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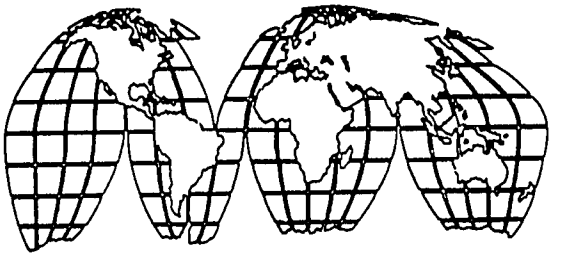

How USAID Energy Saving Programs Are Faring in the Czech Republic

March 1996

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How USAID Energy-Saving Programs Check Out In The Czech Republic

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EXECUTIVE SUMMARY

The Czech Republic is in one of the world's environmental hot spots; the "Black Triangle" covers the northern Czech Republic, and extends into Poland and the former East Germany.

Severe environmental degradation exists throughout the Czech Republic as a result of it's large metallurgical and chemical industries, heavy reliance on low-grade coal and limited treatment of municipal and industrial wastes. These problems are largely the result of 40 years of Communist economic policies that promoted heavy industry and discouraged energy conservation by pricing energy and capital well below their real economic costs. Compared to West European countries, even though Czech income levels are several times lower, Czech per capita energy consumption and pollution emissions are several times higher.

While the Czech people had many complaints against the Communist government, a universal rallying cry was the environment. The relatively peaceful "Velvet Revolution" of November 1989 which ended Communism included many environmentalists. They may not have fully understood how economic theory relates energy efficiency to energy pricing and pollution, but they understood how poor environmental conditions affected their health and living conditions.

After the fall of Communism Czechoslovakia[1] launched major economic reforms. But in late 1990, just as reforms were starting, Iraq's invasion of Kuwait disrupted international oil supplies and sharply increased the price of oil. The Soviet Union, the primary supplier of oil and gas to Czechoslovakia, cut back oil deliveries and demanded payment in hard currency. Faced with an energy crisis, there were fears that the country might start backing off from its economic reforms. USAID wanted to keep the economic reform momentum going forward.

USAID assistance began with the 1990 Emergency Energy Project. It was designed to provide immediate technical assistance, training and energy efficiency equipment. It was followed six months later by the Regional Energy Efficiency Project which dealt with longer-range needs. The rationale for USAID assistance was economic; if the Czech economy could use energy more efficiently it could maintain economic momentum and move forward on economic restructuring. It also could deal better with pollution problems. The projects recognized that industrial energy efficiency (and related markets and institutions) needed to be improved.

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[1]Czechoslovakia separated into the Czech Republic and Slovakia on January 1, 1993.

This evaluation examines those efforts. It looks at the energy problem, the USAID program, and the economic and environmental impact of USAID assistance. It then examines four factors that are important in explaining the impact of USAID assistance: policy reform, technology, education and awareness, and institutional development. It then examines program effectiveness, sustainability and replicability.

The problem. The Czech Republic has an economy strikingly dependent on energy; Compared to Western European countries it uses five times more energy per unit of GDP and eight times more energy per capita. This is due to inefficient energy production, use of antiquated and energy wasteful capital equipment and artificially low energy prices that discourage conservation. In addition, high energy intensity and dirty fuels generate air pollution four to eight time higher than in Western Europe.

The USAID program. USAID projects provided energy consultants, funds for energy conservation investments, and training for Czech energy auditors who then helped factories improve their energy efficiency. The project also provided start-up funding for an energy/environmental NGO known by the Czech acronym "SEVEn," which is now highly successful and operating independent of donor funding. SEVEn helped spawn two private energy service companies. USAID projects supported energy conservation demonstration investments in 5 factories---generally low-cost, quick payback measures such as steam traps, steam valves, thermostats, and monitoring equipment.

Economic impacts. Investments have been completed at all 5 factories. Based on economic analysis of completed investments they generate annual energy savings of $189,000 and annual pollution reduction benefits of $104,000. These are savings that will be generated every year. Against the annual benefits of $293,000 were one-time investment costs of $518,000. The economic rate of return on the investment is 50 percent. The payback period on the energy conservation investments (the point at which cost savings equal investment costs) is under a year in all but one of the plants.

Environmental impacts. The vast majority of air pollutants come from burning coal, which is mainly low quality, high sulfur, brown coal. The air is thick with sulfur dioxide levels four times greater than in Western Europe. However, over the last three years air pollution country-wide has been reduced between 14 and 20 percent. Pollution is now less of a problem, due in large part to the decline in economic activity, but also due to energy price increases, a switch to cleaner fuels, shutting down highly polluting heavy industry, and modernization of industry by replacing old and energy inefficient equipment.

USAID energy conservation demonstrations at factories helped reduce emissions, though they had a very small impact on national pollution levels. The main reason for the drop in Czech pollution is the fact that with major economic restructuring the economy has been in decline for several years. With reduced production less fuel is burned.

Policy reform. Previously energy prices were set low to encourage industrial production and to provide cheap energy to households. Major reforms started in 1989 with the end of Communism and from 1989 to 1991 energy prices were raised dramatically, moving close to world market levels. However, since 1991, as the economy has gone into recession and political resolve has softened, energy prices have not kept pace with inflation. For the commercial and industrial sectors most energy prices are now close to costs of production, but the residential sector still receives large energy subsidies.

Czech environmental policy has been successful in reducing pollution through regulation. New laws require major reductions in pollution by 1998 with reductions being phased in over several years. When factories exceed emission limits they must pay fines, and if they fail to meet the 1998 standards they will be forced to shut down. Factory managers are taking the regulations seriously. The fines, and in particular the prospect of having to close down production in 1998 have provided them with a strong incentive to clean up their smokestacks. Factories and the electricity generating company are switching from coal to cleaner fuels, installing stack scrubbers, changing production processes, and improving their burners and boilers to reduce pollution. In addition to reducing pollution, a major benefit of this approach is that it discourages wasteful energy consumption.

Technology. USAID-funded energy equipment was appropriate to local conditions and local engineers quickly learned methods to reduce energy costs. The projects generally introduced low cost, off the shelf equipment that Czech engineers understood and were familiar with. Probably as important as the equipment was the introduction of automatic control software, energy planning techniques, and training on how to develop business and financial plans for energy conservation. The projects demonstrated how a good financial and business plan incorporates and ranks investments in a manner understandable to company managers. This approach enabled engineers and management to agree on investments that generated energy savings.

Education and awareness. On the rebound from 40 years of socialist planning, Czech manufacturing firms have taken to the new religion of market capitalism, but only part of the religion, increasing output not reducing costs. The old socialist mentality of meeting production targets and focusing all efforts

on output, and letting costs take care of themselves, is alive and well.

Each country has its own business culture and the culture in the Czech Republic was heavily influenced by socialist state planning. Firms focus on production, not on costs, and cost-saving investments in energy conservation are difficult to promote. Success with energy conservation often depended on where a plant is in the privatization process. Plants still owned by the state or by local management tend to take a limited view of the future, and are reluctant to make any investments. The best hope for energy conservation is with privatized firms with foreign partners since foreign firms bring technology, management, finance and marketing skills. They are also concerned with cost controls and take a strong interest in energy conservation and are willing to make energy conservation investments with a longer payback period. USAID training, workshops, equipment and energy audits helped to change these old attitudes, but a change in a factory's ownership and management usually was more important.

Institutions. USAID institutional development efforts focused heavily on SEVEn an energy efficiency NGO. SEVEn has done it all---combining the missionary zeal of an NGO with technical savvy. It has actively gone after business contracts and shows good business sense (in contrast to some environmental NGOs that want to "save the earth" but don't know how to balance a checkbook). SEVEn has effectively organized annual technical interchanges--the Energy Efficiency Business Week and numerous meetings, newsletters, demonstrations and other forms of information dissemination. It has promoted energy policy reform with the government and served as a "matchmaker", linking energy users with engineering and equipment firms. SEVEN is a highly effective NGO and its performance stands in sharp contrast to the weak performance of government energy agencies in many other countries.

Program Effectiveness. The program was effective at reaching target groups and benefits have continued. All participant firms had adopted the energy saving measures and are continuing to utilize USAID-funded equipment. The only exceptions were companies that had installed new equipment or production process which required removal of the USAID supplied equipment. In these cases the USAID equipment was replaced with even more energy efficient equipment.

The USAID program had mixed objectives which created problems. On one hand it wanted to bring about the maximum reduction in energy use through energy efficient investments, and that meant targeting those industries which are energy intensive and large energy users. On the other hand it wanted to bring about improvements in a broad range of industries. The factories

selected for demonstration investments tended to be those where energy was a very small share of costs and thus the energy savings were limited.

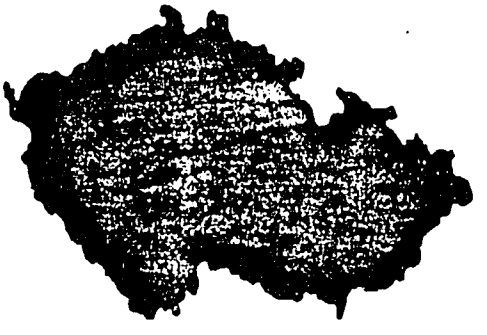
The question is one of tactics. It is clearly easier to deal with dozens of firms that are large energy users rather than thousands of firms that are small energy users. However, if the USAID goal is to support smaller firms (rather than large, heavy industry) it is necessary to deal with the more difficult task of reaching a large number of firms. USAID seems to have had mixed objectives but opted for firms that were not energy intensive. The problem, which USAID had difficulty addressing, was how to spread the lessons from 5 demonstration factories to several thousand factories throughout the country.

Sustainability and Replicability. The demonstration effect or spread of information between plants and industries is limited. Plants are isolated and unfamiliar with their competition and what others are doing on energy conservation. Several managers spoke of the "good old days" of central planning when technical directives and instruction came regularly from government ministries. Now they receive little guidance and don't know how to seek information on their own.

