, the evaluation is generally based only on their potential to reduce the quantity of pollutant released to the environment. There is no particular consideration of other factors, such as human exposure, that affect potential reductions in risks to human health and the environment.

The SFZP recommended three projects for us to consider in our preliminary review of potential projects for USAID technical assistance under EAP.

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[2]The fund's priorities explicitly exclude small sources of pollutants (i.e., less than 200 kilowatts, and between 200 kilowatts and 3 megawatts) that do not serve public activities and sources greater than 100 megawatts.

A3. Housing Guarantee Loan Program

Once established, the HG Loan Program will fund commercial banking loans at competitive rates, which, in turn, will be lent to municipalities and municipally owned entities for infrastructure projects. An important criterion for projects under this program is their credit-worthiness and ability to repay the loans over a seven- to 15-year period.

The type of environmental projects that may qualify for such loans include water treatment, wastewater and solid waste management, and district heating systems. USAID/Prague provided us with a list of approximately 240 projects compiled from letters of interest submitted to the ministries of the economy and finance late last year. Thirty-nine of these projects relate to conversion of heating supplies, and 24 relate to water supply—two areas with potential environmental implications. Of particular interest to us were the proposed activities involving clean coal technologies, conversion to natural gas, and other district heating environmental rehabilitation projects.

B. Project Selection

Based on the priorities of the Lucerne Agreement and the criteria outlined above, we prepared an initial list of projects that seek to address serious environmental threats to human health in a timely and cost effective manner. We then refined our screening process by taking into consideration MOE and SFZP priorities and the HG Loan focus on small municipal infrastructure projects.[3] On the basis of this screening, we identified 14 projects with good potential for human health risk reduction, but we managed to investigate only 12 during this mission. These are listed on the following page.

Over a two-week period, we visited the project sites and met with city officials and technical specialists familiar with local environmental conditions and the proposed activities. During these meetings, we discussed the environmental, technical, and financial issues related to each proposed project, as well as the potential human health benefits associated with them. A list of the people we met is presented in Annex A.[4]

After preliminary review, we determined that two of the projects listed—the Louny medical waste incinerator and the Rotava district heating system—are not appropriate for direct technical assistance by USAID (although in the case of Rotava, local officials may benefit from the "generic" training recommended in this report). While the projects in

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[3]The projects selected in Ostrava, however, are not municipally owned. However, in view of the excessive low-level emissions from coke ovens, it was determined that future technical assistance under EAP may be appropriate.

[4]In addition to the projects listed on page 20, we reviewed proposals for iron ore sinter plants in Ostrava. From a human health perspective, these plants are of concern because they are a major source of low-level emissions that pose potentially serious threats to the many people living in proximity to Ostrava's iron and steel plants. Due to time constraints of the mission, we were unable to fully evaluate these sinter plant proposals. Though the sinter plants are of less immediate concern in objective terms than the coke ovens, they are very important sources in absolute terms and should be included in subsequent work related to Ostrava.

Louny and Rotova are appropriate and have some human health benefits, neither project site has air pollution problems comparable to other locations, and both would have health benefits for only a small number of people. In addition, the ability to fund these projects through loan financing is highly uncertain in view of the limited fiscal resources of the two cities.[5]

Projects with Potential for Human Health Risk Reduction

City	Region	Description	Source
Žatec	N. Bohemia	DHS (conversion)	MOE
Litoměřice.	N. Bohemia	DHS (em. control)	MOE
Decín	N. Bohemia	DHS	MOE
Usti (municipality)	N. Bohemia	DHS (conversion)	HG
Meziboří	N. Bohemia	DHS (cogeneration)	SFZP
Louny	N. Bohemia	Med. waste incineration	SFZP
Rotava	N. Bohemia	DHS (conversion)	HG
Aš	N. Bohemia	Apt. bloc gas boilers	HG
Pilsen	N. Bohemia	DHS + expansion	USAID
Ostrava/Sverma	N. Moravia	Coke ovens	MOE
Ostrava/Nová Hut	N. Moravia	Coke ovens	MOE
Ostrava/Třinec	N. Moravia	Coke ovens	MOE

[5]In the case of the medical waste incineration project in Louny, we believe the local hospital does not generate enough waste to warrant the building of a new plant, and the city can use the services of another incinerator in northern Bohemia to dispose of it. Rotava, on the other hand, requires some special attention. The district heating plant seems to have sufficient capacity for the service area. However, we believe that switching to better quality coal and repairs to the system will lead to short-term improvements.

SECTION V
PROJECT EVALUATIONS

In this section, we present our assessment of proposed activities, which, in our opinion, are promising and deserve further technical assistance under the auspices of USAID. The projects range from relatively simple upgrades to complete overhaul of large district heating plants and networks. They consist of the following proposals:

- District heating system rehabilitation, upgrade, and expansion in the cities of Decín and Žatec.
- Cogeneration options in Decín and Meziboří.
- Coke oven pollution abatement processes in Ostrava.

A summary of our recommendations for further technical assistance is found in Section I. A brief description of the projects in the cities of Aš, Litoměřice, Louny, Pilsen, Rotava, and Usti can be found in Annex B. The technologies applicable to district heating are presented in Annex C.

A. District Heating Improvements in the Town of Decín

The town of Decín is a major industrial town of about 50,000 in northern Bohemia. The town has severe problems with air pollution caused largely by coal burning for industrial purposes, heating of individual residences, and district heating. The town has launched an aggressive program to convert from coal to natural gas. Individual homes are given a subsidy to convert to gas. An effort to convert the district heating system is underway, beginning with the Bynov plant. USAID has provided assistance to the town in developing a plan for the upgrade of the district heating system through the Center for Clean Air Policy (CCAP). The Danish Ministry of the Environment has supported a general review of the district heating system and a study of the Bynov plant in particular. The general study is complete. The Bynov study is scheduled to be completed in June, with construction to start in January 1995. The town has made a commitment to the local gas utility to purchase natural gas for heat generation in Bynov. In return, the gas utility is constructing the necessary gas line. Gas is expected to be available at the Bynov plant in the fall of 1995.

A1. Background

The air quality in Decín is poor with maximum 24-hour concentrations of SO_2 reaching 1336 $\mu g/m^3$ in 1992. The principal cause is the combustion of coal. The table

below shows estimates from the Danish study of emissions by fuel source.[1] Coal burning accounts for 79 percent of SO_2 emissions, and virtually all of the particulate emissions.

Among the sources, about 37 percent of emissions are estimated to be from district heating plants, about 40 percent from major industrial sources, and the remainder from small sources, principally small boilers and furnaces in residences and other buildings not served by district heat. This apportionment by pollutant holds true across all pollutants, since emissions are generally estimated from fuel use rather than measured.

Total Neat Heat Demand and Emissions						
Source	NHD TJ	SO_2 t/a	NO_x t/a	CO_2 t/a	Particulate t/a	šh t/a
Coal	970	774	352	179500	1935	19258
Oil	658	202	139	63000	48	0
Gas	635	4	62	39200	0	0
Other	5	0	0	0	0	0
Total	2267	980	553	281800	1984	19258

The district heating system in Decín has several medium size heating plants which deliver steam. Hot water is delivered to households through a system of heat exchangers and secondary pipes. Total capacity of the system is 100 MW. The 25-kilometer distribution system is aging and will need substantial repair and replacement over the next several years.

A2. Engineering Analysis

Given the size and complexity of the Decín district heating system, there are, in theory, many options for improvement. Based on their experience with the district heating company, Brun & Sorensen have narrowed the focus of interest to five plants, to be addressed in order. The first focus is the Bynov plant, followed by CZT, then Zelenice, and then finally smaller plants. The mayor feels that, for the near future, the town can afford to work only on Bynov, and perhaps CZT. He does not feel they will be likely to begin work on Zelenice for several years, and has no timetable for the smaller plants. Accordingly, the analysis to date has largely considered only Bynov, CZT, and Zelenice.

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[10] Bruun and Sorenson Group AS, *Environmental Study: Reduction of Air Pollution and Waste Handling in the Decin Area - CR*, April 1993, Commissioned by the Danish Environmental Protection Agency.

The Bynov plant has four brown coal boilers—three 8 MW units, and one 4 MW unit. The boilers produce steam, but hot water is delivered to households for heating and tap water. The plant serves about 3,500 people and one factory. These boilers are a moving grate fire tube design and burn unsorted coal. The oldest was installed in 1980. The youngest was installed in 1988. The plant is reported to be in good shape. The instrumentation is very complete, with a capability for monitoring CO_2 and O_2. However, some of the instruments do not work reliably and cannot be repaired easily. Air/fuel ratios are adjusted every 2 to 3 weeks by an outside company that brings portable instruments to the boilers.

The CZT plant is a modern steam plant with 15 MW boilers that burn pulverized coal in wall-fired units. The plant has a complete system of air preheaters and an 80-meter stack. It is on the opposite side of the river from the Bynov and Zelenice plants and was intended to supply all steam and heat on its side of the river, replacing six smaller boilers. The plant was completed in 1990 but has never been used. The factories it was to supply have converted to gas, so its full capacity is not needed. Ing. Josef reported that there are many problems with welds throughout the plant; they would have to be fixed before it could be brought on line. Further, despite the plant's very recent construction and generally modern design, it has no flue gas desulfurization or particulate control beyond a cyclone. It cannot meet current emissions standards. Bringing CZT on line would not reduce emissions in Bynov, though its tall stack and high flow rate might improve air quality over the low height smaller sources now in use. The CZT plant is currently owned by the state, so the Decín district heating company has little authority over its future.

The Zelenice plant is similar in design to Bynov, but is six years older. It was brought on line in 1974, and the newest boiler was installed before 1980. It has two 8 MW boilers and one 4 MW boiler, with moving grates burning unsorted coal. A Decín regulation requires the plant to burn coal with less than 1 percent sulfur. At present, the plant is supplied with coal with a sulfur content between 0.7 and 0.8 percent. The mine that supplies this coal is shutting down in 1995, and the new supplier reports that it can provide coal with about 1.5 percent sulfur. The heating company's analysis of the coal showed that the actual sulfur content is 2.1 percent. SO_2 emissions from Zelenice will nearly triple when the plant switches coals. The plant is in poor condition. There are no instruments for measuring emissions. The water treatment system is leaking a strong odor of ammonia. Pipe insulation is torn. There is a pervasive odor of exhaust gas inside the plant and its immediate vicinity. The exhaust plume is dark and opaque. The plant is nominally 10 years from the end of its service life, but is already showing obvious signs of neglect. Zelenice is, unfortunately, located very close to the center of town and residential areas.

Given these plants, Brun & Sorensen concluded that the strategy for upgrade was, in order, to (1) replace the Bynov boilers with gas boilers, (2) convert CZT to gas, and (3) convert Zelenice to gas. From the description of the plants above, it would seem obvious that Zelenice should be a higher priority than Bynov or CZT because it is older, dirtier, and affects more people. The decision to attack Bynov first was based entirely on its access to natural gas. The town of Decín is not served by natural gas at the present time. Town gas is burned instead. A natural gas line is being built to the town. This line will reach Bynov

in the fall of 1995. It will reach Zelenice three years later. In effect, the decision to address Bynov first is based on the premise that conversion to natural gas is the best and only strategy for cleanup of the district heating system.

This conclusion is either an input to, or a conclusion of, the Brun & Sorensen study; it is not clear which. The documentation of the Brun & Sorensen study does not provide sufficient detail to determine how gas conversion was selected over the many other options. Principal alternatives include stack gas cleanup, fluidized bed combustion, dual oil/gas fired boilers, and dual coal/oil fired boilers.

The Brun & Sorensen study assumes an increase of coal prices from 1.6 ECU/GJ in 1994 to 2.05 ECU/GJ in 2010 (28 percent). The increase in natural gas prices is from 3.1 ECU/GJ in 1994 to 4.2 ECU/GJ 2010 (35.5 percent). This is apparently the projection of the Danish Ministry of Environment and the International Energy Agency for world market prices.[2]

The Brun & Sorensen study further recommends that CZT produce both heat and power. The study estimates the break-even selling price for electric generation at approximately CK 2.59 per kwh. Current purchase prices from CEZ for baseload power are about CK 0.8/kh for peak power. Prices for peak power are about 1.7 CK/kh. Investment in cogeneration at CZT would be very risky for Decín, particularly since electrical generation at CZT would require the production of steam, blocking the conversion of the system from steam to hot water, which would otherwise be possible if the boilers are replaced as part of the environmental improvement program.

It is difficult to evaluate the engineering analysis at Decín because the documentation is incomplete. On the basis of material in hand, it is certainly not possible to endorse either the decision that conversion to gas is appropriate at every plant or that Bynov should be addressed first. The more detailed analysis done by the U.S. firm Gilbert/Commonwealth for similar plants in Pilsen found that fluidized bed combustion and stack gas cleanup were 10 to 15 percent less costly, in present value terms, than conversion to gas. The conclusions of the Brun & Sorensen study may be correct, but the documentation is not adequate, and is quite possible that the scope of the modest Brun & Sorensen study was too limited.

A3. Human Health Considerations

The air quality in Decín is poor but improving as conversions to gas and low sulfur fuels are taking place. Average annual concentrations of sulfur dioxide at some monitoring stations exceeded the Czech emission limits in 1992, with maximum 24-hour averages as high as 1336 μg/m3. The air quality may adversely impact human health. In 1989,

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[2] The U.S. analyzes coal markers very differently, emphasizing local rather than world prices, since coal is costly to transport, and the cost for specific categories of coal, since coal is not a uniform commodity. In general, however, the U.S. is predicting higher escalation rates for natural gas and lower rates for the categories of coal used in Decín.

mortality from respiratory diseases and cancer in Decín was substantially above the average for the Czech Republic.

As mentioned above, combustion of coal for heating is the major source of air pollution in Decín.[3] As the engineering analysis points out, the most polluting of the three major district heating plants considered in the proposal is Zelenice. Not only are the emissions of particulate matter and SO_2 high, but the plant has a low stack and is located in the center of the city in a densely populated residential area. We do not have measured emissions data for this sources, so it is difficult to determine the potential health risks that it poses to the residents of the neighborhood or the population of the city. We can assume, however, that low elevation emissions of particulates and sulfur dioxide could be reduced substantially by making environmental improvements to the plant. These pollutants can cause respiratory problems of varying severity ranging from chronic bronchitis to premature death. In addition, organic pollutants and metals adhered to particulates can also have serious toxic effects.

While the Zelenice heating plant clearly deserves attention, the town is moving forward to convert the Bynov plant to gas. This plant is located outside of the city center next to the large housing development (housing 3,000 people) that it serves. The engineering assessment indicates that the emissions from this plant are likely to be substantially lower than those of the Zelenice plant. Because the plant has a tall stack and is located outside of the city center, the benefits of reducing emissions from this plant are likely to be less than the benefits that could be realized from upgrading the Zelenice plant.

An important aspect of air pollution from heating sources in Decín is the many small coal burning sources. The Danish study estimates that approximately 30 to 50 percent of SO_2 and particulate emissions from heating sources are from small sources. Some of these sources are converting to gas, but they remain a significant threat to human health because they release pollutants at ground level in densely populated areas of the city. Plans to improve the Bynov and Zelenice plants do not incorporate expanding the district heating systems to eliminate any of these small sources. The plans for opening the CZT plant, however, would eliminate six small boilers. Three are oil burning, two are coal burning, and one is gas. Because only two are coal burning, the benefits may not be substantial. On the other hand the stack on the CZT plant is 80 meters high and thus would eliminate the low-level emissions of the six smaller sources.