Replicability within an industry or geographic region appears to be very limited. The Czech Republic still lacks the institutions that disseminate information in the West: trade associations, technical societies, industry newsletters, industry seminars, and in particular--private sector equipment salesmen. Clearly good energy conservation technology is not enough; effective and continuing dissemination is needed if management is to keep abreast of new ideas, new solutions and new technologies.

GLOSSARY

CEZ	Czech Electric Utility
CH4	Methane - a greenhouse gas
CO	Carbon Monoxide - a pollutant
DSM	Demand Side Management
ERR	Economic Rate of Return
ESCO	Energy Service Company
IRR	Internal Rate of Return
Kcs	Krown - Unit of Czech currency
kWh	Kilowatt hour
NOx	Nitrous oxides - common air pollutants
PPI	Producer Price Index
SEVEn	A Czech energy non-governmental organization
SOx	Sulfur oxides - common air pollutants



Czech Republic

1. BACKGROUND

A. OVERVIEW

Under Communism central planners determined what would be produced and how. For a new factory, planners would choose a site, pick a production process, select necessary equipment, and determine the type of workers needed. Planners and factory managers only made technical decisions---they did not have to worry about prices and markets. The price of machinery, labor, raw materials, energy, and market demand were not a concern. Planners believed that society's problems were best solved by cheap energy, cheap capital, and subsidized prices for key industrial inputs and essential consumer goods. The environment was seen as a free input into production, with almost no attention to environmental quality and health related effects.

With the end of Communism in 1989 the economy quickly shifted to international prices and local firms had to face international competition. The move to a market-based economy was traumatic, particularly so for industry, which had extremely old and inefficient equipment. Czech industry had some advantages---industrial quality was good and workers were highly skilled and relatively low-cost. However, industrial energy requirements were extremely high and industrial pollution was poisoning the population:

- Levels of pollution, sulfur dioxide (SO_2) for example, exceeded those of former Soviet Bloc neighbors by 74 percent, and were greater than in European OECD neighbors by 453 percent[2].

- Excessively high energy consumption --- in 1989 primary energy supply averaged 4.84 thousand tons of oil equivalent (MTOE) per capita as compared to their OECD European neighbors which required 2.96 MTOE per capita;

- And in 1989 MTOE per dollar of GDP was 1.30, more than four times greater than the 0.27 MTOE per dollar of GDP in OECD Europe[3]. (See Figure 1 below)

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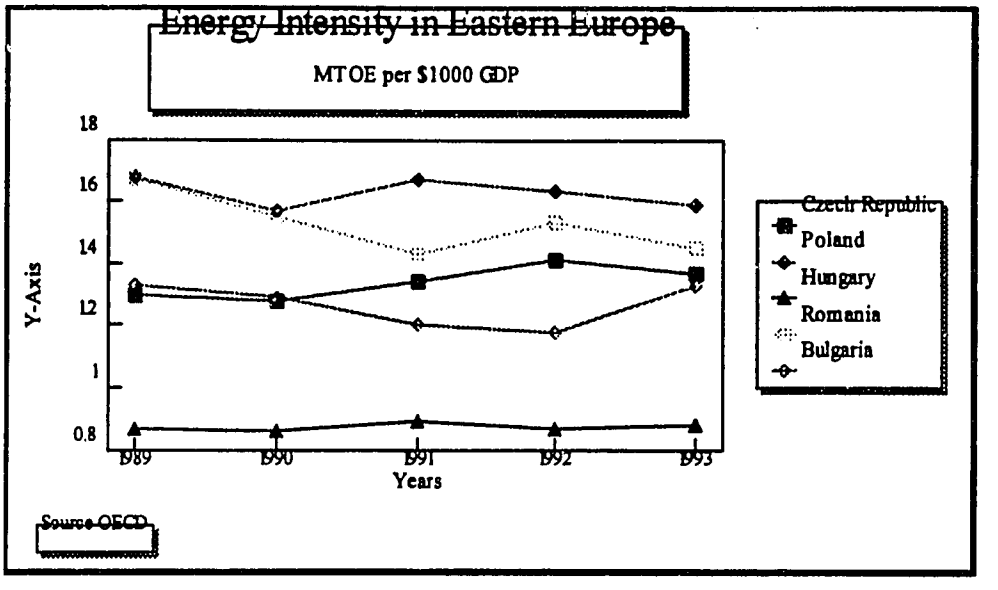
[2]Source: Environmental Issues in Central and Eastern Europe, U.S. General Accounting Office, May 1994.

[3]Source: Energy Policies of the Czech Republic, International Energy Agency, 1994

Figure 1.



The Velvet Revolution of 1989, which ended communism in the Czech Republic, was a reaction to many problems including pollution and environmental damage, which was an important public grievance. Major economic reforms took place as the government: 1) pegged the Czech currency to the US dollar and German Mark; 2) decontrolled many prices; 3) privatized most industries; and, 4) adopted prudent monetary and fiscal policies.

As a result of these reforms and the drop in trade with Soviet Bloc partners, real Gross Domestic Product (GDP) fell almost 14 percent from 1990 to 1991. At the same time the country began to experience significant inflation. Reforms continued and in 1992 average annual inflation was 20 percent and real GDP fell another 7 percent. These problems notwithstanding, including the breakup of the Czechoslovakian federation, some parts of the Czech economy were actually prospering by 1993. Exports to OECD countries were growing eventhough OECD economies were in recession. Private borrowing by Czech companies from foreign sources provided needed capital inflows and by the end of 1993 real GDP was growing.

B. Energy Production and Use in the Czech Republic

Despite attempts by the Czech Government which began in 1991, erasing the impact of four decades of central planning on energy production and consumption has been difficult. The Czech economy is still dependent upon Russia for the predominant share of its

energy imports, still remains highly energy intensive, "dirty" coal is still the overwhelming fuel source, and energy prices are still determined by the government with industrial prices subsidizing household prices. As Table 1.1 illustrates, from 1989 to 1993 energy supply[4] has fallen by 17 percent. Yet, at the same time economic activity, as measured by real GDP, has fallen more than 21 percent. Energy supply is not falling as fast as the fall in GDP--the economy is becoming more energy intensive.

The Czech Republic is dependent upon low quality brown coal for the lion's share of energy, 63.7 percent of the supply. Coal production is declining due to closure of unprofitable mines and to growing environmental concerns. Oil and petroleum products are the second largest source of energy, accounting for 16.7 percent of net primary energy supply; imports from Russia account for 99 percent of total supply.[5] Gas, consisting predominantly of imports, is the third largest source of energy and has begun to grow slowly since 1991. The country is seeking to diversify by purchasing Norwegian gas but Russian gas still accounts for over 90 percent of imports. Czech concerns with pollution have encouraged a shift to gas, which is a relatively cleaner fuel. Nuclear and hydro energy are the final components of primary energy supply accounting for 7.3 percent and 0.3 percent of primary energy supply respectively.

Led by reductions in coal and petroleum products, energy use has been declining in the last few years as a result of economic restructuring and in reaction to increasing environmental standards such as the 1991 Czech Air Protection Act, which sets tough emission standards. Table 1.2 exhibits the changing energy use patterns since 1989.

Even though coal consumption has fallen by 23 percent since 1989, it still accounts for 35.6 percent of total energy consumption. Factors influencing this sharp decline in coal consumption are reduced economic activity and increasingly tough environmental standards. As a result, less use is being made of higher cost and "dirtier" coal power plants and residential conversion to natural gas has been subsidized.

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[4] Net energy supply treats imports and stock withdrawals as additions and exports and stock additions as subtractions to total supply. Differences between net energy supplied and energy consumption result from losses due to transformation, transmission, distribution, theft and accounting errors.

[5] Czech Statistical Agency

Table 1.1 Primary Net Energy Supply
(Thousands of Tons of Oil Equivalent - MTOE)

Energy	1989	1991	1993	1989-93
	MTOE	MTOE	MTOE	%
Coal	32,216	28,451	26,758	-17
Petroleum	9,713	7,235	6,982	-28
Natural Gas	5,049	5,062	5,084	1
Nuclear	3,236	3,162	3,086	-5
Hydro	141	108	128	-17
	Billion	1987	Dollars	
Real GDP	$38.61	$32.72	$30.40	-21

Source: International Energy Agency

Crude oil and Petroleum products are the second largest source of energy or about 21 percent of final consumption. While total consumption has fallen 21 percent, consumption in the transport sector increased. Since 1991 when energy and economic reforms began, petroleum used for transportation has risen 30 percent.

Table 1.2 Czech Final Energy Consumption in Thousand TOE

	1989	1991	1993	1989-93
	MTOE	MTOE	MTOE	% Change
Coal	12,702	10,883	9,841	-23
Petroleum	8,121	6,352	6,399	-21
Gas	3,619	3,573	3,551	- 2
Electricity	4,012	3,824	3,603	-10
Heat	5,049	4,596	4,256	-16
Total	33,503	29,227	27,650	-17.5

Source: Energy Economy Yearbook, various issues, Ministry of Industry and Trade

Growth in exports, tourism and automobile purchases are primary factors behind this growth. On the other hand, industrial and other use has fallen by 16 percent.

Like any other economic good, energy use responds to changes in economic activity and to price changes. Total energy use in the Czech Republic since 1989 has been driven by the decline in economic activity brought on by restructuring and loss of trade with Soviet Bloc trading partners. Declines in real GDP lead to a reduction in aggregate energy use but energy use declined less than economic activity. Czech energy intensity should be declining, but it is increasing. It is not following the pattern of neighboring OECD countries where energy intensity is falling during economic recession.

Energy Intensity

On a per capita basis the Czech Republic used 1.6 times more energy than their OECD neighbors in 1993 and about 1.6 times more than other Eastern Europeans. (Table 1.3) They also required five

Table 1.3 Energy Intensity for Selected Countries (1989-1993)

Country	Total Primary Energy Supplied (MTOE) per $1,000 GDP				
	1989	1990	1991	1992	1993
Bulgaria	1.33	1.29	1.20	1.18	1.33
Czech Republic	**1.30**	**1.28**	**1.34**	**1.41**	**1.37**
Hungary	0.87	0.86	0.89	0.87	0.88
Poland	1.68	1.57	1.67	1.63	1.59
Romania	1.67	1.55	1.43	1.53	1.45
OECD Europe	0.27	0.28	0.27	0.26	0.25
	Total Primary Energy Supplied (MTOE) per capita				
Bulgaria	3.41	3.1	2.51	2.35	2.53
Czech Republic	**4.84**	**4.71**	**4.25**	**4.15**	**4.05**
Hungary	2.81	2.71	2.62	2.43	2.40
Poland	3.14	2.57	2.52	2.49	2.52
Romania	2.95	2.56	2.07	1.92	1.84
OECD Europe	2.96	3.08	2.96	2.86	2.61

Source: "Energy Statistics and Balances of Non-OECD Countries, 1992-1993," OECD, Paris.

times the energy to produce $1,000 of GDP as compared to OECD Europe. The economic changes since 1989 began to reverse the policies established by previous communist governments, however, energy intensity has increased since the revolution. From 1989

to 1991 MTOE (Million tons of Oil Equivalent) increased from 1.30 to 1.34 per $1,000 GDP and by 1993 it increased to 1.37. In European OECD countries it declined from 0.27 to 0.25 MTOE. This increase in Czech energy intensity is the results of several factors:

- First, the most recently available data covers only a period of two years after the major policy reforms began[6]. This is insufficient time to fully judge economy-wide energy efficiency measures.

- Second, unlike market economies where recessions weed out inefficient producers, many Czech firms are still government controlled. Government subsidies and loans help cushion the fall in revenues and keep unprofitable firms in business.

- Third, energy efficiency requires investment. Given the decline in economic activity, many companies are reluctant to spend funds.

- Fourth, as Table 1.4 illustrates, real energy prices actually declined over this period, making energy cheaper relative to other goods and services. As energy prices declined relative to other inputs more energy was used.

- Fifth, as factories produced less, capacity utilization declined and economies of scale were lost---more energy was needed per unit of output.

- Sixth, given the joint product nature of the Czech energy system (many plants produce both electricity and heat), reduced heat consumption would not be reflected in lower primary energy supply unless it was accompanied by a similar reduction in electricity demand.

In 1991 the Czech Government undertook measures to introduce market forces into energy production and consumption. But attempts at rationalization were overshadowed by a major economic recession and ongoing industry restructuring. There were energy price increases but they were outweighed by massive inflation. In 1991 the consumer price index (cpi) increased 56.7 percent and the producer price index (ppi) increased 70 percent. Inflation leveled off in 1992 but by January 1993 inflation was again heating up. From 1992 to 1993 the consumer price index increased 21 percent and the producer price index rose 14 percent.

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[6]Preliminary indications are that energy intensity has declined from 1993 to 1994 by a small margin. Data are not yet available to support this trend.

Table 1.4 Selected Real Energy Prices

	1989	1991	1994 (est)	1989-1994	1991-1994
				%	% Change
Electricity	Kc/kWh				
Household	0.6	0.49	0.42	-30.0%	-14.3%
Industry	0.7	0.9	0.72	2.9%	-20.0%
Natural Gas	Kc/m3				
Household	1.12	1.3	1.13	0.9%	-13.1%
Industry	2.2	1.97	1.55	-29.5%	-21.3%
Lt Fuel Oil	Kc/ton				
Industry	3,696.0	3045.7	2615	-29.2%	-14.1%
Hard Coal	Kc/ton				
Industry	489.6	416.6	370.4	-24.3%	-11.1%
Brown Coal	Kc/ton				
Industry	234.0	191.3	196.6	-16.0%	2.8%

In the near future, energy intensity is likely to decline due to the following factors:

- Privatization is more comprehensive - privatized firms can invest and disinvest - managing resources, including energy, in a more economic manner and providing much needed access to capital;
- The Government appears committed to cost based pricing for energy ;
- Environmental policies such as the 1991 Air Protection Act force users to burn fuel more efficiently or switch to cleaner fuels; and,
- A stronger economy which allows industries to take advantage of economies of scale and thus reduce energy requirements per unit of output.

C. Environmental Issues Related to Energy in the Czech Republic

Unbridled production and consumption of energy in the Czech Republic results in significant environmental damage. For

example, Prague has the worst air quality of any European capital.[7] Pollution is a major concern throughout the country and was a major complaint of the people against the previous socialist government. Air pollution is the top priority[8] and energy ranks as the number one source of air pollution. Effects of this pollution are easily seen as buildings, statues and monuments are blackened from coal combustion and show the wear of abnormally high levels of sulfur dioxide. Other effects such as respiratory disease, hypertension and elevated blood lead levels are not easily seen. However, the Czech Ministry of Environment reported that air pollution harms the health of over 20 percent of the population.[9] The vast majority of air pollutants, such as SOx, NOx, Ozone, CO and particulates, are the direct result of energy consumption.

Table 1.5 Comparative Emissions (1992)

Country	Kg Per Capita	Kg per $1000 GDP
	SOx	**SOx**
Hungary	80.1	14.1
Czech	179.1	24.7
Poland	73.8	16.7
OECD Europe	42.0	2.9
	Particulates	**Particulates**
Hungary	15.7	2.7
Czech	45.5	6.3
Poland	41.2	9.3
OECD Europe	14.2	0.7
	NOx	**NOx**
Hungary	17.7	3.1
Czech	67.1	9.3
Poland	29.5	6.7
OECD Europe	30.9	2.1
	CO2	**C02**
Hungary	6.4	1.07
Czech	14.2	1.96
Poland	9.2	2.11
OECD Europe	8.2	0.57

Source IEA

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[7]Source: World Bank Tables and the Ministry of Environment.

[8]Source: The State of Environmental Policy in the Czech Republic, 1993.

[9]Source: The State of Environmental Policy in the Czech Republic, 1993

Table 1.5 compares emissions in the Czech Republic with those in other Eastern European countries and with OECD Europe.[10] The Czech Republic's emissions on a per capita basis and in relation to GDP are higher than other East European or OECD countries. This is not purely the result of socialist planning errors but is also due to the use of dirty energy resources. In 1992 per capita emissions of sulfur dioxide (SO_2) in the Czech Republic were, at about 179 kg, over four times the average for OECD Europe. Emissions of SO_2 per $1,000 of GDP were more than 8.5 times the OECD average. Environmental quality in the Czech Republic is far lower than its OECD European neighbors.

Table 1.6
Emissions of Major Air Pollutants, 1990
(metric tons)

Source	SOx	NOx	CO	CH4
Public Power, district heating & Cogeneration	955,778	217,242	25,026	5,148
Industrial combustion	425,898	214,966	278,250	726
Commercial,institutional, residential	427,610	97,630	333,762	57,096
Extraction & Distribution of Fossil Fuels	--	--	--	844,842
Road Transport	NA	151,634	154,168	2,605
Other Transport	5,862	51,383	9,067	341

source: Ministry of Environment

Table 1.6 lists emissions of important energy related air pollutants and their source. The vast majority of air pollutants result from coal combustion, whether for power generation, district heating or small scale residential heating. Industrial consumption is the second largest source of air pollutants. This is followed by commercial, institutional and residential power & heating plants. In all cases except transport, coal is the major fuel used.

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[10]OECD Europe and Germany are presented since this is the model to which the Czechs aspire. Data on Hungary and Poland are presented as a comparison of other ex-Soviet states.

The Government has been very active in attempting to reverse the trend in environmental degradation and as Table 1.7 shows, all emissions have declined since 1990. These reductions are the combined result of the decline in economic activity and environmental measures adopted by government.

Table 1.7 Historical Emissions
(thousand metric tons)

	1990	1991	1992	1993
SOx	2,224	2,091	1,863	1,793
NOx	742	725	698	NA
Particulates	544	522	473	460
CO_2	171,100	161,000	148,000	NA

Source: Czech Environment Yearbook (1992 & 1993), Czech Energy Yearbook (1993), and author's estimates.

After air pollution, the next major source of energy related pollution is the effects of coal and uranium mining. Little of the mined area is reclaimed. Erosion is commonplace and surface and ground water have become seriously contaminated. Of 26,000 hectares mined in Northern Bohemia, less than 10,000 have been reclaimed. In Northern Moravia underground mining is causing surface areas to subside more than 10 meters.[11] Runoff from coal washing also presents a serious environmental problem to surface water sources. The use of acid for insitu leaching of uranium has had serious impacts on water resources. Four million metric tons of sulfuric acid have been pumped into the ground during uranium mining operations. Drinking water sources have become contaminated in these areas and some rivers and streams are virtually dead. Sludge ponds and waste pits from uranium mining also present problems for land use and water contamination.

Oil refining operations are the third most important source of pollution. Refining operations produce air pollutants and leaks from storage of liquid have contaminated ground and surface water. For example, leaks at the Kralupy refinery allowed benzene, toluene and styrene to enter the nearby river and endanger drinking water supplies.[12]

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[11]Source: Ministry of Environment

[12]Source: Ministry of Environment

D. USAID Energy Conservation Program

Why Energy Conservation?

Under central planning the country's energy supply and consumption patterns were very inefficient. The economy was built on relatively low-cost and abundant energy and environmental controls existed but were not enforced.

After the fall of Communism Czechoslovakia launched major economic reforms. But, in late 1990, just as reforms were starting, the economy faced a serious economic crisis due to dramatic changes in international energy markets. Almost all oil and gas had been imported from the Soviet Union and the Soviet Union was now cutting back on oil deliveries and shifting to hard currency payments for both oil and gas. Iraq's invasion of Kuwait and the cutoff of Iraqi and Kuwait oil, international prices moved sharply higher. Experts assumed oil prices would remain at $31 a barrel and possibly move higher.

The new, democratically elected Czech government was starting to reform and modernize the economy. But higher oil prices and energy shortages could derail those efforts. In such a situation, faced with mounting financial and industrial problems, there might be pressure to return to the old system of state controls and allocations. USAID assistance could help cushion the shock and even use the energy crisis as a way to reform Czech industry.