Due to technical reasons related to the location of the gas line, the town is planning to first convert the Bynov plant to gas and later address the CZT and Zelenice plants, if funding is available. A more reasoned approach would be to evaluate the relative costs and benefits of various plans and the sequencing of implementing those plans, so that the solutions with the highest benefit to cost ratio are addressed first. Technical assistance in helping the town of Decín set priorities for controlling pollution from heating sources in this way could reduce the most serious pollution problems quickly and at reasonable cost.

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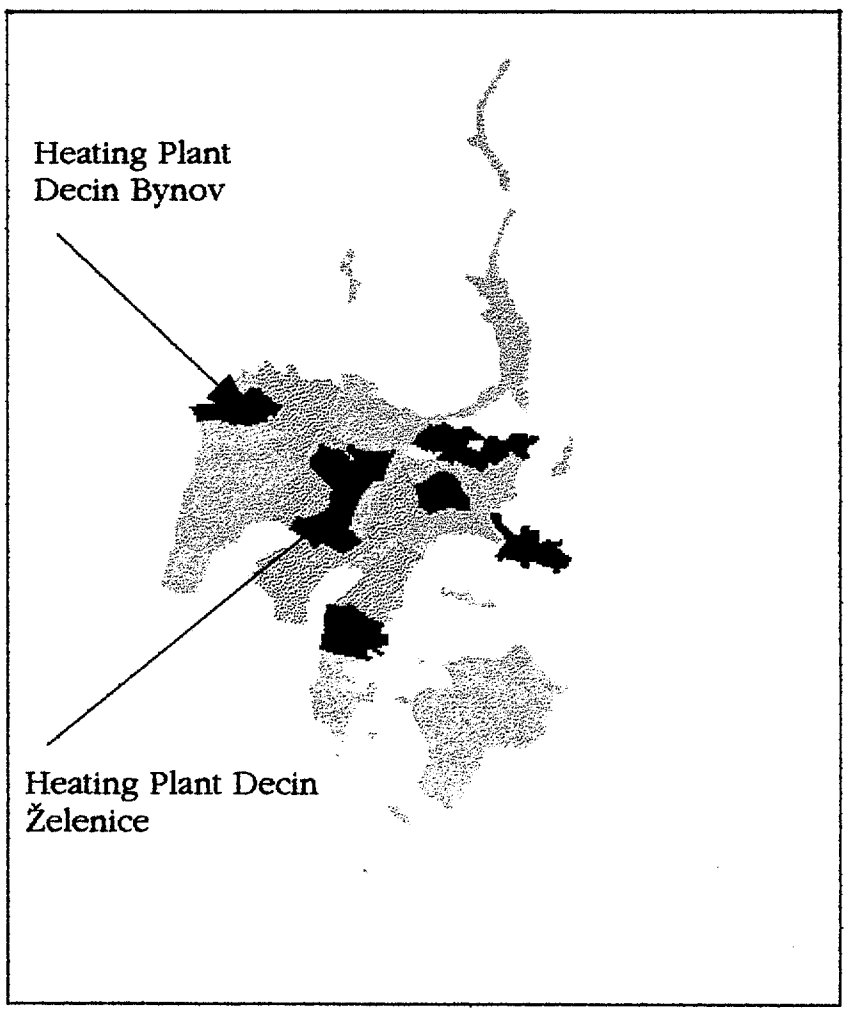
[12] It is important to note that we have not identified or evaluated pollution sources located outside of the town that may also be impacting the air quality in Decin.

Decin Project

Location	*Pollutant*	*Avrg. 1992*	*Max. 1992*
DECIN - POHR.STRAZE	SO2	62	679
DECIN - POHR.STRAZE	NOX	54	207
DECIN - POHR.STRAZE	Dust	60	316



Dark gray indicates the highest density of population
Medium gray indicates a medium density of population
Light gray indicates the smallest density of population

B. Heating System Improvement for the Town of Žatec

The town of Žatec has applied for a EU PHARE grant from the MOE to upgrade the district heating system and extend it to unserved areas. Improvements include:

- Conversion of the major oil-fired district heating plant to natural gas.
- Improved interconnection of the heating systems to permit the phase out of smaller, less efficient boilers.
- Improved system controls.
- An improved secondary distribution system that would reduce the necessary plant outlet temperature.
- Heat recovery at the coal boilers.

The project is well along in its development, but the town does not have the funds to proceed with the improvements using its own resources. The USAID project team met with representatives of the town to review the town's proposal and other district heating related projects and proposals.

B1. Background

The town of Žatec in northern Bohemia has a population of about 20,000. The economy is based on agriculture and light industry, including screw manufacturing, paper, brewing, and hops production. Heating is the principal source of air pollution. This includes district heating, coal burning at individual residences, and emissions from the 17 MW heating plant at the military base on the south edge of town. The industry is primarily located across the river from town. The industries have their own, unconnected heating plants, but few people live near the factories.

Beyond this proposal, the town is pursuing a more complete program for overhaul of the heating system. As the first step in this effort the town solicited proposals for a technical feasibility study of options for district heating. Final selection of a contractor for the feasibility study is scheduled for the end of March. Options for structuring and organizing the district heating company and financing the improvements are not part of the feasibility study.

B2. Engineering Analysis

It is difficult to make an engineering, health, or financial assessment of Žatec's plans, since these are not yet firm. The proposal submitted to the MOE is only part of a broader effort to rebuild the district heating system. The broader effort is currently only in the feasibility stage so there are no specific design decisions to evaluate. Accordingly, the discussion here can only address the elements in the EU PHARE proposal and, in a more general way, the types of options discussed in the meeting with the town.

The Žatec district heating system consists of 18 boilers, predominantly burning brown coal, and a dated distribution system. Many of the heating plants are located very close to

the center of town, which is densely populated. The principal plant, Perc Heating Only Boiler (HOB), is coal-fired, has excess capacity, and is located south of the city center and main residential areas. It is the focus of the systems' rehabilitation. The objective is to shut down the 17 older coal boilers and to develop replacement capacity at a modernized Perc Plant. Sufficient capacity will be developed to connect several areas of coal-fired buildings. One coal-fired unit (Vrchlického) is being converted to natural gas and will serve in a peaking role. The Podmesti boiler house is current oil fired and produces only hot water. The town would like to convert it to a gas cogeneration plant.

In addition to the changes in the boilers, the distribution and control systems need to be upgraded. The town also plans to evaluate the possibility of burning municipal waste for heat and using waste heat from a nearby power plant. The Pocerady power plant is a major 1,000 MWe facility located about ?? kilometers from Perc HOB. This is at the limit of existing waste heat systems, but is technically possible. The power plant uses a wet limestone scrubber and a high level of particulate control.

Though the design of the upgraded Perc HOB is not final, the town expects to use a fluidized bed combustor (FBC) burning brown coal. The plant will not produce electricity. The town's preference for coal is based on the cost of the fuel, and its desire to use different fuels as a hedge against price fluctuations and availability problems. The town has examined the FBC produced by the German company BAY, and feel that it will meet the town's needs.

The town estimates the overall cost of the program to be about CK 280 million, but no definite estimate can be made until the design is more fully specified. Emissions of SO_2 should be effectively eliminated, while particulate emissions should be reduced by about 98 percent, from an average control level of 90 percent for the cyclones now in use to around 99.8 percent if FBC is employed at Perc. Further reduction of emissions in Žatec can be achieved if waste heat from Pocerady is used.

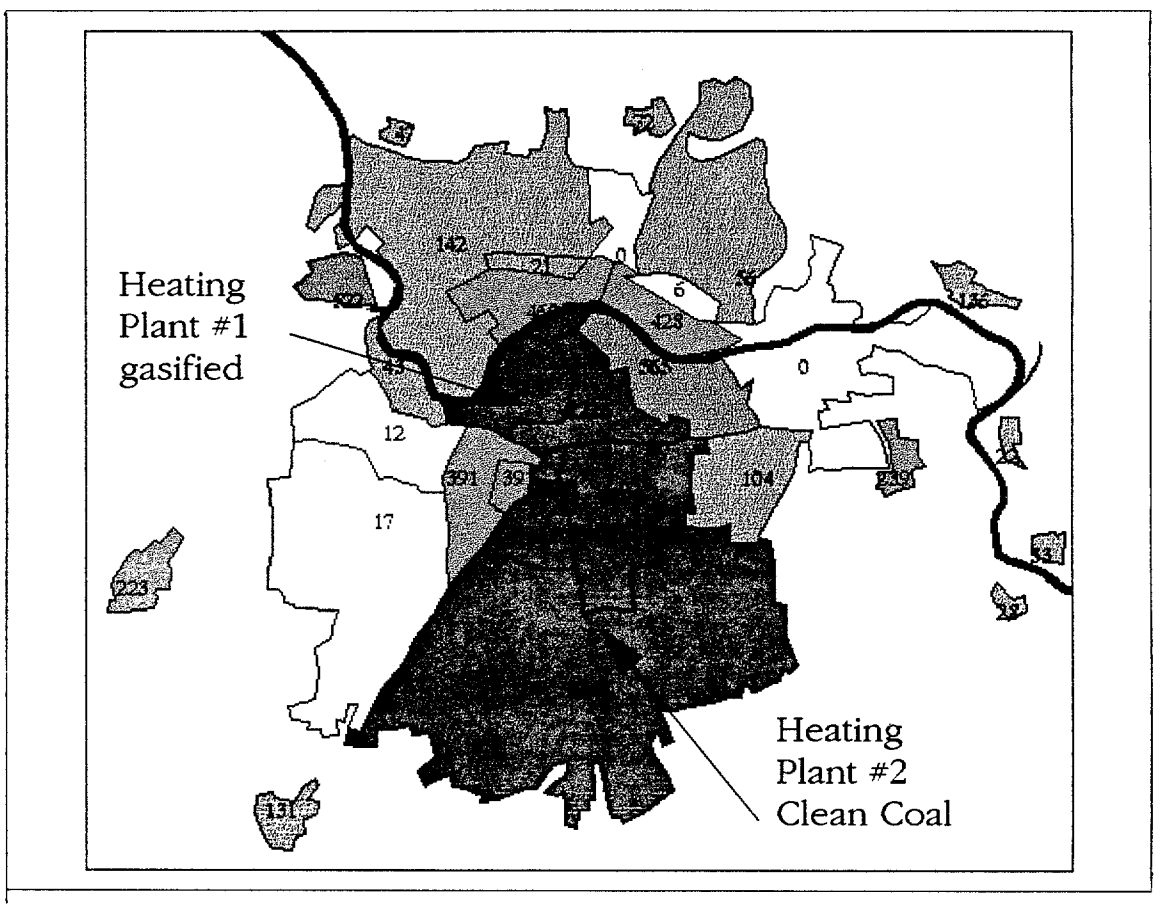
While the Žatec program is only in the feasibility stage, the problem has clearly be the subject of considerable analysis, and the proposed solution is well considered. The scope of the program is comprehensive and likely to have an impact on air quality, if it can be financed.

B3. Human Health Assessment

The air quality in Žatec is better than in some of the other towns visited on the mission. We do not have data on ambient concentrations of particulates, but average annual concentrations of sulfur dioxide and nitrogen dioxide in 1992 were well below the Czech emission limits (35 μg/m3 for SO_2 and 36 μg/m3 for NO_x). In the heating season, however, maximum 24-hour averages can be high. In 1992, the maximum for sulfur dioxide was 377 μg/m3, and the maximum for nitrogen dioxide was 943 μg/m3.

Zatec Project

Location	*Pollutant*	*Avrg. 1992*	*Max. 1992*
ZATEC SVERMOVO NAM.	SO2	35	377
ZATEC SVERMOVO NAM.	NOX	36	943



Within each settlement unit, the number of its inhabitents is listed

As mentioned above, heating is the major source of air pollution in Žatec.[4] The most polluting sources are the 17 small coal burning boilers in the center of the city and in densely populated neighborhoods. The low-level emissions from these sources impact much of the city's population. The most significant human health benefits of the town's district heating proposals would result from eliminating these sources and providing heat to the population they serve by upgrading the Perc plant and expanding its service. We do not have data on the emissions from the small boilers, so it is difficult to determine the potential health benefits. However, we can assume that low-level emissions of particulates and sulfur dioxide would be reduced substantially. These pollutants can cause respiratory problems of varying severity ranging from chronic bronchitis to premature death. In addition, organic pollutants and metals adhered to particulates can also have serious toxic effects. Some non-carcinogenic effects are experienced only if exposure concentrations exceed threshold levels, and because air quality in Žatec generally meets emission limits (as indicated by 1992 sulfur dioxide and nitrous oxide concentrations), existing levels of such contaminants may not pose significant risks to the population.

Particulate and sulfur dioxide emissions from the Perc plant in 1993 were 70 tons and 38 tons, respectively. Total pollution charges for this plant alone were CK 297,895 in 1993. The town is concerned about upgrading the Perc plant, because it does not meet state emission requirements and pollution charges are increasing substantially each year. However, because the plant has a tall stack and is located south of the town in a less populated area, the benefits of reducing emissions from this plant are likely to be less than those realized from eliminating the small boilers in the center of the city and expanding the Perc distribution system to reach these customers.

C. Heating Improvements in the Town of Meziboří

Meziboří is a small town of about 5,200 in northern Bohemia. The town has problems with air pollution from local sources and surrounding power plants and factories, but is not in a valley and does not experience severe inversions. The town is counting on national emissions standards to reduce emissions from the surrounding plants over the next several years, but is taking active measures to reduce emissions from district heating, the only major source of pollution in the town. The town has four district heating plants. Two small coal-fired units will be shut down by Fall and replaced with natural gas boilers in individual buildings. The boilers will be fueled with town gas until natural gas lines reach the town in 1996. Of the two remaining plants, the smaller one is a dual fueled oil/gas facility that can burn gas when required by atmospheric conditions. The larger plant is oil fired, and the town would like to replace it with a dual fueled cogeneration plant.

C1. Background

The population of the town lives in a mix of high-rise concrete apartment buildings, town houses, and small detached houses. There are only a few commercial and public

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[4]It is important to note that we have not identified or evaluated pollution sources located outside of the town that may also be impacting the air quality in Zatec.

buildings in the town, including the school, two shopping areas, and a movie theater and casino. All but 22 residences are served by district heat. Seven of these use electric heat, five town gas, and 10 burn coal but will convert to gas next year. There is no significant polluting industry. The town estimates that 30 to 40 percent of the ambient concentration of pollutants stems from the local heating sources, with the remainder attributable to the surrounding power plants and a very large chemical plant.

The town has been very aggressive in cleaning up the district heating system. It has borrowed heavily to (1) replace the two 4.6 MW coal boilers with 29 individual boilers at the concrete flats they serve, (2) replace the burners in the 8.9 MW oil-fired unit so that it could burn gas or oil, and (3) improve insulation in the buildings owned by the city. They have been very successful in obtaining financing at favorable rates, but currently cannot afford to address the fourth and largest plant in the system, an 11.6 MW oil-fired unit.