The rationale for USAID assistance was economic; a Czech economy using energy more efficiently would save foreign exchange, maintain economic momentum and then move forward on economic restructuring. Energy conservation was the **means** to help the economy--not an **end** in itself. Pollution control was a subsidiary concern.

The Program

USAID assistance focused both on the immediate emergency need to reduce energy consumption, and longer-term efforts to restructure the economy and move toward a modern, efficient energy system. The November 1990 Emergency Energy Project included some longer-range efforts but concentrated mainly on short-term energy conservation. In the next year, the May 1991 Regional Energy Efficiency Project focused on longer-range problems.

The Emergency Energy Project 0015) had four objectives. The focus of this evaluation is on:

-- Improved energy efficiency in industry
Key energy using companies were identified, energy audits conducted, and then low-cost energy saving equipment and training

provided to those companies. Energy savings of 5-15 percent were expected.

Other components were:

-- Oil refinery debottlenecking and efficiency improvements.

-- Purchasing oil more effectively

-- Price rationalization and reform

The Regional Energy Efficiency Project was designed to cover longer term needs and this evaluation focuses on:

-- Improved energy efficiency and reduced energy-related environmental damage

-- Developing a market for private energy efficiency and environmental services

Other components included:

-- Restructuring and privatizing the electrical power sector

-- Improving nuclear power plant safety

-- Developing a policy and institutional framework for energy investments and increased energy trade

Project Results

Five energy audits of industrial firms were completed: the Pragolaktos dairy plant, Branik brewery, DETOA wood products plant, Cerny Dul fabric plant and Autobrzdy auto parts plant. Energy conservation investments were then completed at each plant. They were generally low-cost, quick payback measures such as steam traps, valves, thermostats and monitoring equipment. The dairy plant investment was $35,500 and the average investment at the other plants was $10,725. The payback period on the energy conservation investments (when cost savings equal investment costs) was under a year for all plants except the dairy plant---where it will take 13 years of energy savings to recover costs.

USAID supported creation of SEVEn, an energy/environmental NGO which served as a national energy efficiency center. A direct spin-off from SEVEn was an energy services company--Energy Performance Services Co., a Czech-U.S. joint venture -- which has introduced energy performance service contracts in the Czech Republic. Intesco is another energy service company whose local

operation was spawned from one of the SEVEn-sponsored energy efficiency seminars.

The final area of project efforts (consultants, studies, and training) were in energy pricing reform. USAID worked successfully with the World Bank to bring most industrial energy prices in line with real economic costs. However, energy prices for households are still well below economic cost levels.

2. ASSESSMENT FINDINGS

A. Program Impact

1. Economic and Financial Impact

This evaluation considers both the economic impact of the project at the national level and the financial impact on direct program participants, the energy using companies. The economic impact analyzes benefits and costs from the point of view of society, not the individual energy using company. Economic benefits and costs are calculated using economic or border prices excluding local taxes, subsidies or transfers. Costs reflect the opportunity cost to the economy from using a resource rather than cost to the firm. For example, the price the plant pays for coal does not include the health and environmental damages which coal causes.

A major difference between the benefits to the firm and those to society are the benefits associated with reduced emissions. The most appropriate method of valuing these reductions is society's total **willingness to pay** for a cleaner environment. However, such data are not available. On the other hand, the minimum value society would place on reducing pollutants can be estimated from the cost of pollution abatement equipment. Assuming society values reduced pollution by as much as the cost avoided, these figures can be used as an estimate of the opportunity costs which the Czech society would not incur in cleaning up the environment. This would represent an economic benefit.

The economic rate of return (ERR) is 311 percent with a NPV of $1,284,254. Payback is achieved in 3.9 months. This represents the ERR for the Czech Republic and is one measure of the economic rate of return. Under the topic of Program Efficiency (Section 2.C.2), the return from USAID's total investment including USAID implementation costs is estimated at 50 percent.

Financial or private benefits are determined differently. In this case the perspective is that of the firm---the benefits the firm receives---and excludes benefits to the economy at large. Benefits to the firm use the actual after-tax rate of return on investment, usually measured in terms of net present value or

rate of return on equity. The firm makes investment decisions based on internal investment criteria related to factors such as the private discount rate, tax consequences, cost of capital and terms of financing, labor costs, and government incentives available. The financial impact of the project is evaluated from the point of view of the firms which purchased the equipment: What was the impact to their bottomline? How much energy was saved?

The direct measure of financial benefits from energy efficiency investments is the reduction in energy consumption---estimated to be 401 metric tons of oil and 16,947 metric tons of steam per year. This amounts to an annual pre-tax savings of $189,030 for the five participating factories. These estimates are slightly greater then those in the 1994 Scientech evaluation report due to increased energy prices.

The net financial benefits of the project are overwhelming. Annual pretax benefits totalled $189,030 against one-time procurement and installation costs of $93,400.[13] After-tax benefits amounted to $113,418. This yields a payback period of 9.8 months, an internal rate of return (IRR) of 122 percent and a net present value (NPV) of $603,505 (see table 3.1 below).

Direct economic benefits of the USAID program include the reduction in energy costs or increased plant efficiency or reduction in air pollution emissions. However, the program had less easily quantifiable benefits: (1) development of an institution to promote energy efficiency once the program was complete - SEVEn; and (2) fostering financial, management and economic skills among industrial managers unaccustomed to these disciplines. Complicating estimation of more direct benefits is the fact that initially, adoption of energy efficiency measures was, for the most part, limited to the five target companies. Yet, as the economy expands and real energy prices rise, lessons learned from this program and the institutions and companies created as a result of its activities will promote energy efficiency; but these long term benefits are indeterminable at this point.

2. Environmental Impact.

Energy efficiency and positive environmental impacts go hand-in-hand. Reductions in energy use lowers emissions of SO_2, CO_2, NO_x and particulates. There are two types of environmental impacts from this project - **direct** impacts generated by the firms' direct participation in the program and **indirect** impacts which include future reductions from other firms influenced by

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[13]Equipment procurement costs totalled $78,400 and company related installation costs were estimated at $15,000.

the project and impacts of the participating firms as they make additional energy efficient investments. Indirect benefits are expected to be large and some firms have already made additional

Table 2.1 Estimated Reduction in Air Pollution as a Result of the USAID Projects

	Metric Tons[A]	Cost of Control[B] $Per Ton	Total Value If In U.S.	Total Value In Czech Republic[14]
Carbon Monoxide	21.0	$ 56	$ 1,176	$ 588
Carbon Dioxide	5464.6	$ 25	$136,614	$ 68,307
Sulfur Dioxide	58.8	$ 865	$ 50,833	$ 25,417
Nitrous Oxides	9.3	$ 1,980	$ 18,365	$ 9,183
Particulates	15.1	$ 15	$ 227	$ 113
Total	5568.7		$207,215	$103,608

Sources: (A) These estimates were developed by the team based on specific fuel savings and their appropriate emissions coefficients. (B) Based on an average of the California Energy Commission and Tellus Institute estimates.

energy efficiency investments. However it is not possible to quantify the level of impacts. Direct environmental impacts were calculated by the evaluation team on the basis of energy saved from the USAID energy efficiency investments (see Table 2.1).[14]

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[14]In the economic rate of return analysis for this evaluation (Section 2.C.2) abatement cost avoided is estimated at one half of abatement costs in the U.S. This lower amount is used to reflect two factors: the difference in income levels and the technical stage of pollution abatement: (1) **Income level.** Full U.S. costs are not used since Czech incomes are lower than U.S.levels. It is assumed that cleaner air has a higher value for higher income citizens. With a lower income the Czech Republic is not willing to pay as much as the U.S. to reduce pollution. (2) **Technical considerations.** Cost of additional pollution control in the US is higher than in the Czech Republic. The relationship between costs and reductions in emissions is exponential. When things are very polluted, the first units of reduction are much less expensive than further reductions. The Czech Republic has high levels of pollution and measures to reduce pollution are much cheaper than in the U.S. where the easy and low cost early measures have already been completed.

As can be seen from Table 2.1 the value of reducing this amount of emissions in the Czech Republic is substantial--$207,215. Yet the reductions in emissions from the five firms came at no additional cost! No control devices were used; reductions are a benefit of energy efficiency---less fuel is burned and less pollutants are produced. **Herein lies one of the most powerful justifications for pursuing energy efficiency: Cost effective energy efficiency investments yield environmental benefits.**

B. ROLE OF KEY PROGRAM ELEMENTS

1. POLICY REFORM

Project 180-0015 contained an energy price reform component which included meetings with government officials, a conference on energy pricing, and development of an energy use model and industrial and transportation energy models. This component was not designed to directly change policies, but to provide the government with the knowledge and understanding needed for policy reform. The evaluation team could not trace any government energy policy reforms directly to the project. However, to provide a framework for understanding the other contributions of the project, key government policies are examined in this section.

There are several areas where government policies support energy efficiency - energy pricing, financial incentives for energy efficient investments, privatization, and environmental standards. Some of these policy changes have had immediate effects on energy efficiency; others will only be felt over the long run.

Energy Pricing

Until 1976 energy prices were set low to encourage industrial activity and to provide cheap energy to households. Policy change began in 1977 when cost-of-production based pricing was introduced but theory did not translate well into practice, and energy prices, while rising, remained heavily subsidized. Raising energy prices proved to be a difficult step in an economy so accustomed to inexpensive energy. Major price increases didn't come until 1989-1991.

As Table 2.2 below illustrates, substantial nominal price increases took place from 1989 to 1991 when political and social resolve was strong and the pace of economic activity had not significantly declined. In the three years following 1991 nominal prices increased more slowly. Had inflation remained in check these nominal increases would have been sufficient to encourage significant reductions in energy consumption. However, inflation was not kept under control.

Table 2.2 Nominal Energy Prices

	1989	1991	1994 (est)	1989-91	1991-1994
				Percent Change	Percent Change
Electricity	Kc/kWh				
Households	0.48	0.81	0.93	68	15
Industry	0.55	1.53	1.61	178	5
Natural Gas	Kc/m3				
Households	0.93	2.17	2.51	133	16
Industry	1.80	3.35	3.45	86	3
Lt Fuel Oil	Kc/ton				
Industry	3,080.0	5,190.0	5,480.0	69	6
Hard Coal	Kc/ton				
Industry	408.0	710.0	823.0	74	16
Brown Coal	Kc/ton				
Industry	195.0	326.0	437.0	67	34

In 1995 prices for the household sector are still well below their economic costs, while industrial and commercial customers pay prices close to economic costs of production. In some cases industrial and commercial prices exceed economic costs; industrial customers are subsidizing household consumption of electricity and natural gas. Fuel switching is also subsidized at the household level as consumers are encouraged to switch from highly polluting coal to clean, natural gas. While there are strong political pressures to proved cheap energy to the household sector, the government remains committed to market based pricing and expects to completely remove subsidies by the year 2000.

Economic Incentives

The government currently has no explicit incentives to encourage energy efficient investments. Recent trials with metering of buildings and apartments has demonstrated that households will reduce consumption when they pay for their actual consumption---linking behavior with payment. The Energy Management Bill scheduled for Parliamentary debate in 1996 includes several incentive mechanisms to promote investments in energy efficiency. These include investment credits and low interest loans.

Privatization

The government's privatization policy affects energy efficiency in three ways. First, many companies do not yet have private owners. Companies that are unsure of their future ownership are hesitant to make investments of any kind, and even if they wanted to, lack the resources to do so. Second, privatization in the Czech Republic does not necessarily mean private ownership and control. The government continues to hold a majority share in many "privatized" companies. Many companies continue to be subsidized and shielded from the realities of the market. Third, while the government has begun corporatization and privatization of energy utilities, no regulatory structure exists. This lack of regulatory structure and government ownership contributes to lack of incentives for conservation by any party. The generation company has no incentive to promote efficiency - profits are split between the generation and distribution companies by government decree, rather than market realities. Distribution companies face price controls and have no mechanism by which to recoup costs they would incur to promote energy efficiency.

Environmental Policy

Czech environmental policy is universally seen as the number one factor encouraging companies to improve energy efficiency. The 1991 Clean Air Act provides fines and sets standards for emissions.

The long term environmental goals of the Ministry of Environment are: Careful management of renewable and nonrenewable resources; Gradual reduction in health risks associated with environmental quality; Gradual decrease in activities which cause irreversible environmental and natural resource degradation; and, Integration of environmental considerations into all economic and social activities.

To achieve these goals, the government uses a system of regulations and controls along with economic instruments. The Ministry of Environment understands the linkage between energy efficiency and the environment and many of its policies are directed at energy conservation. Pollution fines and standards are important tools which indirectly bring about more efficient energy use. Based on a polluter-pays-principle the State Environmental Fund is funded by fines and user fees and provides additional funding to implement environmental policies.

Beginning in October 1991 a series of government decrees and acts has sought to limit air emissions and these decrees have had favorable impacts on both pollution and energy efficiency. Ambient air quality standards were set at limits similar to the European Union standards. This decree also set pollution limits

on existing stationary sources over five megawatts of installed heating capacity. Plants were given 1 to 2 years to comply and fines were assessed starting in 1992 and 1993. By the end of 1998 plants not in compliance can face shutdown of their boilers. New source emissions are subject to Best Available Technology Not Exceeding Reasonable Cost (BATNERC).

In the case where companies exceed emission limits fines can be raised by 50 percent. In reality these fines are quite small and the real incentive for energy efficiency is that by 1998 a factory can be shut down if it does not meet pollution standards. This, coupled with what must be a social concern for pollution has encouraged business to reduce energy consumption and use it more efficiently.

2. TECHNOLOGICAL CHANGE

The Czech Republic, long known for its industrial excellence, is a country comfortable with technology and innovation. Prior to World War II the machines, tools, craftsmanship, and quality of Czech products were known throughout the world. Even after the Communist takeover in 1948, Czech manufacturing standards remained high compared to other Soviet bloc countries. However, over time industrial emphasis shifted more toward production and output levels and less concern was placed on costs, including energy costs. With central planning there was little initiative to bring innovative technologies to management. It was in this environment that the USAID projects were initiated in 1991.

In many projects in other countries USAID introduces new technologies. That was not the case in the Czech Republic. Changes initiated by the projects were mainly in the use of **existing technologies** to **solve problems new to The Republic**.

In the U.S. in 1974 the age of "cheap" energy ended and with increased energy prices and public concern over pollution a new business environment was created. Energy conservation investments became economic, government energy agencies were created, energy service companies emerged and financial markets for energy related loans came into being. The Czech Republic is now entering a similar situation. Industrial energy prices have risen, environmental concerns have become public issues and the government has created new energy policies and energy agencies.

The USAID projects by design took low or no cost hardware and software technologies and applied them to Czech industries. Under the previous regime management had little incentive to apply their knowledge to solving cost or pollution problems. The USAID projects demonstrated low-cost, quick-fix, off the shelf solutions that could meet the needs of energy conservation. Principal "hardware" consisted of valves, thermostats, steam

traps, insulation and lighting. Principal "software" introduced was automatic controls, energy policies and planning techniques, and business plans and know-how.

The projects did not introduce new hardware. Most of the energy conservation hardware was known to Czech engineers. However, the projects did train engineers in preparing financial feasibility studies management could understand. Management was quick to realize that off the shelf, low-cost devices could save energy and reduce operating costs while having a positive environmental effect.

The projects demonstrated how a good financial and business plan incorporates and ranks investments in a manner that can be understood by a company's managers. This knowledge caused both engineers and management to seek out and propose investments that generated energy savings. Industrial managers and lenders have been shown by demonstration the benefits of energy conservation investments.

Now that Czech energy prices are beginning to achieve parity with international prices and environmental pollution costs are being assessed, engineers are able to propose technological solutions that address multiple problems. **It has been the acceptability of technological and policy change rather than the knowledge of technology that has been helped by the USAID program.**

3. EDUCATION AND AWARENESS

The USAID program has increased government and industry awareness and interest in energy conservation. SEVEn (the energy conservation NGO) is a prime example of success in stimulating new ways of thinking about energy. SEVEn was started with USAID funding to promote the concepts of energy efficiency. In 1991 SEVEn received over 90 percent of its funds from USAID. After three years of USAID funding SEVEn is now independent of donor aid and funds its operations from commercial contracts.

SEVEn provided technical support and information to several USAID- sponsored energy conservation efforts. As an example, SEVEn was involved with district heating[15] in the town of Pilsen. The project exposed Czechs to US products and how energy savings can be cost effective. Since brown coal used in district heating is a primary source of air pollution this project was an excellent choice to demonstrate simultaneous energy conservation and pollution reduction. Probably as important as the technical side of energy conservation SEVEn learned how to package and

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[15]Each city has a large district heating plant providing steam heat to several thousand apartments, offices and factories.

market energy conservation proposals. It is now highly skilled at preparing business plans, feasibility studies and loan applications.

SEVEn hosts an annual conference, the Energy Efficiency Business Week. It is at the annual Business Week that information is exchanged, technologies discussed and probably the most important side of information exchange---informal networking takes place. The Business Week 1995 program was very practical. It admonished participants to "give concrete examples of energy efficiency projects that have been implemented including their specifications." Representatives of the Czech government, USAID, other donors, equipment suppliers, energy service companies (ESCOs), lending institutions and engineering firms made presentations and described experiences. There were 45 exhibitors representing energy using industries, along with firms dealing with architecture, lighting, appliances, transport, renewable energy and energy services. One of the goals of the Business Week is to match Czech energy using firms with service providers. One of the first Czech energy service companies (an ESCO) met some of its first clients at the 1993 Business Week. It eventually developed energy performance contracts with three Czech firms and consulting agreements with other firms.

RAEN is an energy related service firm that has grown rapidly since 1991 and specializes in energy policy, ecology, power systems, alternative energy sources and water economy. RAEN worked with the U.S. firm, Gilbert Commonwealth on the Pilsen district heating project. The USAID Pilsen project exposed RAEN to U.S. energy conservation technology, products and services and helped it launch its consulting services to a wide range of Czech firms.

Energy Consulting and Information Service (EKIS) companies have been established (and partially funded) by the government and are located in all regions of the country. There are two types of EKIS. The 12 EKIS "A" companies have been charged with maintaining energy related databases, demonstrating energy conservation measures and consulting on energy problems. The 60 EKIS "B" companies are commercial firms that focus on specific projects. They provide both advisory services and specific engineering services. EKIS B companies also help firms that want to do energy conservation investments find lenders. Most EKIS firms have targeted or specialized on specific technology or industrial sectors. For example, RAEN targets industrial boilers and steam systems. The EKIS structure, as it develops and matures, will be an excellent source of information to spread technical and managerial knowledge throughout the country.

The Czech Energy Agency (CEA) is the energy policy arm of the government. The agency is small, with only eleven employees and a 1995 budget of Kcs 200 million ($7.6 mil.). The CEA is a main

presenter in the annual Business Week conference. It is through these conferences that CEA keeps aware of energy problems and opportunities. However, the Agency is relatively new and as part of the government, is in the thick of the political process. Currently it's budget is mainly devoted to demonstration projects and it has had little impact on energy conservation.

The Czech Electricity Company (CEZ), the principal generator of electricity, has done much work on energy efficiency and efforts to improve environmental standards. It is also a principal sponsor of the Business Week. Since the breakup of the utility into a generation company (which is CEZ) and eight distribution companies, CEZ has no direct customer contact. It sells electricity to the distribution companies who then provide electricity to the final consumer. Therefore, CEZ has little leverage in implementing Demand Side Management (DSM) and other energy saving efforts. The utility has no certainty that it will be allowed to recapture investments in efficiency. The Ministry of Finance has the final say on rates and revenue allocations between the generation and distribution companies so CEZ has little motivation to institute any energy savings hardware or training programs.