The plant managers have estimated emissions improvement from the coal boiler phaseout as shown in the table below. Emissions estimates from the 8.9 MW oil/gas boiler are shown in the subsequent table. These emissions reflect the recent switch from 2.2 percent sulfur oil to 1.0 percent sulfur oil. The second table also presents estimated emissions from the proposed new cogeneration plant and from the 11.6 MW oil plant it is intended to replace. The emissions estimates from the new plant were prepared by the town. Emissions from the current plant were estimated assuming proportionality with the 8.9 MW unit.

Emissions from coal-fired district heating plant and the 29 replacement individual boilers

Pollutant	Coal Emissions (t/a)	Individual Boilers (t/a)
Particulates	95	0.4
SO_2	121	0.2
NO_x	15.6	2.2
CO	5.2	0.4
HC	2.6	0.2

Emissions from oil/gas coal-fired district heating plants and proposed Cogeneration plant			
Pollutant	8.9 MW Unit t/a	11.6 MW Unit t/a	Proposed Cogeneration (t/a)
Particulates	7.4	9.62	1.8
SO_2	124	162	0.06
NO_x	25.2	33	23.4
CO	1.4	2.7	1.4
HC	1	1.3	0.3

The MOE has determined that the proposed cogeneration conversion or simple conversion of the plant to a gas/oil dual fuel unit would still have unacceptable NO_x emissions (as in the table shown above), and requires or recommends a catalytic NO_x control system. Based on these emissions estimates, the steps the town has taken thus far will reduce district heating emissions by 55 to 65 percent. This is an impressive achievement, and the town is clearly ahead of any other town visited in this mission. Unfortunately, the impact of other sources means that the town's efforts will only improve ambient concentrations to about 75 percent of current levels.

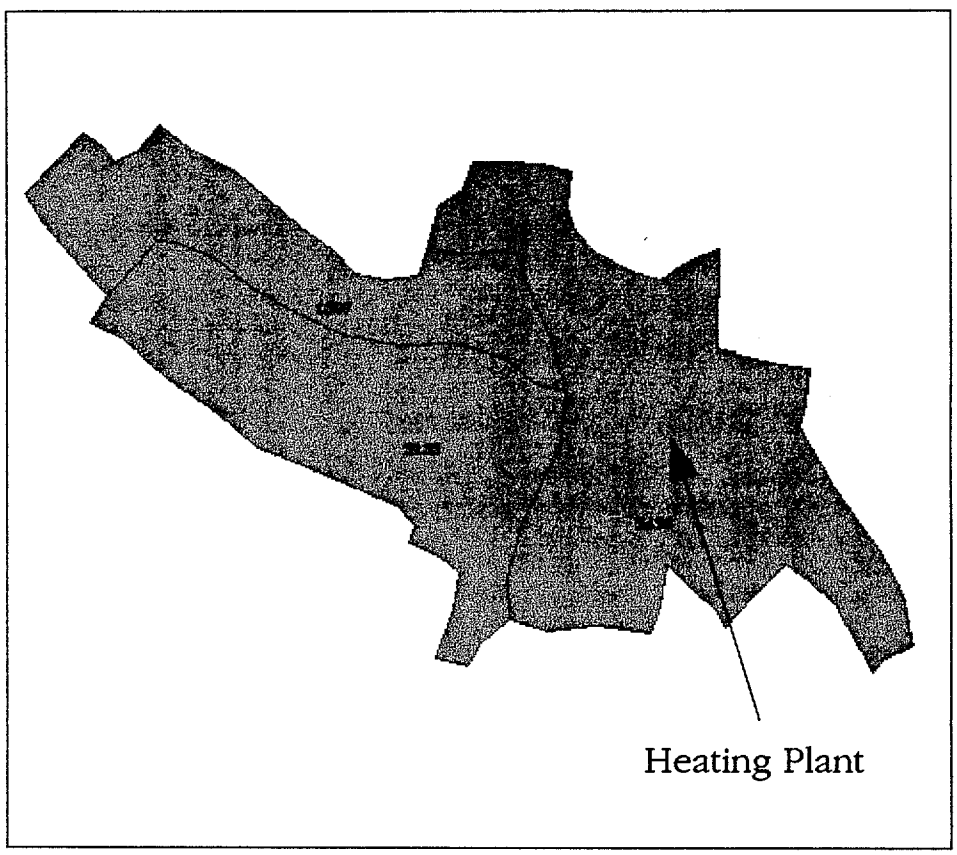
Questions about the Meziboří program are related to the incremental health impact of controlling the final source, whether or not cogeneration makes financial sense, where the town can obtain financing, and whether they can afford additional debt.

C2. Project Review

The fundamental engineering problem is whether or not to opt for cogeneration. At present, the 11.6 MW plant delivers hot water. The burners can be changed at moderate cost to provide oil/gas dual fuel capability; however, installation of a catalytic NO_x control system will still be required. The town managers estimate that about $330,000 would be required for the conversion, and that the boiler and infrastructure are in good enough condition to justify this conversion, as was done for the 8.9 MW boiler. They estimate that the cogeneration plant would cost $1.7 to $2.0 million to provide 11.6 MW of heat and about 5 MW of electricity, and that cogeneration would pay off assuming a selling price for electricity between 1.5 CK/kwh and 2.0 CK/kwh. The town reports that discussions with CEZ centered around prices in this range. The break-even price reported by Meziboří is lower than the price estimate by the Danish firm Brun & Sorensen in Decín, and higher than prices reported by other towns for the sale of cogenerated electricity, which were on the

Mezibori Project

Location	*Pollutant*	*Avrg. 1992*	*Max. 1992*
MEZIBORI	SO2	83	648
MEZIBORI	NOX	39	532



Within each settlement unit, the number of its inhabitents is listed

order of 0.67 CK/kwh for off-peak power to 1.67 CK/kwh. Engineering technical support could benefit the city in two areas—specification of NO_x controls and more detailed analysis of whether cogeneration is cost-effective. The town intends to issue a request for proposals for a feasibility and engineering study of the conversion of the fourth boiler. These two elements may be included in the scope of work of follow-up USAID missions.

C3. Human Health Considerations

Air quality in Meziboří is a problem affecting the health of the town's residents. In 1993, the annual average ambient air concentration of SO_2 was 83 μg/m3. (The Czech emission limit for SO_2 is 60 μg/m3. Air quality has improved over the last year, as the town has taken measures to reduce emissions from local heating sources, and large plants located in surrounding towns have taken similar measures. In 1993 air quality exceeded emission limits 21 days of the year, while air quality in the 1994 heating season was rarely above the limits.

As mentioned above, the district heating plant is the major source of locally generated air pollution in Meziboří. The town estimates that improvements to the diesel plant will reduce particulate emissions by 76 percent, SO_2 by 99 percent, and hydrocarbons by 70 percent and, with a catalytic converter, CO_2 emissions by 95 percent. These measures will significantly reduce local sources of air pollution in Meziboří and presumably have subsequent health benefits. Without a more detailed evaluation of the dispersion of pollutants from the plant and the exposures of town residents, however, it is difficult to determine the potential health benefits. Exposures to particulates and sulfur dioxide would be reduced as a result of plant improvements, but because their contribution to overall air pollution in the town is relatively small, the reduction is unlikely to have significant human health benefits. In addition, because Meziboří is not located in a valley susceptible to serious inversions, the risks from air pollution are not as severe as in other towns in northern Bohemia.

D. Reduction of Airborne Emissions from Coke and Steel Production in Ostrava

D1. Background

Ostrava is the industrial heart of northern Moravia. The population of the city is 325,000 and about 2 million people live in the region. The principal industries of Ostrava are steel and pig iron, with the majority of the Czech Republic's production concentrated in and around the city. Steel and iron production are currently depressed, reflecting the general European economy. Production of steel is about 9 million tons per year, with pig iron production at 6.4 tons per year. About 22 million tons of hard coal are mined in the region, principally to produce coke for steel making. A chemicals industry depends on coke waste and by-products as its feed stock. The manufacturing industry produces machinery, tubes, and pressure vessels among other high value products.

In contrast to many large industrial centers in the former planned economies, the plants in and around Ostrava are relatively modern, efficient, and in good repair. Coal, steel, iron, chemicals, and metal products production will undoubtedly continue (at some level) in

the Ostrava region for the foreseeable future. The industry faces several problems with a common root. The demand for steel and steel products has declined worldwide, particularly in Europe, over the last several years. Combined with the ongoing restructuring of the Czech economy, this decline has put pressure on the steel and related industries in Ostrava to consolidate operations, reduce costs, and increase efficiency. The steel companies and coke producers must deal with limits on airborne emissions and escalating charges for pollution.

As indicated in Section III, the companies must restructure operations and make significant capital investments to limit emissions and improve efficiency. The necessary capital is not readily available. The key issue is establishing the credit-worthiness of the enterprises. However, they lack corporate track records as corporate entities and were, until recently, part of integrated state conglomerates. There has been insufficient time for companies operating independently to establish their profitability. A second difficulty is the evolving methods of accounting and business planning. Balance sheets and plans are not presented as required by Western financial institutions, and independent audits are not always available for the companies.

D2. Project Reviews

The steel industry in the Ostrava region is comprised of four companies: Nová Hut´, Třinec, Vítkovické Stavby Ostrava, and OKK. All except OKK produce coke, steel, and steel products. OKK produces coke for sale and is associated with a coal producer within the same holding company.

On March 21, an initial meeting was held with Helena Cízková of project Silesia at the MOE. The subject of this meeting was the eight environmental cleanup projects developed by the Ostrava steel and coke industries. Ms. Cízková stated that the greatest emissions concerns about human health risks are related to the coking operations. She noted that the most important of the coke projects address emissions from Třinec battery No. 12 and Nova Hut battery No. 11 as these are large, modern batteries that are expected to remain in operation for many years. Ing. Pavel Nemeskal, from the Section of Metallurgy, Ministry of Industry confirmed this conclusion. Accordingly, this mission focused on the five Ostrava projects related to controlling emissions from coke ovens.[5]

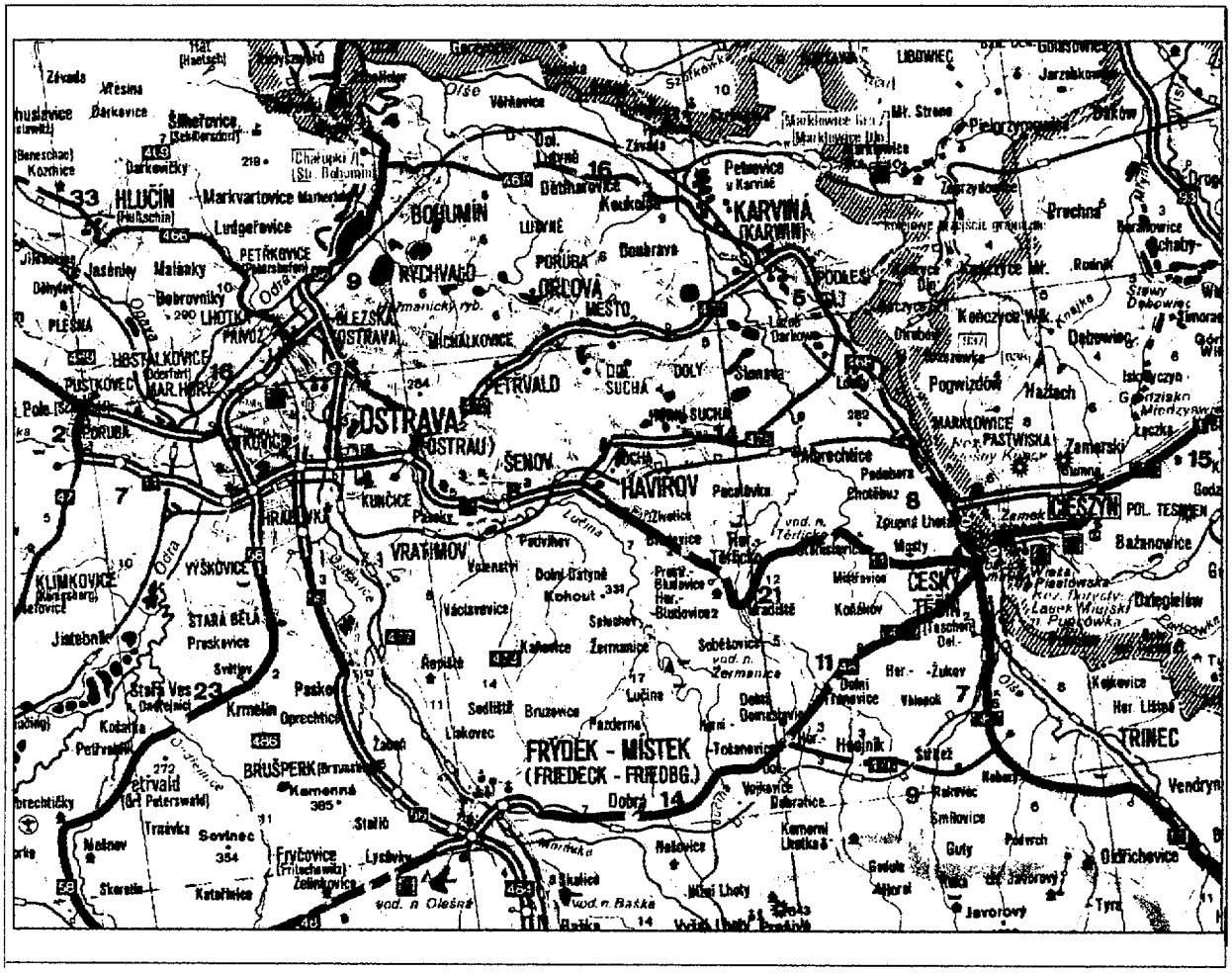
The Ostrava coke batteries have been the focus of considerable research by the U.S. EPA, the Czech firm INORGA Consulting, and several U.S. firms under contract to the EPA. Consequently, a great deal of information is available about the coke ovens, their design, and their emissions performance. Work by the Hygiene Institute and the U.S. EPA has concentrated on benzene soluble organics (BSO) and particulate matter as the pollutants posing the principal health risks from coking.

It is clear that some of the coke ovens have much lower emissions than others, and greater potential for reducing emissions at lower costs. In particular, the Nova Hut battery No. 11 has the lowest emissions rate, while batteries at Třinec are at the other end of the

[5] Background material on other potential projects will be provided to USAID under separate cover.

Ostrava Region

Location	*Pollutant*	*Avrg. 1992*	*Max. 1992*
OSTR. KUNZ	SO2	47	175
OSTR. KUNZ	NOX	55	117
OSTR. KUNZ	Dust	119	326



spectrum, as reported by INORGA Consulting and the U.S. EPA. In addition, it is generally accepted that the design of the top charging batteries will make them easier to control. The batteries at Vitkovice are expected to be closed before 1998 and were not the subject of any proposals.

It is not clear which batteries will survive the next several years. There is excess steel making and coking capacity in the Ostrava region. Unless there is a dramatic recovery in the European economy and world demand for steel, some batteries will undoubtedly close. It is clear, from an emissions perspective, which plants should close batteries to serve the public interest, but the decision to close batteries largely will be made by independent companies acting in their own competitive interest, provided they meet emissions limits.

Which batteries will remain in operation and for how long will rest in part on the cost efficiency and emissions of the batteries. The financial resources of the companies, local pressures, and their initiative in building markets will also be factors.

D3. Dust Control at OKK Coke Batteries Sverma 3 and 4

Substantial dust is emitted during the pushing out of the coke. The proposal is to install a stationary fabric filter and electrostatic precipitator to be fed by a mobile suction unit positioned on the coking side above the open door during the pushing out process. The project will reduce particulate emissions from pushing out by more than 97 percent, from the current rate of 0.190 kg/ton of coke to 0.005 kg/ton of coke. By law, this reduction must be accomplished by 30 September, 1996. OKK estimated that the total cost would be $4 million, with the cost spread over three years—1994: $666,000; 1995: $2,333,000; 1996: $1,000,000.

This project addresses two relatively modern top charging coke batteries, which are likely to operate beyond the end of the century. It is, perhaps, the most developed of the coke oven projects presented at Ostrava. Primary engineering has been completed by the local engineering and construction firm Hutní Projekt. Bids were solicited from several companies to supply the dust control equipment. A German firm, Krupps, was selected and is working with Hutní Projekt to finalize the design. One quarter of the project will be funded by a grant from the state government. Assistance in obtaining the additional financing was a prerequisite for selecting the supplier. OKK is preparing financial data for submission to commercial banks with the cooperation of the German firm. Financing will be from a German bank working with a Czech bank.

The project is expected to reduce emissions of dust by 200 tons per year. Benzene soluble organics (BSO) have been identified as posing high-cancers risks to people exposed to coke oven emissions in Ostrava. BSOs adhere to the surface of, or are contained within, the particulate emissions. Therefore, dust control will also achieve reductions in BSO emissions.

Human health benefits. Reductions of dust emissions and BSO will lead to improvements in the health of the exposed population. Dust can cause various respiratory illnesses and premature deaths, as well as toxic effects from pollutants adhered to particulates. Benzene soluble organics are known human carcinogens.

As part of Project Silesia and under contract to U.S. EPA, Industrial Economics, Incorporated (IEc), estimated the human health benefits of 100 percent reduction in particulate emissions from the Sverma coke ovens (batteries 3 and 4).[6] These estimates were adjusted to reflect the estimated 97 percent reduction in particulate emissions from the proposed control technologies for OKK batteries 3 and 4. The resulting benefits associated with reductions in particulate emissions are:

11.64 fewer premature deaths	32,195 fewer work days lost
37.83 fewer hospital admissions	51,216 fewer restricted activity days

The adjustment assumes a linear relationship between the reductions in particulate emissions and health effects. This is a reasonable assumption as long as particulate concentrations in the ambient air exceed the threshold below which there is no adverse health effect. Therefore, our analysis assumes, as does IEc's analysis, that other sources of particulates remain constant as emissions are reduced at coke ovens, and that emissions from other sources meet or exceed the thresholds for health effects from particulates.

IEc also estimated cancer risks posed by 1993 BSO emissions at Sverma coke ovens.[7] Estimates of reductions in BSO emissions associated with the proposed pollution control measures are not available; therefore, we have not estimated cancer risk reduction benefits. IEc's estimates, however, indicate the severity of the health effects associated with current emissions from the Sverma coke ovens. IEc estimates that individual lifetime cancer risk is 2.7E-4. Given the number of people exposed, this represents an estimated five cancer cases per year. Using these risk estimates and emissions and production data obtained from an audit of the coke oven, IEc calculated that there are 3.1E-2 annual cases of cancer per ton of BSO emitted and 5.7E-3 cancer cases per 1,000 tons of coke produced at the Sverma plant.

D4. Desulfurization of Coke Oven Gas at OKK Coke Batteries Sverma 3 and 4

The proposal is for desulfurization of the coke oven gases by means of two scrubbers: one to remove hydrogen sulfide and the other to remove ammonia. The proposed design includes a processing stage to remove the ammonia and hydrogen sulfide from the wastewater. The wastewater will then be processed at the municipal wastewater treatment

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[6] *Estimates of the Benefits of Controlling Particulate Emissions at Coke Plants for the Project Silesia Coke Ovens Demonstration Project*; Memorandum from Jim Neuman, Diana Fisher and Tom Walker, IEc, to Dr. Michael Vit, KHS, and Ing. Bretislav Klic, INORGA Consulting; March 15, 1994.

[7] *Revised Coke Oven Risk Assessment Results*, Memorandum from Jim Neumann, and Tom Walker, IEc, to Dr. Michael Vit, KHS, January 19, 1994; and *Overview of Cost-Benefit Analysis of Coke Oven Emission*, Memorandum from Jim Neumann and Tom Walker, IEc, to Ing. Břetislaw Klíč, INORGA, January 21, 1994.

facility. The proposal did not address whether the municipal plant is adequate in terms of design and capacity to accept this waste. The waste plant clearly could not accept water with significant amounts of ammonia.

An existing dephenolization process provides additional treatment of the water and extracts phenol in sufficient quantities to support the production of phenol-based chemicals. The ammonia would be split into its elemental components while the hydrogen sulfide would be converted to elemental sulfur and water using the Claus process. Upon completion, the scrubbing system would obviate the need for the current gas cooling system, which is reported to be a source of hydrogen cyanide in addition to the sulfurous gases.

The proposed process is appropriate and should result in very high level of emissions reduction. The performance data supplied with the proposal are as follows:

Emissions Reductions from Flue Gas Desulfurization at OKK Coke Batteries Sverma 3 and 4 (OKK Projections)

	Current emissions (g/m^3)	Emissions after Project Implementation		Percent Reduction (based on average) (g/m^3)
		Average (g/m^3)	Max (g/m^3)	
H_2S	3.5 to 5.0	0.45	0.5	89%
NH^3	4.5 to 6.0	0.03	0.05	99%

These emission rates are not unrealistic for flue gas desulfurization. However, they are at the high end of typical values.

Human health benefits. The primary health benefits associated with the coke oven desulphurization plan for OKK relate to the 89 percent reduction in hydrogen sulfide emissions and the 99 percent reduction in ammonia emissions. Both substances have respiratory effects. Hydrogen sulfide can cause respiratory paralysis at high concentrations, and inflammation of the nasal mucosa and eye membranes at lower concentrations. IEc estimates that as many as 758,000 people in the six districts in the Ostrava region are exposed to hydrogen sulfide concentrations that exceed U.S. EPA's reference concentration.[8]

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[6] Reference concentration is an estimate of the daily exposure level below which there will be no adverse effects during the course of a lifetime. Reference concentrations are developed by EPA for ambient air exposures to different toxic pollutants.

Ammonia has also been identified as a problem pollutant in the Ostrava area. It can cause respiratory effects at concentrations exceeding 0.1 mg/m3. IEc estimates that as many as 4,300 people in the Ostrava region may be exposed to concentrations of ammonia that exceed this reference concentration.

In addition, human health benefits would likely be realized by eliminating releases of hydrogen cyanide and hydrogen sulfide from cooling tower emissions. Hydrogen cyanide exposures can lead to thyroid effects, nerve damage, and weight loss. IEc estimates that 4,300 people in the Ostrava region are exposed to concentrations that exceed the reference concentration for hydrogen cyanide.

Budget. This project began in December 1993 using State funds for partial financing. The project budget is approximately $18.7 million over a four-year period as follows:

1993	$2.36 million
1994	$5.13 million
1995	$5.10 million
1996	$6.13 million

As with the proposed dust control project, this project is being done with Hutní Projekt.

D5. Emissions Controls for Coke Battery KB12 at Třinec Iron and Steel Works

The emissions controls proposed for KB12 include several elements: recovery and combustion of gases released during charging, collecting and filtering the dust released in pushing out, mechanical cleaning of coking chamber frames and doors to improve the seals, improved temperature control within the coking chamber, and continuous emissions monitoring of SO_2, NO_x, CO, dust, and other unspecified pollutants. The coke battery KB12 is currently being overhauled, with the work scheduled to last through June 1995. The projected effectiveness of emissions controls are shown in the table below.

Pollutant	Emissions Before Control t/a	Emissions After Control t/a	Percent Reproduction
Dust	276	95	66
SO_2	312	198	36
NO_x	359	296	17
CO	459	330	28
Aliphatic Hydrocarbons	36	25	31
Aromatic Hydrocarbons	137	95	31
Other Gaseous Emissions	77	55	29

The cost of the emissions controls was estimated by the plant to be $3 million, with an operating lifetime of 15 years. Assuming that KB12, after refurbishment, will operate beyond 2012 (which is the projected retirement date for the identical unit, KB11, refurbished two years earlier), the expected lifetime of the control equipment is less than the lifetime of the coke battery.

All analyses and projections regarding coke production in Ostrava agree that KB12 will remain in production for many years under any demand scenario. Despite being a top charging unit, KB12 is relatively dirty in its present state. The entire project is projected to cost $3 million for a capacity of 370,000 tons per year, or $8,100 per ton of production capacity. This is in contrast to the controls proposed for OKK Sverma batteries 3 and 4, which are estimated to cost $20,833 per ton of capacity and one of the units (battery 3) has a much shorter lifetime—to 2003 versus 2012.

Human health benefits. While the reductions in emissions of all pollutants will benefit the health of the exposed population, the most important health benefits are likely to be realized from reductions in particulate emissions and benzene soluble organics.

As part of Project Silesia, IEc estimated the human health benefits of 100 percent reduction in particulate emissions from the Třinec coke ovens. At the time, battery KB12 was idle so the estimates do not include its emissions. Scaling these estimates based on

production levels of the batteries and assuming 66 percent reduction in emissions, we estimate the following health benefits associated with improvements to KB12.[9]

7.5 fewer premature deaths
25 fewer hospital admissions
21,090 fewer work days lost
33,550 fewer restricted activity days

IEc's estimates indicate that the Třinec coke ovens, as a whole, account for approximately 34 percent of the particulate-related health effects posed by OKK Sverma, Třinec and Nová Hút coke ovens.

IEc also estimated cancer risks posed by 1993 BSO emissions from Třinec coke ovens. These estimates provide an indication of the severity of the health effects associated with current emissions from the Třinec coke ovens. IEc estimates that individual lifetime cancer risk is 1.8E-3. Given the number of people exposed, this represents an estimated 30 cancer cases per year. Using these risk estimates and emissions and production data obtained from an audit of the coke oven, IEc calculated that there are 4.0E-2 annual cases of cancer per ton of BSO emitted, and 2.5E-2 cancer cases per 1,000 tons of coke produced at the Třinec coke ovens.

Other health benefits will likely be achieved by reductions in carbon monoxide, nitrous oxides, and hydrocarbons. Carbon monoxide increases COHb in the blood, causing cardiovascular effects and placing added burden on people with heart disease. Nitrogen dioxide is a deep lung irritant and capable of producing pulmonary edema and increasing the incidence of asthma attacks. Hydrocarbons react with oxygen, resulting in increased NO_2 and ozone levels. Emission reductions for these substances on the order of 20 to 30 percent will add to the benefits achieved by reductions in particulates and BSO.

D6. Coke Gas Desulfurization at Nová Hut´

Nová Hut´ has proposed the installation of equipment for the ammonium catalytic dissociation of the exhaust stream and production of sulphur using the Claus process. The quantity of gas to be processed is 72,000 m^3 per hour. The objective is to reduce the concentration of hydrogen sulfide in the exhaust gas from the current 4 to 6 g/m^3 to the legal limit of 0.5 g/m^3, which must be reached by the end of 1998. This will result in a total reduction of H_2S emissions by 5,300 tons per year. The flue gas desulfurization system (FGD) should also reduce emission from the current final gas cooling system, which is a source of phenol, hydrogen cyanide, and BSO. The total reduction of these pollutants is estimated by the plant to be 660 tons per year.

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[7] *Estimates of the Benefits of Controlling Particulate Emissions at Coke Plants for the Project Silesia Coke Ovens Demonstration Project*; Memorandum from Jim Neuman, Diana Fisher and Tom Walker, IEc, to Dr. Michael Vit, KHS, and Ing. Bretislav Klic, INORGA Consulting; March 15, 1994.

Human health benefits. As for the coke oven desulphurization plan for OKK/Sverma, the primary health benefits associated with desulphurization technology at Nová Hút´ relate to the reduction in hydrogen sulfide emissions. As noted in the evaluation of potential health benefits for desulphurization at OKK/Sverma, hydrogen sulfide poses significant health risks to the people of Ostrava. Reductions in emissions of phenol, hydrogen cyanide, and benzene soluble organics currently released from the cooling tower will have added benefits, similar to those noted for OKK/Sverma.

Economic feasibility. The plant has identified two potential suppliers in Germany—Still-Otto and Krupp-Koppers, but the process is not unique, and comparable equipment can be obtained from other companies, including Research Cotrell in the United States. No bids have been solicited yet. The budget for construction is as follows:

1994	$ 0
1995	$2.66 million
1996	$5.00 million
1997	$8.33 million
1998	$6.66 million
1999	$1.35 million
Total	24.00 million

This is a relatively expensive investment relative to others proposed. However, it is for the largest single battery in the Ostrava region, with a total capacity of 1,125 tons per year. Nová Hut´ battery 11 is a top charging unit, and is generally expected to operate for at least 20 years. Nová Hut´ battery 11 has the lowest rate of BSO emissions of all Ostrava batteries by a large margin. The project schedule is reasonable, and there is time for U.S. technical assistance to play a role in developing specifications, evaluating bids, and qualifying for and obtaining financing.

D7. Particulate Control at Nová Hut´ Coking Battery 11

The objective of the project is to reduce dust emissions from Nová Hut´ Coking Battery 11 to the legal limit. Emissions are principally related to the pushing out process. The proposal is for a mobile dust collector that will be positioned above the door of each oven as it is opened and would return emissions to a central dust extraction facility. Filtered dust would be returned to the ovens. The dust is of importance not only as a respirable particulate, but also because carcinogenic benzene soluble organics are contained in, or adhere to, the dust. The system, which would use a fabric filter and electrostatic precipitator, is expected to remove 97 percent of the dust emissions, to a rate of 5 grams per ton of coke produced. The project is currently in the early design stage, with alternative configurations and specifications being evaluated. Completion is scheduled for September 1998.

The budget for the project is $7 million, with $1.3 million for design, and the remainder for construction. The same attributes that recommend flue gas desulfurization at Nová Hut´ Coke Battery 11 pertain to the particulate control.

Human health benefits. Nová Hut´ engineers estimate that the proposed changes to battery 11 will reduce annual particulate emissions by 91 percent. As part of Project Silesia, IEc estimated the human health benefits of 100 percent reduction in particulate emissions from all Nová Hut´ coke ovens.[10] Scaling these results based on production levels of the different batteries, and assuming 91 percent reduction in emissions, we estimate the following benefits of proposed dust controls.

75 fewer premature deaths
84 fewer hospital admissions
69,622 fewer work days lost
110,756 fewer restricted activity days

The percentage of the total health benefits for the Nová Hut´ coke ovens attributed to battery 11 is not available. Therefore, we have not estimated the health benefits associated with the proposed improvements to battery 11. However, IEc's estimates indicate that the Nová Hut´ coke ovens as a whole account for approximately 55 percent of the particulate related health effects posed by Sverma, Třinec and Nová Hut´ coke ovens.