There is little formal energy conservation training available anywhere in the country. Government training funds are limited (approx. $575,000) and the electric utility cannot include in its rates an ongoing training program. The university offers a few energy efficiency courses but interviewees were unsure about course content and emphases. The firms that received USAID funded energy audits and energy conservation investments were trained and received exposure to methods and technologies that are still being used today. However, none of the recipients has established formal energy conservation training programs. Whatever new exposure was obtained seemed to come from informal personal contacts or conferences.

To summarize the current status on energy education and awareness:

--USAID energy efficiency projects effectively demonstrated the benefits and process associated with energy conservation

--Since its founding in 1991 SEVEn has quadrupled in size and is now financially self-sufficient. It is the leader in spreading the word on energy conservation.

--Two energy service companies (ESCOs) have developed and serve a number of industrial firms.

--Sales by manufacturers of energy related control equipment have gone up substantially.

--Energy conservation and its benefits seem to be well understood but not all of this is directly attributable to the USAID projects. Other factors such as energy price increases, environmental regulations, increased competition as the market has been decontrolled and government energy policies all have played a role in making engineers and managers energy conscious.

--While the need for energy conservation is understood, there seems to be a disconnect between knowledge and practice. Conferences and meetings are fine but actual application is the critical factor. The spread of information has been limited.

4. INSTITUTION BUILDING

USAID institutional development efforts focused heavily on SEVEn, the NGO Energy Efficiency Center, which was sponsored and funded by USAID from 1991-1993. SEVEn has been highly successful in promoting energy efficiency; promoting energy policy reform; and serving as a "matchmaker", linking energy users with the engineering and equipment firms that have energy conservation solutions. Sections 2.C.3 and 2.B.3 of this report provide further information on SEVEn.

In addition to SEVEn there are a four other institutions (some very new) that play a major role in energy conservation efforts: the Czech Energy Agency (CEA), the Energy Consulting and Information Centers (the Czech acronym EKIS), the Energy Policy Department of the Ministry of Industry and Trade, and the Ministry of Finance.

The Czech Energy Agency (CEA) was established in 1993 with the goal of realizing an effective state program of energy savings as soon as possible. To achieve this goal nearly $20 million has been spent, mainly on demonstration projects. CEA supports a network of Energy Consulting and Information Centers (EKIS), which disseminate information and provide technical help on energy conservation (Section 2.B.3 describes the EKIS program). The focus of the Czech Energy Agency (CEA) up to 1994 has been on improving energy efficiency in buildings and apartments, but it is now moving on to industry.

The CEA is under the Ministry of Industry and Trade and works closely with the Energy Policy Department of that Ministry. The Policy Department is currently working with the CEA to establish a legislative proposal that would allow the Ministry of Industry and Trade to conduct statewide audits, label the energy ratings of appliances and motors, and have direct oversight over demonstration funds. The proposal has not yet been accepted by the legislature.

The CEA recognizes that one of the most effective conservation tools is pricing, but only the Ministry of Finance has that authority. Without such jurisdiction the CEA is largely a demonstration and advisory agency. Until energy prices are used more strongly to promote conservation most demonstration programs will have only limited success.

Most electricity companies focus on the supply side and deal with a long-run increase in peak demand by building more generating stations. In contrast, Demand Side Management (DSM) works on the demand side. Effective DSM eliminates or delays the need to build new electrical generating capacity by helping users to reduce their energy demand and to shift demand away from peak demand hours. By using cash incentives and penalties, factories can be encouraged to use energy more efficiently and shift demand to off hours. The electricity company does not have to build new electrical power plants and society benefits since less fuel is burned, resulting in less pollution. Ratepayers benefit since less investment is needed and electricity rates do not have to increase. The utility benefits since new electricity generating plants will not have to be operated.

However, the industries that use electricity and have to deal with DSM may face production disruptions, higher operating costs and administrative problems. In a well structured DSM program industry would realize some economic benefit. However, it is unlikely that the industry would promote DSM on it's own as society and the utility are the main beneficiaries. Higher energy prices will make energy saving devices more attractive to households and industry, but it is only a regulatory body that can promote concepts such as DSM through rules and regulations. The Czech Republic lacks such a regulatory body so DSM would be very difficult to introduce.

DSM faces many problems. Energy prices as well as revenue sharing between the Czech electrical generation company (CEZ) and the distribution companies is determined by the Ministry of Finance. There appears to be no relation between the amount of investment a utility makes in energy conservation and the return it receives. The Ministry of Finance sets energy prices based on financial and political considerations and usually energy conservation is not a high priority policy. In most countries this problem is solved by creating an energy regulatory body or public utility commission.

A regulatory body has the specific goal of implementing energy policy through rate setting. The rate setting process must consider the public good, the financial health of the utilities, environmental costs and business interests. No such body exists in the Czech Republic and that is a key institutional weakness that makes energy conservation difficult.

In summary, at the regional level the EKIS companies, NGO's such as SEVEn, and energy service companies (ESCO's) provide a limited institutional framework. In the Prague area they are relatively strong but results in the rest of the country are not as clear. The lack of an energy regulatory body is a serious constraint. However, the energy conservation ethic has come a long way since 1991. In the U.S., after the energy crisis of the early 1970s, the institutional structure took five to ten years to develop. In the Czech Republic the institutional framework has been put in place in just a few short years. Now the need is to put more substance behind the policies and goals.

C. PROGRAM PERFORMANCE

1. Program Effectiveness

Program effectiveness questions **how well** project-sponsored energy conservation techniques, services and products were at **reaching the intended target groups**. Or stated another way -- **who received the benefits and were they the right people**. Effectiveness also relates to improved institutions, markets and the policy environment for energy conservation. In this case we want to know how effective the project was at developing institutions and improving market functions. A final questions is whether the project selected the right groups; were these the groups that could generate the greatest energy saving per dollar of investment?

Target Groups. The project goal was to lower energy consumption and pollution by achieving more efficient energy use. Efforts focused on two groups - the primary target group of participants and the secondary target group of other firms through the promotion of SEVEn, demonstration projects and local energy consulting companies.

All participant firms had adopted energy saving measures and were continuing to utilize USAID-funded equipment. The only exceptions were where the companies had installed new equipment or production processes which required removal of USAID-supplied equipment. In these cases the USAID equipment was replaced with even more energy efficient equipment. Examples include the brewery's installation of new boilers with water preheaters and the upgrading of the energy system computer at the dairy. This continued use of more energy efficient equipment or energy efficient methods is one indication that the program was highly effective with the direct participants. Another example is the wood products factory. Based on results achieved under the USAID project, they were going to upgrade the remainder of their plant and adopt many ideas from the audit report, not previously implemented. In fact, they were meeting with an Energy Service

Company (ESCO), Energy Performance Services Co., at the time of the team's visit to the plant.

But were the right groups targeted? Since the objective of the project is to generate the maximum reduction in energy use through energy efficiency investments, then it seems likely those industries which are the largest users should have been targeted. The project action memorandum clearly states: "...a large percentage of total energy use is probably concentrated in a relatively small number of large plants. It should be possible to identify in a relatively short time the plants that are the largest energy users." The USAID projects targeted the correct groups but the contractor that implemented the project did not strictly follow that approach. Energy consumption at the participant companies was a smaller percentage of total costs than for other industries such as chemicals and heavy manufacturing and district heating plants. The question is one of tactics. It is clearly easier to deal with several dozen firms that are large energy users rather than several thousand firms that are small energy users. However, if the USAID goal is to support smaller firms (rather than large, heavy industry) it is necessary to deal with the more difficult task of reaching a large number of firms. The contractor seems to have had mixed objectives but opted for firms that were not energy intensive.

Institutions. SEVEn participated in some of the audits and carried cut other tasks under the USAID program, in the course of their work developing skills and a reputation which have allowed it to act as an advocate of energy efficiency. This effort of SEVEn gave birth to two energy service companies (ESCOs) which continue to operate and continue to help private firms improve their energy efficiency.

The role of ESCOs in energy efficiency is only now being defined. At first they targeted companies which participated in the USAID project but now have begun to branch out to serve other companies. Both ESCOs have targeted firms where energy is a relatively large share of total costs and firms which are privately owned and managed. Moreover, since these ESCOs have very limited access to capital they are beginning to target companies with access to foreign capital, either through export earnings or foreign participation. So far they have not been able to package energy investments for commercial bank loans.

Investments. If the USAID project approach of targeting firms that are not major energy users is to be successful, it must be adopted by large numbers of industrial energy users. These users will not adopt energy efficiency measures until it is in their own financial interest to do so.

The project sponsored energy audits and energy saving investments at five factories. The investments demonstrated that relatively

low cost measures could have short payback periods and generate moderate to good rates of return. However, rates of return on energy investments were probably lower than rates of return on alternative investments such as increasing output. Czech management is mainly interested in increasing sales and output rather than reducing costs. They are not that convinced that investments in energy efficient equipment yield the highest rate of return.

Privatization. Another factor impacting the willingness of firms to invest is their form of ownership. The non-privatized, state owned firms are carrying on much as before. With an assured market and government subsidies or price controls they focus on production rather than efficiency or costs. Many so called privatized firms are still majority owned by the national government or by a municipality and energy conservation is of minor interest.

For firms awaiting privatization or those that have been privatized by turning the factory over to managers and workers things are only slightly different. While these firms worry about markets and costs, they lack the capital resources to invest in equipment modernization and energy efficiency. They can make a few no-cost and low-cost energy investments, but cannot afford major expenditures.

The best hope lies with privatized firms that have a foreign partner or owner, since foreign firms bring technology, management, finance and marketing skills. They also are concerned with cost controls and take a strong interest in energy conservation. They have funds and are willing to make energy conservation investments with a longer payback. Most Czech firms lack capital and given the uncertainties, are reluctant to make investments with a payback period of over a year.