IEc also estimated cancer risks posed by BSO emissions at Nová Hut´coke ovens in 1993. These estimates provide an indication of the severity of the health effects associated with current emissions.[11] IEc estimates that individual lifetime cancer risk is 1.9E-3. Given the number of people exposed, this represents an estimated 31 cancer cases per year. Approximately 3 of the 31 cases are attributable to battery 11. Using these risk estimates and emissions and production data obtained from an audit of the coke ovens, we estimate that there are 3.8E-2 annual cases of cancer per ton of BSO emitted and 2E-3 cancer cases per 1,000 tons of coke produced at battery 11.

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[8] Estimates of the Benefits of Controlling Particulate Emissions at Coke Plants for the Project Silesia Coke Ovens Demonstration Project; Memorandum from Jim Neumann, Diana Fisher and Tom Walker, IEc, to Dr. Michael Vit, KHS, and Ing. Bretislav Klic, INORGA Consulting; March 15, 1994.

[11] *Revised Coke Oven Risk Assessment Results*, Memorandum from Jim Neumann and Tom Walker, IEc, to Dr. Michael Vit, KHS, January 19, 1994; and *Overview of Cost-Benefit Analysis of Coke Oven Emissions*, Memorandum from Jim Neumann and Tom Walker, IEc to Ing. Břetislaw Klíč, INORGA, January 21, 1994.

ANNEX A
MEETINGS

In the course of our three-week mission to the Czech Republic, the members of our team met, either individually or as a group, with several government representatives at the national and regional levels, as well local technical, environmental, public health and economic experts. The information collected from these sources was supplemented with valuable insights and analyses shared with us by USAID staff and consultants in Prague. The following is a partial listing of the officials and experts interviewed:

USAID/Prague

Ms. Lee Roussel, AID Representative in the Czech Republic.
Mr. James Bednar, Program Officer.
Mr. Fred Van Anthwerp, Project Officer, Housing Loan Guaranty Program.
Mr. Jan Pisko, Project Specialist.
Mr. Thomas Sherwood, Sr. Energy Advisor and Regional Business Development Officer, Capital Development Initiative Project for Eastern Europe.
Ms. Laura Keresty, Capital Development Initiative Project for Eastern Europe.
Mr. Michael Schaefer, Consultant, Housing Loan Guaranty Program.
Mr. Leos Jirasek, Project Manager.

Ministry of the Environment

Mr. Vladimir Bízek, Deputy Minister.
Mr. Václav Krejčí, Project Management Unit.
Mr. Petr Raab, Project Management Unit.
Ms. Alexandra Orlíková, Head, Project Management Unit.
Ms. Helena Cížková, Project Management Unit for Region of Northern Moravia and Silesia.
Mr. Thomáš Hák, Projects Department and OECD Liaison Officer.

State Environmental Fund

Mr. Jan Beneš, Director
Mr. Václav Chytil, Technical Director
Mr. Jan Kužel

Other Meetings in Prague

Mr. Pavel Neměskal, section of metallurgy, ministry of industry and trade.
Ms. Jitka Smidochova, Czech American Enterprise Fund.
Mr. Jaroslav Maroušek, Executive Director, The Energy Efficiency Center (SEVEn).
Mr. Jan Vozáb, Foundation for Assistance to Local Administration (based in Most).

Dr. Petr Sauer, Head, Environmental Economics Dept., University of Economics.
Dr. Radim Šrám, Laboratory of Genetic Ecotoxicology.

Meetings in Ostrava, Northern Moravia

Ms. Helena Čížková, Project Management Unit for Region of Northern Moravia and Silesia.
Mr. Břetislav Klíc, INORGA Consulting
Mr. Kamil Barta, INORGA Consulting
Dr. Michael Vít, Regional Hygiene Institute
Dr. Lobemír Dobiás, Regional Hygiene Institute
Project Silesia Coke Oven Work Group—including representatives of Nová Hut´, Trinec, OKK, and OKD Coking Plants and Engineering consultants.

Meetings in Northern Bohemia

Mr. Přemsyl Hautke, head of environmental department in the city of Zätec.
Mr. Václav Janoušek, head of the district heating department in the city of Zätec.
Mr. Jiří Hellinger, enginnering department at the hospital of Nemocnice S Poliklinikou, city of Louny
Mr. Zdeněk Prosek, Deputy Mayor, city of Pilsen.
Mr. Zdeněk Grundman, Chairman, Pilsen Holding Company.
Mr. Josef Wenig, Infrastructure Project Manager, Pilsen Holding Company.
Ms. Jana Hógelová, Manager of the Economic Office, city of Pilsen.
Mr. J. Skuhrovec, engineering department (permits), city of Aš.
Ms. Olga Chaluprikova, Mayor, city of Rotova, and housing enterprise staff.
Mr. Milan Kunc, Mayor of Decín
Mr. Miroslav Baudiscky, deputy Mayor of Decin
Messrs. J. Sýkora and Charouzd Josef, heating department, city of Pilsen.
Dr. Jarmila Vonkova, manager of the environmental department, city of Decín
Mr. Leopold Kukačka, deputy Mayor, city of Usti upon Elbe.
Mr. Jiří Bavor, deputy Mayor, city of Usti upon Elbe.
Mr. Josef Sedláček, finance department, city of Usti upon Elbe.
Mr. Karel Koukolicek, Director for Strategic Planning, Severoceske Teplarny, Most (a private heating company)
Manager, Kocanda district heating plant, Litoměřice.
Mayor, city of Meziboří

Others

Mr. Eduardo Maal, Deputy Chief of Party, EP3 Project (met in Decín)
Mr. Lars Isager Hedegaard, Ministry of the Environment, Demnark (met in Decín)
Mr. Stanslav Kolář, Center for Clean Air Policy (met in Decín)

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ANNEX B
ADDITIONAL PROJECT DESCRIPTIONS

In this annex we present a description of project proposals reviewed in the course of our mission but not included in our recommendations for further technical assistance under the auspices of USAID. The proposed activities consist of district heating projects that differed widely in their stage of development, scale, and proposed technologies. They range from the simple installation of gas boilers in apartment blocs to the complete overhaul of large district heating systems, with advanced fluidized bed combustors.

A. District Heating Plant Upgrade for the Town of Aš

The town of Aš has proposed to convert a district heating plant from coal to natural gas, with modifications of the system to extend coverage, and to switch several buildings from a district heating plant at a local factory to the municipal plant. After this switch, the factory heating plant would be required to meet Czech emissions standards, improving air quality in the downtown area.

A1. Background

The city of Aš is located in the Nokriny region, in northwest Bohemia. The city has a population of 3,800, but a population of 12,000 live in close proximity. The principal local industries are textile, and clothing. Though sewing and cloth making are not major air polluting industries, the heating plant for the Tosta factory is considered a problem. Emissions from the factory's heat production exceed Czech limits, and the city government would like to upgrade the municipal district heating plant to reduce its emissions and eliminate dependence on the factory heating plant.

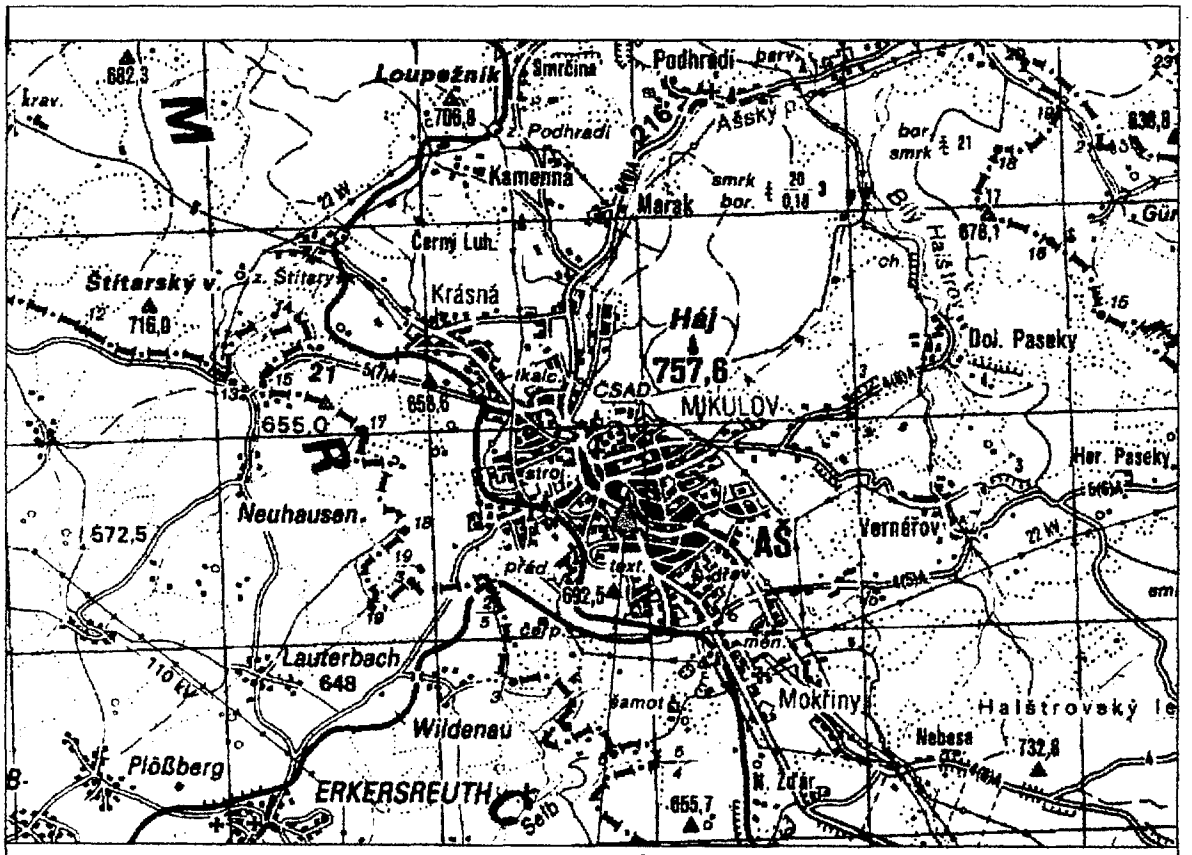
A2. Project Review[1]

The city has four district heating plants, three of which are operated by the municipality, with the fourth operated by one of the two textile plants. The table on the following page lists the capacity, units served, and fuel of each of the four plants. The numbering scheme is used in this report only. The town does not refer to the plant by these numbers. Plant 4 is operated by the Tosta textile factory.

[1] Note that the estimate of emissions presented earlier does not include emissions from Mokriny as there is insufficient data, nor does it include emissions generated by households heated with individual coal furnaces.

As Project

No serious air ambient data available



Heating Plant

The grid square on the map has a resolution of 1 km

60

District Heating Plants in Aš

Plant No.	Capacity (MW)	Units Served	Stack Height (m)	Fuel
1	20	1000	60	Unsorted low grade coal from Sokholov
2	6.5	350	40	Unsorted low grade coal from Sokholov
3	3.6	300	25-30	Higher grade coal from Most
4	3	300	40	Unsorted low grade coal from Sokholov

Three of the plants use unsorted coal from Sokholov Basin in moving grate stoker boilers. Mr. Skuhrovec, of the city's engineering department, was not able to provide us with technical details on the boilers, fuel, or emissions. By assumption, however, the coal used in Aš probably resembles the coal from Sokholov used in Rotava. If this is the case, the heat content is probably between 13.5 to 14.0 MJ/kg. This is slightly higher than average for brown coals in the region, but is well below available bituminous coals. The ash content of Sokholov is nominally 25 percent, with 0.6 percent sulfur. The sulfur content of the fuel is not low, when adjusted for the low heating value, but it is low enough that SO_2 emissions are not considered a serious problem. Mr. Skuhrovec could not specify the type of emissions controls in place, but standard practice in the region is a cyclone with 85 to 90 percent removal. Boiler 3 is also a stoker boiler, but does not use a moving grate. It uses a higher quality coal from the Most region and operates without emissions controls. The entire district heating system supplies hot water rather than steam. The Tosta boilers supply only heat; there is no factory requirement for steam. The boilers are 20 to 30 years old.

Emissions are not measured, but are estimated on the basis of fuel consumption by type (ash and SO_2 contect, etc.) by the MOE's environmental inspectorate to assess pollution charges. The emissions estimates presented below were prepared to compare the Aš proposal to other proposals. They are based on several assumptions: (1) the cyclones remove 90 percent of particulate emissions, (2) emissions from plant 3 are the same as at the other plants, and, most critically, (3) coal use is 24 tons per year, which would give the system roughly the same energy use per unit served as in the town of Rotava (see Rotava project review further below). The standard state emissions factors used and the results are rounded to reflect the highly approximate nature of these estimates.

SO_2	275 tons
NO_x	350 tons
Particulates	25 tons
Hydrocarbons	10 tons
CO	400 tons

The proposal from Aš has several components:

- The three boilers in plant 1 would be replaced with natural gas boilers.
- The distribution system would be improved to allow plant 1 to serve the areas now served by plants 2 to 4.
- The system would be extended to include parts of the downtown not served by the district heating system.
- The Tosta textile factory, which now operates plant 4, will be pressured to meet state emissions limits.
- Natural gas lines will be extended through the Mokriny region, allowing that area to convert to gas from the direct combustion of coal.

The town of Aš estimates that CK 30 million will be needed for the conversion to gas, CK 10 million for extension of the district heating system and improved interconnection, and CK 18 million for extension of the natural gas network.

The Aš proposal is still in the early stages of development. The general concept seems to be worth exploring. A single new central plant could certainly improve on the poor quality plants now in operation. The decision to select gas, however, was based on the preferences of the regional environmental organization, not on any engineering analysis. Improved emissions controls (baghouse or electrostatic precipitators), better coals, and fluidized bed combustion were not considered. Mr. Skuhrovec stated that they did not have the technical ability to make this comparison. Other options, such as increasing the capacity of plant 1 to supply the Tosta factory in exchange for financial participation, may also be practical. It is appropriate to consider these basic issues in more detail before proceeding with detailed design. This type of assistance is within the scope of USAID follow-up missions.

A3. Human Health Evaluation

The air quality in Aš is better than in of most of the other towns visited by our mission. This is due in part to its location in the northwestern-most part of the country, with no major sources of air pollution in surrounding towns.

Heating plants in Aš have been identified as the major source of air pollution threatening the health of residents. Currently, approximately one third of the population of Aš and its suburbs are served by the coal-fired district heating plants, one third by town gas, and one third by individual coal-fired furnaces. The town is in the process of converting from town gas to natural gas.

The initial objective of implementing the proposed plan is to control the large sources—the main district heating plant and the Tosta factory heating plant—so that they will meet state emission requirements. Of the two, the Tosta plant poses the greatest risk to human health. While we do not have emissions data from the plant, we were told it is the oldest and most polluting. It is located in the center of the city and has a low stack (40 meters); thus people throughout the city are exposed to pollution from this source. Bringing

this plant into compliance would significantly reduce emissions of particulates and sulfur dioxide. These pollutants can cause respiratory problems of varying severity ranging from chronic bronchitis to premature death. In addition, organic pollutants and metals adhered to particulates can also have serious toxic effects, including cancer. Conversion of the main district heating plant will have similar human health benefits, but because of its location outside the city and taller stack, pollutants are dispersed away from the population and thus have less of an impact.

The town's plans to convert family homes in nearby Mokriny from coal to gas heat will also have human health benefits. The location of these air pollution sources in neighborhoods, and the poor quality of the coal burned suggest that home furnaces may be the sources that pose the greatest human health risks in Aš. Unfortunately, the proposed improvements to district heating in Aš do not include reducing low-level pollution from family homes that currently burn coal. While converting homes in Mokriny will address part of the problem, additional human health benefits might be achieved by extending the district heating system to individual coal burning customers. A detailed evaluation of all heating sources, their emissions, locations, and human exposure would be necessary to evaluate the relative human health benefits of proposals to address the different sources.

A4. Recommendations

The district heating project in the town of Aš is in its earliest stages. The staff can use assistance in designing changes to the system. The key issue is fuel selection.

B. Environmental Improvement to the Kocanda Heating Plant in Litoměřice

The Kocanda Heating Plant in Litoměřice has five brown coal boilers with inadequate emissions controls. The plant submitted a grant application to the MOE to improve the controls on one boiler and to extend and reduce losses in the distribution system. Our team met with the plant manager and a senior engineer to review their proposal and assess the merits of planned improvements.

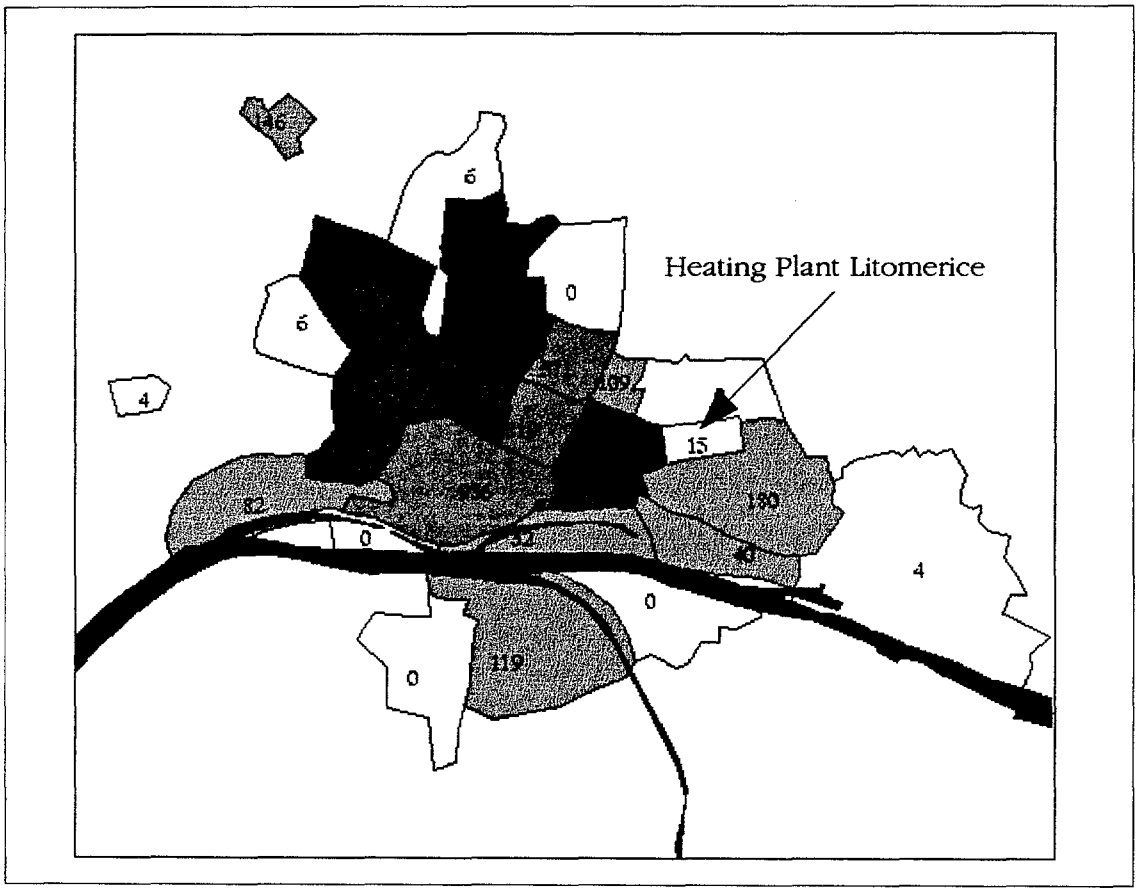
B1. Background

The Bohemian town of Litoměřice is located about 80 miles northwest of Prague. It has a population of 28,000, of which about 17,000 are served by district heat. The principal heating plant is the Kocanda plant, located on the edge of the city. Kocanda serves about 4,800 flats with approximately 15,000 inhabitants. The remainder are served by heat from three boilers at industrial plants, including the local brewery and a textile factory. Two of the factory boilers burn diesel oil. The third burns coal. Sixty to 80 percent of the residences and other buildings not connected to the district heating system burn coal. The remainder burn gas.

The management of the Kocanda plant would like, in the short term, to improve the emissions controls on its boilers to meet Czech emissions standards. Eventually, they would

Litomerice Heating Plant

Location	*Pollutant*	*Avrg. 1992*	*Max. 1992*
LITOMERICE OHS	SO2	49	280
LITOMERICE OHS	NOX	17	121
LITOMERICE OHS	Dust	80	309



Within each settlement unit, the number of its inhabitents is listed

like to expand capacity with a fluidized bed combustor to replace the industrial boilers now providing district heat, and to extend its system to serve buildings now burning coal.

B2. Project Review

The Kocanda heat plant has total capacity of 40.5 MW in five boilers. The three older boilers have a capacity of 5.8 MW each, while the two newer boilers have a capacity of 11.6 MW. All the boilers deliver hot water with the temperature range 120°C to 170°C. The fuel is 1.1 percent sulfur coal from the Sokolov basin with about 15 percent ash, and a lower heating value of 16.5MJ/kg. The heat content is higher than average from Sokolov, and the ash is lower, but coal with 0.6 percent sulfur is available in the region. The plant manager stated that major and sulfur dioxide emissions are not a problem. However, the 1.1 percent sulfur coal is not exceptional when the lower (by U.S. standards) heat content of the coal is considered. To operate without fuel gas desulfurization in the United States, a coal of this heat content would have to have a sulfur content of 0.5 to 0.6 percent.

The Kocanda plant has older boilers and minimal emissions controls but is in very good condition and appears to be well run. The insulation was tight, there were no steam or gas leaks, strip chart recorders were operational, and every surface on the boilers and throughout the boilerhouse was clean. All of the boilers operated through the last heating season without interruption. The buildings appeared sound.

Dust control at Kocanda is inadequate. The existing cyclones remove 85 to 90 percent of the particulate emissions to achieve a flue gas concentration of 720 mg/m3 versus a standard of 50 mg/m3. The Kocanda boilers are well instrumented, and oxygen is measured continually to improve efficiency and minimize NO_x emissions. The company plans to install baghouses. These should be adequate to reach the emissions limit, and may be preferred to electrostatic precipitators because of the low sulfur content of the coal, the high variation in coal quality, and the variation in particle size from the stoker boilers. The solution proposed is straightforward and should be effective.

The plant did not have emissions data available. Based on typical emissions factors for the region, current emissions of particulates would be on the order of 1,000 tons per year, which should be reduced to 6 tons per year with the new controls. These estimates are very crude due to the lack of specific data on coal quality, coal use, and the performance of the boilers. Emissions of heavy metals will be reduced in roughly the same proportion.

The rationale for expanding the system is not as straightforward as emission controls. The plant estimates that demand for heat will drop by about 20 percent over the next several years due to conservation measures and a decline in the local economy. Therefore there is no immediate need to expand. However, the poorly controlled industrial boilers continue to pose environmental problems. Concentration of the heat generation at the well-run Kocanda plant, with upgraded environmental controls, may make sense.

The installation of baghouses and minor improvements to the delivery system would cost about $670,000. The cost of extending the system to replace the industrial boilers is

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estimated at about $1.5 million. The cost of future expansion with fluidized bed combustion depends on the size of unit, which has not been yet determined.

B3. Human Health Considerations

High concentrations of particulate matter in the air in Litoměřice pose significant health risks to area residents. In 1992, the average annual concentration of dust in Litoměřice was 80 μg/m3. This exceeds the Czech emission limit of 60 μg/m3. Sulfur dioxide and nitrogen dioxide concentrations in 1992 were well below the Czech emission limits.

From a human health risk perspective, low-level particulate emissions from small coal burning heating sources are the major air pollution problem threatening the health of residents in Litoměřice. In addition to the one coal burning industrial heating source, there are approximately 2,000 individual coal burning furnaces. Most of these are located in the historic center of the city that is not connected to the district heating systems. While the proposed emission control measures at the Kocanda district heating plant would certainly improve environmental conditions in the area, they do not address these major low-level sources. Significant human health benefits would result from expanding the capacity and distribution network of the Kocanda plant, so that these sources could be eliminated. We do not have data on the emissions from the small coal-fired industrial boiler and individual furnaces, so it is difficult to determine the potential health benefits. However, we can assume that low-level emissions of particulates and sulfur dioxide would be reduced substantially.

The plant manager's primary concern is to implement pollution control measures, because the plant does not meet state emission requirements and pollution charges are increasing substantially each year. However, because the plant has a tall stack (92 meters) and is located south of the town in a less populated area, the human health benefits of reducing emissions from this plant are likely to be less significant than the benefits that could eventually be realized by expanding the distribution network to the center of the city to eliminate small boilers and individual coal burning furnaces. A more detailed analysis of the emissions and dispersion of pollutants from the plant and other coal burning sources in the city would be necessary to evaluate the relative human health risks and the benefits of expanding capacity and distribution to replace other coal burning sources.

B4. Recommendations

The Kocanda plant has a clear, well conceived plan for future development. They would like to upgrade controls on the existing units and ultimately expand the system with a fluidized bed combustor replacing other, dirtier heating plants. The parent company, Severoceske Teplarny, has determined that the FBC option cannot be afforded at this time. Accordingly, the company will install better particulate controls at Kocanda to meet emissions standards. Until the company makes a commitment to proceed with FBC, there is no role for USAID support.

C. Improvement of Hospital Boilers and Incinerator at Nemocnice S Poliklinikou, Louny

The small, 200-bed Nemocnice S Poliklinikou hospital in Louny, northern Bohemia (population 23,000) currently has two coal-fired boilers, with poor emissions controls, that supply heat to the hospital, residences in the neighborhood, and several public buildings. In addition, it operates an incinerator for hospital (including pathological) waste. The hospital managers would like to replace the boilers and incinerator, increasing the combustion temperature and improving the emissions controls.

C1. Background

The hospital is located outside the town center in a low-density residential neighborhood of roughly 1,000 people. It is only one of several medium-sized sources of pollution in Louny, and not the predominant one. An automobile transmission factory with a heating plant is located about 1 kilometer away. The downtown area of Louny was historically heated with coal, but is converting to natural gas. Two district heating plants are located on the opposite side of the city. One burns brown coal, the other burns diesel oil. Several concrete block flats have their own coal boilers. A district heating plant near the center of town is being converted from coal to gas. The local brewery uses gas boilers.

In addition to burning coal for heat, the hospital incinerates waste in a system with poor emissions controls. The combustion temperature is too low for medical wastes (600°C), has only a cyclone for particulate control, and emits substantial quantities of dust and partially burned material when charged with large batches. The hospital has applied to the State Environmental Fund (SFZP) to build an upgraded heating plant with an integrated incinerator and emissions control system.

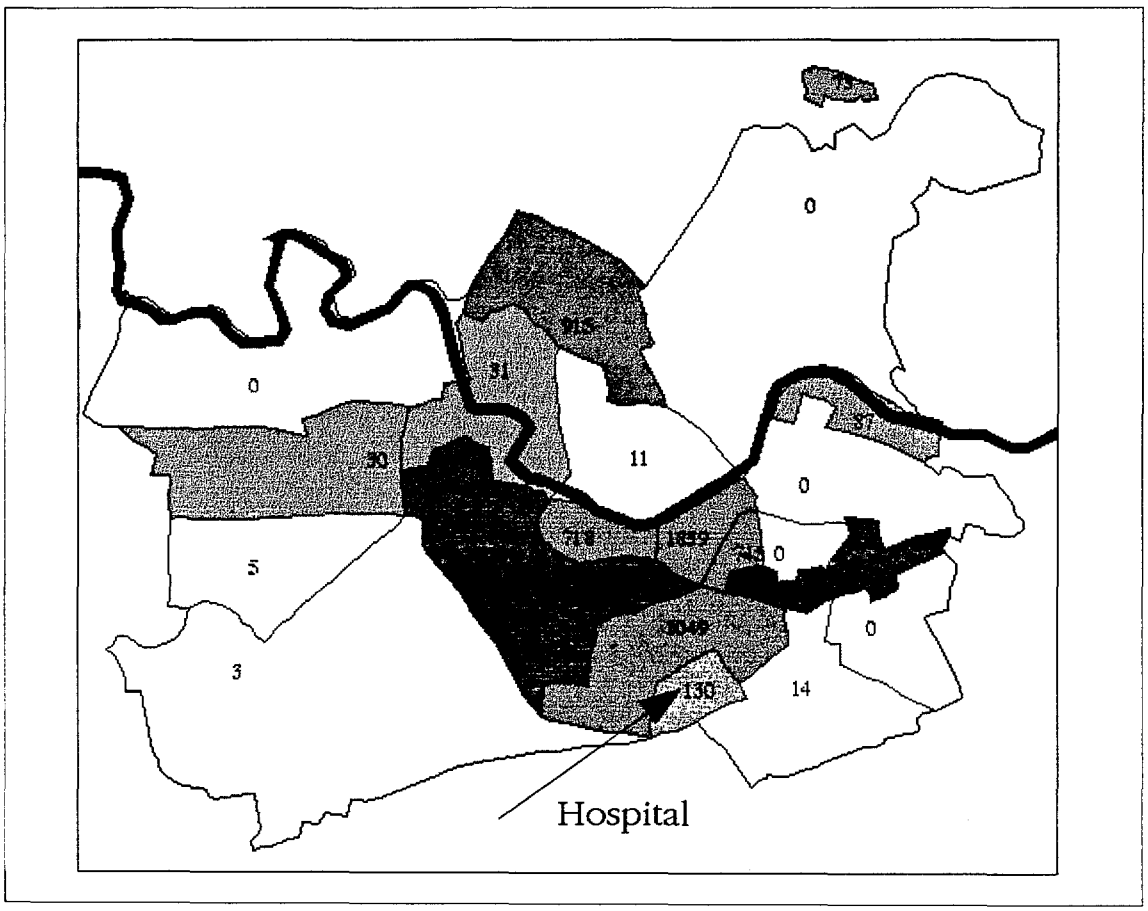
C2. Project Review

The current boilers are coal fired and have a capacity of 12 MW and a baghouse for emissions control. The incinerator is a stand-alone unit, with a very short stack, and only a cyclone for emissions control. Two new configurations are under consideration. One would have two 6 MW boilers, the other four 6 MW boilers. The decision will be based on the demand for heat. The hospital officials interviewed felt the smaller configuration was more likely. The new boilers would have a combustion temperature of 1200°C, allowing them to be used for incineration of the mixed medical wastes. The new unit would include a baghouse for particulate control. The proposed new system would have a capacity to incinerate 700 tons per year of mixed waste versus the current rate of 100 tons per year. The hospital seeks the additional capacity in the hopes of gaining a contract for incineration of wastes from other hospitals. The proposed system is reported to be very similar to the one used at the Motol hospital in Prague.