2. Program Efficiency

Program **Efficiency** looks at project benefits in comparison to costs---"how much bang for buck?" If benefits simply exceed costs, that is not enough. Benefits from program investments must be at least equal to the return that could be earned on alternative investments elsewhere in the economy.

Program efficiency is calculated by first taking all program investments, next valuing the flow of benefits, and finally comparing the costs to the benefits to calculate an economic rate of return (ERR) -- the net economic benefits to the economy. The flow of benefits occurs for a number of years, and that flow, less all costs incurred in their generation, yields the net annual benefit. For example, if a $100 investment generates net annual benefits of $20, the project has an ERR of 20 percent.

The first step in calculating an ERR is identifying USAID's initial investment---the resources used to plan, design and tender the project, along with the costs incurred in procuring equipment and the technical assistance. Excluding equipment costs, a total of $425,000 was spent by USAID on salaries, travel, reports and other implementing activities. The factories spent $15,000 of their own money plus $78,400 of USAID money on equipment. Total costs are then $518,400 ($425,000 plus $78,400). The next step is to estimate project benefits.

Analysis of data on energy savings is needed if benefits are to be determined. The team based its estimates on the 1994 Scientech evaluation report, interviews, and site visits. The only major change from the Scientech estimates was the use of current energy prices rather than the old and now out of date price estimates. Total annual energy savings at the five plants were 401 metric tons of oil and 16,987 metric tons of steam. This amounts to $189,030 per year. To this are added the benefits of reduced pollution of $103,608 to yield total annual benefits of $292,638.

The financial analysis looks at costs and benefits from the perspective of the firm. The economic analysis examines costs and benefits to the whole country, including externalities such as benefits from reducing pollution. The results and assumptions of the analyses are highlighted in Table 3.1. The economic rate of return (ERR) is quite high at near 50 percent.

Table 3.1 Financial and Economic Analysis

Description	Financial Analysis	Economic Analysis #1	Economic Analysis #2
Annual Energy Benefits	$113,418	$189,030	$189,030
Ann. Environmental Benefits		$103,608	$103,608
Total Annual Benefits		$292,638	$292,638
Costs	($93,400)	($93,400)	($518,400)
Payback Period (months)	9.8	3.9	21.3
Internal Rate of Return	122.0%	--	--
Economic Rate of Return	--	311.0%	49.8%
Net Present Value	$603,505	$1,284,254	$859,254
Tax Rate	40.00%	NA	NA
Discount Rate	10.0%	10.0%	10.0%

Notes: In case #1 the benefits of pollution abatement are added to the private pretax benefits and costs of the project. In case #2 USAID's project implementation costs are added to case #1.

3. PROGRAM SUSTAINABILITY AND REPLICABILITY

Definitions

A foreign aid project transfers resources and provides benefits. Which is fine. However, of equal interest is what happens after the project ends. Will new technology and practices introduced by the project continue? Evidence of sustainability is the continued use of energy saving equipment and the institutional capacity do make further audits and equipment installations.

Replicability examines whether conditions and practices promoted by the projects have spread beyond the demonstration companies and whether such spread is occurring spontaneously by "word of mouth" or by more formal institutional means. The Emergency Energy Project and the Regional Energy Efficiency Project could not cover all industries and all factories. They were designed to create a few successful examples that would be picked up and replicated by other plants. The test is the degree to which project supported changes have spread to other companies and whether 5 test installation was adequate.

The projects were implemented in 1991-93 so it is possible to go back in 1995, and ask questions about sustainability and replicability.

Energy Conservation Awareness--has it been sustained, did it increase?

The 1994 SCIENTECH evaluation found that all of the five plants that received energy conservation equipment were effectively using the equipment. In this 1995 evaluation a physical inspection of plants confirmed that USAID equipment was in place and being used. Of even more interest, at the wood products factory when a few project-provided steam valves eventually failed, the plant immediately purchased replacements. Additional steam pipe insulation has been installed. In the future the plant intends to convert from steam heating to hot water, make better use of wood scraps as a fuel and improve ventilation and capture exhaust heat and recycle it to save energy. The wood products plant had received consulting support from EPS, an energy services company (ESCO) that has been spun-off from the USAID supported NGO, SEVEn. However the plant engineers appeared unaware of what was happening at other plants in the Czech Republic, what equipment and services were available, and how to find solutions to energy problems that were beyond their own technical knowledge.

At the brewery (which now has a foreign partner) energy conservation measures included a boiler preheater and steam control and distribution measures. The boiler preheater increased efficiency by 8-10 percent. However the boilers were over 30 years old and not very efficient. Brewery managers replaced two boilers with new energy efficient boilers that include preheaters, better burner combustion control and better insulation. While the USAID preheaters have been scraped, the fact that management would purchase new, high efficiency boilers is one of the best indications energy conservation has taken hold. Brewery management is planning to increase computer networking of the production and energy process and recently completed an energy audit. It has switched from heavy fuel oil to gas (for pollution control and energy conservation reasons) and is working to bring its consumption of heat and electricity per unit of output up to European standards. Management is clearly concerned about energy.

The auto parts plant's manager also seemed very energy conscious. USAID-installed valves, thermostats and other equipment were still operating. The company now has a foreign partner which has injected capital for major upgrading, including energy conservation. The heating system had been upgraded and new, more efficient production equipment had been installed.

For the brewery, wood products plant and auto parts plant management recognizes the importance of energy conservation, is maintaining the equipment and benefiting from energy savings. Sustainability is not that clear at the dairy plant. Management is awaiting privatization and maintenance and investment are almost nil.

At all of the plants energy consciousness was evident: steam pipes were well insulated with few visible leaks; instruments for monitoring and measuring steam and electricity usage were operating; and energy efficient lighting had recently been installed at the wood products plant and auto parts plant. At the auto parts plant the valves, thermostats and other controls introduced by the project had a major impact. Similar equipment is now being used at six other auto parts plants owned by the same company. The demonstration effect of the USAID equipment within the company was strong.

In addition to the USAID supplied equipment, the district heating plant at Pilsen was installing additional valves, thermostats, meters and sub-distribution controls. The USAID project created an awareness and interest in energy conservation and the manager was proud to report that one demonstration housing block was able to save 25 percent on energy costs. There also was a US Department of Energy supported district heating conference held in Pilsen, designed to help disseminate energy conservation lessons.

While in the past the district heating plant had received assistance from SEVEn and the RAEN consulting group, there did not appear to be much information exchange between Pilsen and other city heating systems and Pilsen officials had not received any information from private sector equipment suppliers. It appeared cut off from information needed for future planning. It felt vulnerable since it faced competition from private power suppliers, cooperative heating systems, and gas and electricity distribution companies.

The wood products plant, brewery and auto parts plant had been privatized. They clearly were concerned with costs and energy conservation. The Pilsen heating system had been "privatized" and was now owned by the city. While not private in the true sense, Pilsen government officials did appear to be acting like cost conscious entrepreneurs. The dairy plant, awaiting privatization, was just "treading water", doing almost nothing about energy conservation. Once its status is settled, its engineers appeared to be interested in energy conservation.

SEVEn--a Premier Energy Conservation Institution

USAID provided funding to set up SEVEn, an energy conservation NGO. SEVEn has developed into a respected institution with good contacts within industry and government. In addition to involvement in energy efficiency projects, energy labelling and collaboration in integrated resource planning, SEVEn has organized an annual international conference---the "Energy Efficiency Business Week." This annual conference brings together government officials, local business leaders, consultants, energy conservation suppliers, and international businesses.

USAID has supported energy conservation organizations in a number of countries but none like SEVEn. In most countries USAID supported government organizations, in this case it supported an NGO which is independent of government and private special interests. In most other countries concessional assistance continued for many years. In this case after three years of USAID start-up funding SEVEn is self-sufficient and independent of donors; financing its operations from consulting fees and contracts. It does not compete with private firms, but is a matchmaker bringing together those that have services and those that need help. It also lobbies the government for energy policy reforms. As a spinoff it helped create Energy Performance Services Co.---a private energy services company. It also supports the energy services centers, EKOIS-B located throughout the country. By any measure SEVEn has been highly sustainable and has seen its services continue to expand.

Replicability and the Spread Effect
Except for the auto parts plant, part of a large conglomerate, the demonstration effect or spread of information between plants and industries is very limited. SEVEn is doing a good job but it is one small organization. Government efforts are promising but they are limited, and never could service the whole country. There appears to be very little information flowing between plants or between city heating systems; the plants are isolated and unfamiliar with their competition and what others are doing on energy conservation. Replicability within the industry or even within a geographic region appeared to be very limited.

The Czech Republic lacks the institutions that disseminate information in the West: trade associations, technical societies, industry newsletters, industry seminars, and in particular---private sector equipment salesmen. Dissemination that does take place is encouraged by SEVEn and government agencies such as the Czech Energy agency and the regional energy centers--EKOIS A and B providers. Their efforts are good but cannot begin to meet all needs. As in the West, private sector providers are needed.

3. LESSONS LEARNED

1. Each country has its own "business culture." Many Czech factory managers still follow the old approach from Communism of focusing on output rather than costs.

On the rebound from 40 years of socialist planning, Czech manufacturing firms have taken to the new religion of market capitalism, but only part of the religion--increasing output, not reducing costs. The old mentality from the days of central planning--of meeting production targets and focusing all efforts

on output (and not necessarily costs) still remains. While some inefficient plants have closed, many firms that export have found strong demand for their products. Firms that sell on the local market often face limited competition, and with high rates of inflation, have been able to raise prices. Thus, there is a tendency to focus on increasing production and sales, and not on reducing costs. **When, due to particular market conditions, firms are not oriented toward cost reduction, energy conservation measures are difficult to promote.**

2. **Another part of the socialist heritage is the emphasis on engineering and technical solutions, usually by a factory's own engineers. Business planning, marketing and finance were not needed. Now they are needed. In addition there is a need to learn how others deal with similar problems.**

Several manufacturing firms told us they had pollution and energy conservation problems, but when asked what they were going to do they gave a puzzled expression. They didn't seem to know how to package the problem and deal with related marketing and management issues. Under the socialist planned economy these problems were taken care of--now they are not. In the West there are trade associations, technical magazines, newsletters, equipment salesmen, consultants and other sources of technical interchange. In the Czech Republic those information sources barely exist. Firms don't know how to package and frame their question or where to go for help.

Successful replication of industrial energy conservation requires dissemination that allows management to keep abreast of solutions and technologies. If the information exchange is weak, results will suffer. A USAID sponsored technical demonstration investment is not enough. When USAID design a project it should also develop a dissemination plan. **Good energy conservation technology is not enough; effective dissemination is critical.**

3. **The Czech focus on pollution control through regulation may be the most effective way to cut harmful emissions and improve energy efficiency.**

Pollution control, rather than energy conservation, is the driving force in the Czech Republic. The electricity generating company and industry have been given tough deadlines to reduce emissions (local pollutants such as SOx, NOx and particulates, and greenhouse gases including CO2). Faced with fines for excessive emissions, and a threatened shut-down of the worst polluters by 1998, they have reacted by putting in stack scrubbers, switching to cleaner fuels, improving burner combustion, and redesigning district heating projects. All of these measures reduce emissions and except for scrubbers, are more energy efficient. An important aspect of the environmental

program is its self enforcing nature. Czech companies pay fines even though there is no official enforcement mechanism. **Pollution regulation can do more than just cut down on pollution--it discourages wasteful and inefficient energy consumption.**

4. **The energy conservation NGO SEVEn has done an excellent job of increasing energy awareness and education.**

A key factor in successful energy conservation is getting people to first realize that they have a problem. The next steps are technical information dissemination, bringing suppliers and consultants in contact with energy users, and encouraging appropriate government policies and regulations. SEVEn has done it all. It has combined the missionary zeal of an NGO with technical savvy. It has actively gone after business contracts and shows good business sense (in contrast to many environmental/energy NGOs that want to "save the earth" but don't know how to balance a checkbook). SEVEn has effectively organized annual technical interchanges--the Energy Efficiency Business Week and numerous meetings, newsletters, demonstrations and other forms of information dissemination. **Compared to a government agency, an NGO can often be more responsive and more effective at meeting the needs of all energy players.**

5. **USAID needs to decide whether to focus on a small number of major energy users or a large number of firms that are not very energy intensive.**

If energy is a major cost of production and fuel costs are "expensive", major energy conservation measures will be adopted. Ore smelting, some heavy industries and district heating plants are major energy users. Major impacts are possible by targeting a small number of energy intensive firms. However, the firms that received USAID energy audits and conservation investments were not highly energy intensive; energy was only 5-10 percent of total costs. They were willing to do minor, quick payback investments but not major energy conserving investments. USAID decided to try and reach thousands of small energy users rather than a few large energy users. **To have the biggest impact on energy conservation USAID efforts should focus on the most energy intensive industries.**

6. **Energy conservation is an investment and an uncertain investment climate will deter most investments, including energy conservation investments.**

This is mainly a problem for firms awaiting privatization. Faced with uncertainty concerning market, prices, and employment, they have postponed all but the most necessary investments as they await their transformation from state to private ownership.

Plants that have already gone through a successful privatization showed a strong interest in energy conservation.

7. **The energy "rules" for electricity and gas producers and distributors must be well defined.**

Local distribution companies were broken off from the national electricity authority and national gas authority but the rules on prices, responsibilities and benefits were never adequately defined. Uneconomical prices and subsidies continue to send unclear signals to energy users and providers. **Long term energy conservation requires an independent regulatory body that supports economic prices, minimizes cross subsidization, has a framework for public participation and develops rate structures that support conservation.**

8. **Price distortions harm energy efficiency.**

The household sector pays one-third to one-half the rate industry pays for electricity, coal, gas and heat. This is a politically sensitive area, but the government has pledged to phase out the subsidies by the year 2000. **As long as there are major energy subsidies, conservation is difficult. USAID programs will not be successful if the government fails to implement appropriate policies.**

ANNEX A
DATA SOURCES AND FIELD SURVEY METHODOLOGY

The overall evaluation methodology is described in (cite title), the evaluation design for the Energy Conservation Evaluation Series. This note describes how data were collected in the Czech Republic. Documentation used in this study is listed in the bibliography.

The field evaluation took place over a two week period in September 1995. The evaluation team included a USAID economist who served as team leader, a USAID environmental engineer, and two consultants---an energy economist and a power engineer.

For key informant interviews the evaluation team used the standard Topical Guides (questionnaires) which have been used in all of the individual country energy conservation evaluations. There are four Guides, with each designed for a different data source, using slightly different questions: The first guide was used for data collection from Czech government officials; The second for energy consulting and engineering firms; The third for energy using firms; and the fourth for pollution issues. By asking a standard set of questions to over 30 individuals it was possible to identify key issues and factors, and areas of agreement (and disagreement). These key informant interviews were the major data source for this evaluation. They can be grouped into three categories--energy users, energy service providers, and Czech government agencies.

Energy Users--who received USAID assistance
The evaluation team was able to interview and do a physical plant inspection of four of the five firms that received USAID funded energy audits and energy conservation equipment (the dairy, wood products plant, brewery, and auto parts manufacturer). In addition, the team visited a district heating system (City of Pilsen) that received USAID assistance. Key informants included the chief engineers and management at each of the energy using firms.

Energy Conservation and Energy Services
The evaluation team met with the energy efficiency center, SEVEn (an environmental NGO); two energy consulting firms, Energy Performance Services, and RAEN Energy and Environment Co.; and the Architecture Foundation.

Czech Government
Key informant interviews included the Czech Energy Agency, Ministry of Industry and Trade, and the Czech Energy Company (CEZ).

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ANNEX B

PERSONS INTERVIEWED

SEVEn, An energy efficiency NGO
Jaroslav Marousek, Executive Director
Jiri Zeman, Energy Engineer

Energy Performance Services Co. (EPS), An energy services company
Ivo Slavotinek, General Manager, Central European Operations

The Czech Energy Agency
Jiri Barton, Director

Energy Policy Department
Ministry of Industry and Trade
Pavel Brychta, Head of Energy Policy Department

RAEN, An energy and pollution consulting firm
Michal Palecko
Evzen Pribyl
Frantisek Stejskal

U.S. Foreign Commercial Service
Kathleen Kriger, Assist. Commercial Attache
Hana Jelinkova, Commercial Specialist

Czech Electricity Authority, the national electricity company
Zdenek Tobias, Deputy Director
Vladimir Zeleny, Head of Information and Consulting Center

Nadace Pro Rozvoj Architektury, Foundation for Architecture and Building Design
J. Zajic, Deputy Director

Pragolaktos Dairy Plant
J. Kral, Chief of Energy Engineering

Johnson Controls, A U.S. supplier of energy measurement and control equipment
Dan Mach, Director of Prague Office

DETOA, Albrechtice v Jizerskych horach, Manufacturer of wood products
Petr Hubner, Director of Production

Autobrzdy Jablonec, Manufacturer of auto parts
J. Pajer, Energy Director

"PHARE" Energy Conservation Project (funded by the European Union)
Ministry of Industry and Trade
Jan Poucek, Director
Vladimira Henelova, Project Manager

Arthur Andersen and Co.
Josef Pivonka

City of Pilsen, District Heating Plant
Zdenek Grundman, Deputy Mayor for Finance

Branik Brewery, Prague
J. Zedak, Production Engineer

USAID Staff, AID Representative's Office Prague
James Bednar, AID Rep.
Robert Posner, Program Officer
Jan Pisko, Energy Specialist

ANNEX C
ECONOMIC ANALYSIS, DATA ASSUMPTIONS

ASSUMPTIONS:

Discount Rate: Ten Percent

Expected Life of Investment: Ten Years - This is lower than would be expected in a nontransitional economy. Much of the plant and equipment is old. As companies grow or acquire foreign investors they will most likely make major changes to their plant and this will most likely result in scrapping of the USAID equipment. Some of the plants may be permanently closed.

Physical Depreciation: Ten percent declining balance annually. This is based upon the documented lack of attention to maintenance.

ENERGY PRICES

Nominal Energy Price Growth: Nominal energy prices are expected to be raised but the government has been reluctant to pass along full cost increases to energy consumers. Energy prices are, therefore, forecast to grow 10 percent a year, which is less than the rate of inflation.

Real Energy Price Growth: Worldwide real energy prices are assumed to remain constant over the forecast period. This scenario is supported by a number of energy experts including the U.S. Department of Energy, Energy Information Administration, Office of Energy Markets and End Use. However, as noted above, given the reluctance of the government to raise energy prices sufficiently to cover inflation, real prices will decline in the Czech Republic.

Market Vs Shadow Prices: Economic analysis relies on the use of shadow pricing when market prices do not reflect the true opportunity costs to society. The major costs elements of this project were the cost of the equipment and energy. Equipment prices pose no problem.

In the case of energy there is a divergence between market prices and economic prices. For the industrial sector, the shadow price of natural gas and electricity should be on average 10 to 15 percent greater than market prices.

Environmental costs of energy production and consumption are not reflected in Czech market prices. To collect and analyze data in

order to determine environmental prices is clearly beyond the scope of this work. Another approach is possible.

To reflect environmental costs, the per ton cost of pollution abatement is used. This is the cost avoided by society through the introduction of energy efficient investments. In other words, pollution can be reduced in two ways by either installing pollution abatement equipment or by lowering energy use. Companies are assumed to forego abatement cost by investing in energy efficiency. As a point of reference, the cost of pollution abatement can be assessed using the cost of control technology in the United States.

Since the Czech Republic has a lower income and lower standard of living than the U.S. it is assumed that Czechs would not be willing to pay as much as Americans would pay for reduced pollution. Therefore it is necessary to reduce U.S. values for pollution reduction when analyzing the Czech Republic; most costs are halved. Assuming that society values the reduction in pollution by as much as the cost avoided, these figures are used as an estimate of the opportunity costs which Czech society would not incur in cleaning up the environment.