From an engineering perspective the solution is simple and will work. This project is not, however, a good candidate for an HG loan given the modest revenues of the hospital from the state-run medical insurance system. Further, the hospital is not a major source of

Louny Hospital and Incinerator

Location	*Pollutant*	*Avrg. 1992*	*Max. 1992*
LOUNY - HOSPITAL	SO2	6	92
LOUNY - HOSPITAL	NOX	31	178



Within each settlement unit, the number of its inhabitents is listed

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pollution. While low elevation emissions containing hydrocarbons and pathogens from inadequate incineration of plastics and medical waste may pose high risks to those exposed, the low density of the immediate neighborhood limits the number of people that might be affected to less than 1,000. Finally, the scale of the project, with a waste capacity well in excess of that required by the hospital, raises the capital cost of the project and is difficult to justify for an institution with limited access to capital and precarious financial circumstances.

C3. Recommendations

The Louny project involves replacing a district heating plant based at a hospital as well as the hospital's waste incinerator. The project requires engineering support, particularly in the unique requirements of waste combustion, with the need for supplemental NO_x controls. However, as we noted in our selection approach, the project does not appear to qualify for funding under the HG Program, and its cost effectiveness is doubtful from a health risk reduction point of view. Further, we believe that the hospital administration should consider the option (and cost) of incineration at another site, as well as the market for the excess incineration capacity in the hospital's current plan.

D. District Heating Improvement for the City of Pilsen

The city of Pilsen is developing an extensive plan to refurbish the district heating system and replace numerous individual boilers to improve efficiency and reduce emissions. The study to develop the plan has three components—the demand side, the supply side, and organization and financing. The first two are complete. The third component is underway. All three phases are supported by USAID.

D1. Background

Pilsen is located in the western part of the Czech Republic in the center of the large Pilsen river basin. The city has a population of 175,000 and is highly industrialized. The largest industry is the Skoda Works, which directly employs 27,000 people. Other industries include brewing, pulp and paper, wood working, and building materials. As the center of the west Bohemia region, the schools, hospitals, financial institutions, and media located in Pilsen serve a population of 500,000 to 700,000.

USAID has been supporting the city in its effort to redesign the city's district heating system. The redesign is being done in three phases. The first two addressed the demand for heat and supply options. The third phase considers how the new heating company should be organized, managed, and operated, and how the upgrade can be financed. The first two phases are complete. The demand study was led by Battelle, Pacific Northwest Laboratories, with substantial participation from Czech subcontractors. The demand study was conducted by the Czech firm SEVEn. The supply study was led by the U.S. firm Gilbert/ Commonwealth with four Czech subcontractors making major contributions. The third phase is underway, with leadership by SEVEn. The project is having budget problems, and the scope has been reduced from developing four business plan scenarios to one.

D2. Project Review

D2a. Demand Side

The demand study for district heating in Pilsen focuses exclusively on the potential for conservation in the residential sector. It does not address the basic issue of economically driven growth or decline in energy demand. This is, perhaps, justifiable if the decision is made that no new homes and other buildings will be heated by individual gas boilers rather than the district heating system, and it is assumed that all buildings now connected to the system will continue to be served. These assumptions may be a reasonable starting point but should be verified before the narrow focus of the demand analysis is fully justified.

Given the focus on residential conservation, the demand study essentially develops a list of conservation technologies, identifies a subset of these that are considered technologically reasonable for Pilsen, and evaluates the cost-effectiveness of the measures to develop a supply curve relating energy savings to the cost of heat. The list of technologies is quite extensive, and reasonable models and assumptions were used to estimate the performance of the technologies in prototypical structures. The study estimates economically feasible potential savings at 20 percent of current demand, but states that not all effective saving measures will be implemented. Overall savings are estimated at 12 percent.

The demand study correctly and prudently notes that the results and quality of the analysis depend on the quality of the available data, and that much of the necessary data are not available. In particular, there are no good data on energy use in buildings, on thermal performance of the buildings, or to assess the role of energy use in consumer purchasing decisions and the tradeoff between initial cost and long-term savings. The simple economic model of investment in energy technologies also ignores the vagaries of consumer behavior, their general lack of information about energy use, and the fact that quality of service is more important than energy use. These factors together make it very difficult or nearly impossible to estimate the level of residential energy conservation in Pilsen, as the demand study attempts, given the essentially complete lack of data and precedent. Accordingly, the results of the demand study are not reliable, and it is doubtful whether any reliable estimate can be derived without better data on the building stock or historical data to model consumer behavior.

The demand study has serious problems for the above reasons, but they are not critical to rebuilding the heating system in Pilsen. First, the change in residential energy use is at the margin of total energy use. There will be substantial base demand. The system upgrade will also take time, and the plan can be refined as it moves to completion. For the purposes of planning, the assumption of a 12 percent savings in heat demand for residences is prudent and acceptable. This results in a 25 percent increase in overall demand, if the city's best-guess economic assumptions are realized and many small boilers are replaced by the district heating system.

D2b. Supply Side

Because Pilsen is a large city, the district heating system is large and complex. There are six suppliers:

- Cogeneration Plant (CP Pilsen), with input from Bory and peaking support from Kosutka
- The West Bohemia Brewery Boiler House
- The Railway Maintenance Company Boiler House
- The Doubravka independent district heating system
- The Svetovar independent district heating system
- The Skoda factory

The six sources operate nine heating plants. All supply hot water for heating. The Skoda and Bory plants provide steam for industry. Skoda and CP Pilsen also generate electricity. There are a mix of older stoker boilers and newer pulverized coal boilers. The brewery uses natural gas. Other companies use a mix of brown coal from Sokolov and oil. The older, brown coal stoker boilers are the principal concern in the upgrade and refurbishment. Typical coal characteristics are as follows:

Nominal Characteristics of Coal Used in Pilsen	
sulfur	0.5 to 0.95 percent
ash	13.4 to 18.5 percent
moisture	34 to 37.1 percent
heating value (LHV)	12.73MJ/kg

The largest heat supplier is CP Pilsen, with a hot water capacity of 187MW, a steam capacity of 68.2MW, and an electrical capacity of 55MW. The plant operates during the winter and supplies steam to the brewery. The plant does not meet current Czech environmental standards.

The Kosutka plant provides peaking capacity and was not used during the mild winters of 1991 and 1992. It was used for only a short period during the winter of 1993. It was an oil-fired unit, but is being converted to natural gas. The change was made partly because the oil handling equipment does not meet current regulations.

TEZA enterprises operates four stations—Bory, Letna V1, Doubravka V2, and Svetovar. Bory is near the end of its lifetime. At its phaseout, the system will be connected to CP Pilsen. The interconnection is partially complete. The V1 and V2 plants are interconnected units. They are considered to be a serious environmental problem because of their proximity to the residences served. The G/C review concluded that there is insufficient space for an environmental upgrade. Accordingly, these plants are being phased out and

their hot water systems connected to CP Pilsen. The link will be completed by the end of 1994. The Svetovar plant is obsolete and reported to be in poor condition. Proposals have been made to connect Svetovar to CP Pilsen, but no project is underway.

The West Bohemia Brewery operates four relatively new gas boilers and plans to install a fifth. These units are in excellent condition. They provide hot water during the summer months when CP Pilsen is not operating. These boilers will continue to operate to serve the needs of the brewery.

The railway maintenance company operates two obsolete steam grate boilers burning Sokolov coal. They serve the district heating system year round. These boilers are at the end of their operating life and must be replaced soon.

The Skoda factory operates several large, efficient high-pressure boilers and cogeneration units using pulverized coal. Construction of an additional boiler of similar design was begun and then stopped, but construction has resumed, with completion scheduled by the end of 1994. Then there will be sufficient capacity to take two existing coal and oil units off line to upgrade their environmental controls. The coal units will be equipped with flue gas desulfurization units and unspecified particulate controls. The oil units will be switched to low sulfur oil. The future level of production (and heat and steam demand) and the Skoda factory are matters of some uncertainty given the ongoing corporate restructuring.

Given solid plants at Skoda and the Brewery, and several aging and dirty small plants, the town reached the conclusion that heat generation should be concentrated at CP Pilsen, with facilities there upgraded to current environmental standards. Gilbert/Commonwealth endorsed this conclusion and evaluated several options for new steam and/or heat capacity at CP Pilsen. The evaluation was done in two rounds, with the principal candidates of the first round examined in substantial detail. The final variants examined were as follows:

Options for Upgrade of CP Pilsen	
A1	Combined cycle plant with two 60.9 MWe gas turbines
A2	Combined cycle plant with one 60.9 Mwe gas turbines
A3	Combined cycle plant with one 47 Mwe gas turbine
A4	Combined cycle plant with one 90 Mwe gas turbine
B1	Cogeneration plant with one circulating fluidized bed boiler w/ a 32 MWe steam turbine
C1	Life extension of current units and subsequent construction of a CFB boiler with a 32 MWe steam turbine in 2003

This characterization of the variants is extremely simplistic. Each variant, in addition to the new unit listing includes a plan for all other units in the system, emissions controls for the remaining units at CP Pilsen, and improved interconnection. The options are described in detail in section 6 of the Gilbert/Commonwealth report.

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Evaluating fully the cost of the different options is not possible within the context of this report or with the available data. The conclusion of the Gilbert/Commonwealth study regarding cost is shown below.

Cost of Options for Upgrade of CP Pilsen (Million 1$US)

A1	not in final cut
A2	179
A3	177
A4	not in final cut
B1	141
C1	138

The preferred options are improvements to the current system with addition of a circulating fluidized bed (FBC) unit in 2003, and an immediate investment in FBC. The ranking of these two options depends on the discount rate used in the analysis.

From an engineering perspective, this analysis is sound. The assessment of cost is solid, but is undercut by major uncertainties. Energy markets are still regulated—the price of heat is set by the central government. Basic issues such as the pace of privatization and industry subsidies are still unresolved. On a local level the future of Skoda operations is a major uncertainty. If Skoda thrives, Pilsen will prosper and the demand for heat will be high. If Skoda does not prosper, demand will be lower, and it may even be possible to use some of Skoda's capacity to supply district heat. These factors can affect the change and timing of the options enormously. Ing. Zdeněk Grundman, the chairman of the Pilsen Holding Company that manages the district heating facilities, has said that he sees the merit of delaying action, at least until after the 1996 elections, but would hate to waste the work done so far, which would be largely outdated in a few years.

D2c. Human Health Considerations

The Gilbert/Commonwealth study estimates that the preferred variant to improve the current system at CP Pilsen, by adding a circulating fluidized bed (FBC) unit would substantially reduce SO_2 and particulate emissions from heating sources in Pilsen. It would reduce SO_2 emissions by 55 percent from 11,297 tons in 1993 to 5,097 tons in 2000. It would also reduce particulate emissions by 32 percent from 1,658 tons in 1993 to 1,121 tons in 2000. These estimates of emission reductions from heating sources in Pilsen assume that: SO_2 emissions from the Skoda and Svertovar plants would be reduced by 70 percent, 22 percent of small decentralized coal-burning boilers would shift to district heating, and conservation measures would reduce emissions from small boilers and home furnaces by 10 percent.

It is difficult to determine the human health benefits of these emissions reductions without better understanding the dispersion of pollutants and exposure of the population living and working in the city. However, we do know that a large number of people would

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benefit since there are 175,000 people living in the city and another 300,000 to 500,000 using the city services. Therefore, such dramatic decreases in SO_2 and particulate loadings from heating sources are likely to decrease the rate of respiratory illness and mortality in the population. Additional benefits may result from fewer hospital and emergency room admissions, as well as fewer lost work days.

The immediate objective of the Pilsen district heating proposal is to bring the central heating plant into compliance with Czech environmental emission limits. While this will undoubtedly improve air quality in the area, it may not reduce human health risks in proportion to the reduced quantity of emissions. Other major sources of pollution in the city pose significant risks to the population, because they are widespread and release pollutants at, or close to, ground level in densely populated areas of the city. These sources include 565 small decentralized boilers, small coal burning home furnaces, and mobile sources. Of the small boilers, 165 burn lignite and 65 burn coal.

The Gilbert/Commonwealth study estimates the percentage of emissions from city heating sources that can be attributed to small boilers and home furnaces. It estimates that small boilers contribute 41 percent of particulate emissions, 5 percent of SO_2 emissions, 6.4 percent of NO_x emissions, and 14 percent of CO emissions. Efforts to either connect customers served by these small sources to the district heating system or convert the boilers to gas could significantly reduce overall low-level particulate emissions and thus reduce mortality, respiratory disease, and other toxic effects associated with exposure to high levels of particulates in the air. The Gilbert/Commonwealth study estimates the emission reductions associated with gas conversion and efficiency modifications to these small boilers. The results are presented below.

Small Boiler Emissions (tons/year)

	Particulates	SO_2	NO_x	CO	C_xH_y
Current	1,201,327	682	540	178	399
Suggested	931,961	134	112	50	66
% Decrease	22	80	79	72	84

The Gilbert/Commonwealth study also estimates that home furnaces contribute 23 percent of particulate emissions, 3 percent of SO_2 emissions, 6 percent of NO_x emissions, and 80 percent of CO emissions. Because home furnaces are such a large contributor to carbon monoxide emissions, improvements to the Pilsen plant alone will not reduce the cardiovascular effects associated with high levels of carbon monoxide. We do not have ambient air quality data for carbon monoxide, so are not able to determine whether this pollutant poses high risks to the Pilsen population. Health statistics for the Czech Republic do not indicate an unusually high incidence of circulatory disease in Pilsen. In any case, attempts to reduce the 2,782 tons per year of carbon monoxide released from heating sources in Pilsen must address home heating sources.

D2d. Recommendations

The Pilsen project is highly developed and has been the focus of substantial U.S. engineering assistance. No additional engineering technical support is needed. However, the city can definitely use assistance is developing financing plans for its ambitious program (see discussion related to financial evaluations in Section I).

E. Conversion from District Heating to Individual Building Boilers in Rotava

The town of Rotava has submitted a proposal to the Ministry of Finance for HG Loan Program Guaranty financing to replace its aging, coal-based district heating plant with gas boilers in individual buildings that it currently serves.

E1. Background

The town of Rotava is located in a mountainous area in the western corner of north Bohemia, near the German border. The town has a population of roughly 3,800 concentrated in three clusters. The largest concentration is at the top of a 600-meter hill. There is no polluting industry at this location. The second largest concentration is at the bottom of the hill, about 1.5 kilometers south of town. There are perhaps 40 households in this lower part of the town, located very close to a small factory that does metal casting and machining. The third concentration of population is a small residential area 3 kilometers northwest of the town center. There is no industry in this area.

Rotava has problems with both water and air quality. The town uses surface water for drinking. The water is contaminated with metals, principally iron but possibly others, including uranium. Air pollution problems stem from the heating plant in the lower part of town and the district heating plant in the upper part. The mayor acknowledges that the level of air pollution is highest in the area of the factory, and is less concerned with the factory than with the district heating plant because of its proximity to the majority of residences in the town. Rotava has submitted a proposal in the amount of $1.9 million to the Ministry of Finance to install individual boilers in residential buildings owned by the housing enterprise. This would allow them to close the district heating plant.

E2. Engineering Review

District heat is provided by a single plant to a total of 900 flats, schools, and a sports center. The apartment buildings are typically prefabricated multi-story structures in poor condition with uninsulated windows. Heat is provided by hot water in the range of 120°C to 90°C. Heat is delivered through well-insulated primary lines above ground and buried secondary lines.

The central heating plant has three boilers of the same design, built in 1964 by Skoda. The plant was intended to provide heat for a limited time while a line connecting the town to a nearby central power plant was built. This plan was abandoned due to the difficulty of engineering the link. Each of the boilers has a capacity of 5.5MW, for a total plant capacity

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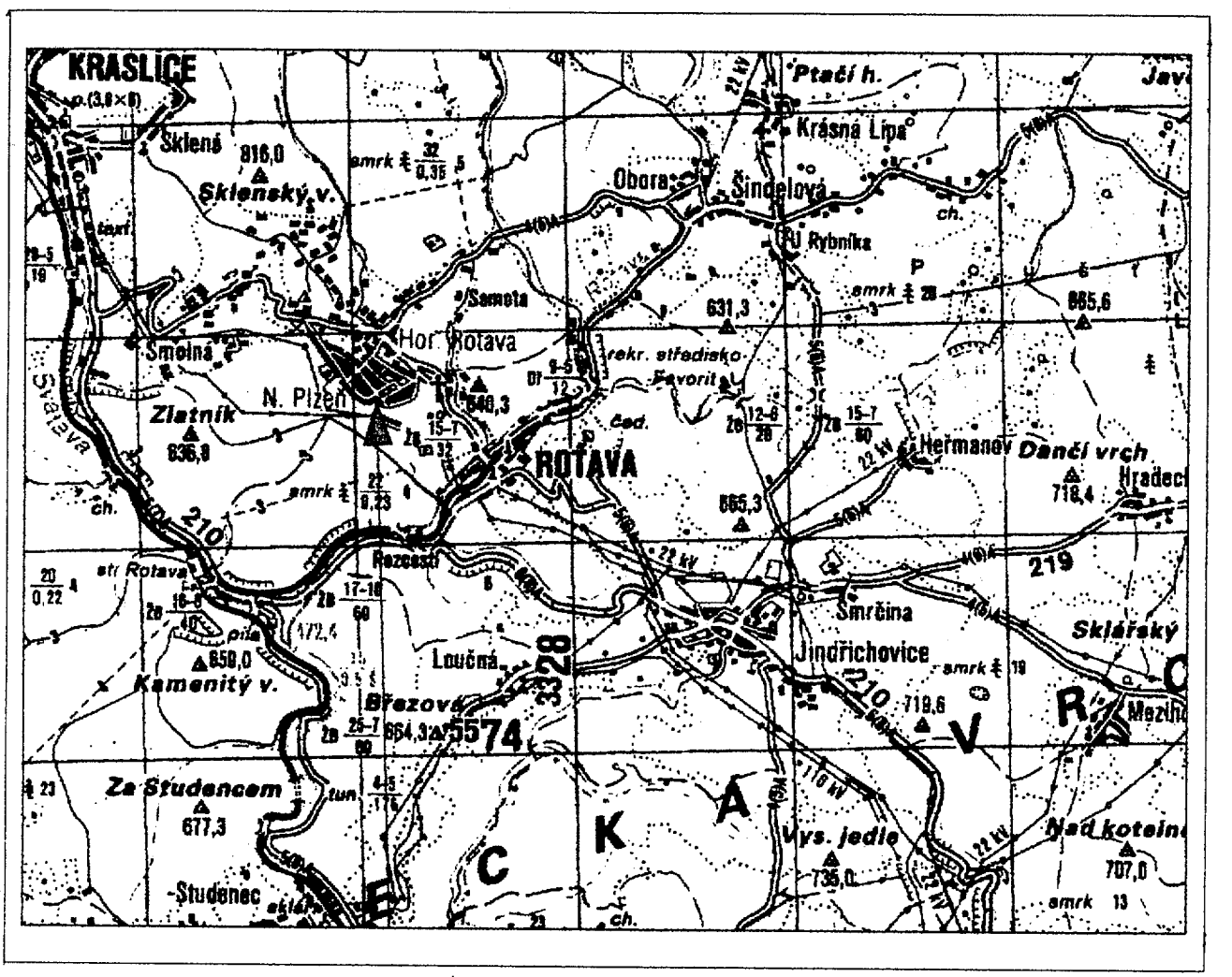
Rotava Project

Location	Pollutant	Avrg. 1992	Max. 1992
SINDELOVA	SO2	28	455



Heating Plant

The grid square on the map has a resolution of 1 km

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of 16.5MW. They burn about 12 tons per year of coal from the Sokholov basin, with an average heat content of 13.5 to 14.0 MJ/kg. This is slightly higher than average for brown coals in the region, but is well below available bituminous coals. The ash content is 25 percent, with 0.59 percent sulfur. By U.S. standards, this is not low sulfur coal, because of the relatively low heating value of the fuel, but it is moderately good by the coal standards used in this region. The sulfur content of the fuel is low enough that SO_2 emissions are not considered a serious problem, and the town's principal concern is with reducing particulate emissions. At present, a cyclone provides 90 percent removal.

The boilers are stoker boilers that burn unsorted coal on a moving grate. This type of boiler design is not common in the United States. It is less efficient and results in greater emissions. Ash is removed by a manual system of hand carts running on tracks below the boilers. The boilers are in poor condition as is the boiler house. Their age is a factor in their poor condition, but they have also suffered from extreme levels of scaling due to aggressivity of the feedwater. The boilers have been retubed three times in their lifetime and are again due to be retubed. During the past winter, one boiler was shut down six times, while the adjacent boiler was shut down five times. The third boiler was not operated. The boilers are nominally controlled from a panel that monitors emissions and oxygen in addition to flows, temperature, and pressure. However, the panel was completely inoperative except for a basic pressure gauge. There is a strong odor of combustion gases throughout the boiler house. The general state of the plant perhaps reflects the town's conclusion that the plant has reached the end of its service life and further minor investment is pointless. This would not be an unreasonable conclusion if the capital were available to replace the plant.

For tax purposes, calculation of emissions from the plant was based on countrywide emissions factors. These do not reflect the specific characteristics of the fuel used. The calculated emissions for 1993 are listed below. It is likely that NO_x emissions are well above the calculated number due to the very poor control of the boiler.

Estimated 1993 Annual Emissions from the Rotava District Heating Plant	
SO_2	192
NO_x	138
Particulates	176
Hydrocarbons	12.6
CO	6.35

The mayor stated that the town has had difficulty in attracting the attention of the state because the air quality is not "catastrophic." The annual average ambient SO_2 concentration at the nearest monitoring station on Haj was 30 μg/m3 in 1992.

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The town's strategy to address the deficiencies of the central power plant is to install individual boilers in all the buildings currently served by the plant. These buildings are owned by the municipality because they have not yet been privatized and because, in the words of the mayor, the buildings are in such poor condition that there may not be a buyer.

The manager of the district heating plant said they had compared the cost of individual boilers in buildings to the cost of upgrading the central plant, and found that individual boilers would be less costly. The individual boilers would cost CK 30 million, while it would cost CK 50 million for new gas boilers or fluidized bed combustors at the central heating plant. This analysis is probably correct in the case of Rotava because of the very poor state of the plant infrastructure. Any new boilers would require completely new controls, major repairs to the boiler house, and secondary steam lines. Given access to an adequate supply of natural gas, the town's proposed solution is probably the best. The conversion would essentially eliminate particulate and NO_x emissions. The town's air quality should also improve as a consequence of converting coal-heated private homes to natural gas or electricity and replacing town gas with natural gas.

At present, the conversion project is still in the engineering design phase, to be completed next September. The capacity, location, and general configuration of the individual boilers have already been determined. The town would like to proceed with converting two buildings as demonstration projects.

E3. Human Health Considerations

The potential health benefits of the proposed project are not likely to be high relative to other projects reviewed. There are only a small number of people that risk health effects from exposure to emissions from the heating plant. In addition, because the air quality is relatively good and there are no other major sources of air pollution, existing levels of such contaminants may not pose significant risks to the population. The other major source of pollution in Rotava is 130 to 200 family homes that burn coal. The proposal would not address these low-level sources of particulates and SO_2.

E4. Recommendations

The plan of the town of Rotava calls for eliminating district heating in favor of boilers at individual building blocs. We see a need for repairing and upgrading the current facilities, but no immediate environmental health risks. However, the town has already proceeded with a well considered plan and is ready to begin construction. No additional technical support is necessary.

F. District Heating Improvements for the Town of Usti

The city of Usti is a major industrial town on the Elbe river in northern Bohemia. The river cuts a deep valley that traps a layer of still air over the city, resulting in a high level of air pollution. Local government and industry officials are pursuing several strategies

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to reduce emissions. Among them are two proposals for funding under the HG Program. The first proposal, which would cost about $2.3 million, has five parts:

1. Conversion of a 20 MW coal plant to natural gas.
2. Replacement of eight small gas boilers with boilers at individual buildings.
3. Continued installation of gas lines to houses in Nikovice.
4. Installation of gas lines in several small neighborhoods.
5. Improved insulation at municipally owned buildings.

Cogeneration was evaluated but not considered cost-effective. The second proposal is $2.5 million to insulate heat pipes and buildings. These proposals are only part of a much larger program that examines energy from large gasworks to catalysts for the city's buses. For the moment, however, the city is intent on these two specific proposals. The deputy mayor believes that these proposals are well-enough developed that they do not require technical assistance at this point.

Technical assistance in developing the broader district heating strategy is being provided by Gilbert/Commonwealth through U.S. DOE and USAID. This study will be done in the fall. It may be appropriate at that time to revisit the city to determine whether assistance is needed in evaluating and implementing the Gilbert/Commonwealth recommendations. The Gilbert/Commonwealth study is likely to be sound from an engineering perspective, but may not specifically address the differential health impact of the various district heating facilities or the financing of the suggested projects.

Projects are also being pursued at three industrial sites in the city. Proposals for projects at these sites were submitted to the Ministry of the Environment (MOE) for EU PHARE funding. Our schedule did not permit visits to these projects during the mission.

ANNEX C
TECHNOLOGIES APPLICABLE TO DISTRICT HEATING

A summary follows of the primary technologies used in district heating generation.

1. Stoker Boilers

The most common method in the Czech Republic for generating steam or hot water in district heating is the stoker boiler. This type of boiler burns pulverized coal, which can range from the size of a grain of rice to that of a large walnut. The fuel may be graded by size, or unsorted sizes may be burned together. There are two type of stoker boilers: fire tube boilers, where the water circulates around tubes containing the hot combustion gases, and water tube boilers, where gases circulate around the water pipes. The fire tube boiler is not suitable for high pressure steam application and cannot be built to the same capacity as water tube boilers. However, they are less expensive and perfectly suitable for low pressure and hot water applications of moderate size.

A small sample of boilers was examined during our mission. The studies we reviewed did not classify the boilers by type, so it is difficult for us to generalize about existing district heating systems in the Czech Republic. However, the steam boilers were of the water tube type, while hot water district heating facilities we observed tended to be of the fire tube variety. The latter used the low cost horizontal return tube (HRT) design, which is easy to build and inexpensive to operate and maintain in comparison with other types of fire tube boilers.[1] A principal disadvantage of the HRT design is that scales are difficult to remove from the surfaces of the inner tubes. Water treatment is critical, and all the plants examined had large water treatment facilities, though the chemical treatment processes used varied. The plant at Rotava, for instance, used extremely hard water, which, despite treatment, severely affected the water tube life and led to an exceptional rate of tube failure due to scaling.

The stoker boilers examined during our mission used a traveling grate, a process where the coal is deposited on a steel conveyor belt that slowly traverses the length the firing region of the boiler as the coal burns. This design accommodates the unsorted coal used at the plants. Unfortunately, such low quality coal results in incomplete combustion and causes higher emissions.

[1]The scotch marine boiler, which is more efficient, has largely replaced the HRT in the U.S. and currently represents only about five percent of installed stoker boilers.

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2. Pulverized Coal Boilers

Pulverized coal boilers use finely ground coal that is sprayed into the boiler in a jet of air. Enough air is injected with the coal to complete combustion of the volatile matter and heat the carbon into incandescence. Secondary air injected around the burner (but not with the coal) completes the combustion of the carbon. The small particles oxidize quickly as the ignition temperature is reached. The small particle size and the control afforded by the systems of primary and secondary air injection provide more complete combustion than in the case of stoker boilers. The pattern of jets (and hence combustion) and flow within the boiler vary with different designs. Pulverized coal boilers were observed during our visit to the (idle) CZT heating plant in Decín. The Skoda factory in Pilsen operates several large pulverized coal boilers that supply heat to the district system, though their principal function is to serve the factory.

The efficiency of these systems and their lower emissions make them well suited for local applications. However, their higher initial cost, including the cost of pulverizers, put them somewhat at a disadvantage. The technology is also not practical for some of the very small boilers used in district heating applications.

3. Cyclone Burners

Cyclone burners receive crushed coal in a stream of high velocity air injected tangentially to the circular combustion chamber in a water cooled furnace. Secondary air is injected parallel to the primary stream. The side of the combustion changer becomes covered with molten ash. The coal is thrown to the outside of the boiler by the centrifugal motion of the air flow. The coal burns while in the slag. The pattern of flow within the combustion chamber tends to reduce fly as emissions to a minimum.

4. Fluidized bed combustion

Fluidized bed combustion (FBC) is among the most efficient technologies at reducing emissions of SO_2 and NO_x. These emissions are reduced by burning coal in an agitated fluid bed containing a sorbent (typically limestone) and inert materials such as sand. SO_2 emissions are reduced because of absorption by the limestone, while NO_x is diminished because combustion temperature is lower. Conceptually, the FBC design is quite simple. The bed is supported by a fine grate to prevent sifting. It is made fluid by a flow of air from below. The combustion temperature is maintained around 843°C, a temperature at which the formation of calcium sulfate on the limestone particles is maximized. New limestone is continually injected into the bed, while spent material is continually drained away. The flue gas can be cleaned up with electrostatic precipitators or baghouses.

FBCs can operate under either regular atmospheric or pressurized conditions. Different designs of combustors accommodate different bed depths (ranging upward form four feet). The circulating fluidized bed recycles a portion of the combustion gas to support the bed.

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5. Waste Heat Boilers

Waste heat boilers produce steam or hot water from the waste heat of industrial processes. The Czech Republic is very industrialized and has great potential for heat recovery from industry and municipal waste incineration. Refuse-to-energy boilers can be problematic because of the nature of fuel used, which consists of inputs of various sizes, heat content, and chemical composition. A large concentration of plastics can be particularly problematic and would require high levels of excess air to prevent the formation of HCl. Unfortunately, this leads to higher NO_x emissions, which necessitates supplementary NO_x control. Additionally, the waste-to-energy boilers produce substantial amounts of ash.

6. Gas Turbine Combined Cycle

Gas turbine combined cycle (GTCC) facilities are designed to produce both electricity and heat. A gas turbine generates electricity while the exhaust gas is used to produce steam, which in turn drives another turbine and produces either low grade steam or hot water. The exhaust of a gas turbine has a temperature of 450°C to 530°C. Since there is no radiate heating component, the waste heat boiler in a GTCC must have large convection heat transfer surfaces.