Climate Change Mitigation: Case Studies from the Czech Republic

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CLIMATE CHANGE MITIGATION:
CASE STUDIES FROM THE CZECH REPUBLIC

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Foreword

The Advanced International Studies Unit (AISU) of Pacific Northwest National Laboratory developed a series of case studies to document an important trend: the emergence of cost-effective carbon mitigation opportunities in transition economies. The following report focuses on selected cases that describe innovative Czech approaches to mitigation. This research captures the essence of AISU's approach to environmental problem-solving. First, the case studies address an applied, global policy issue. They also focus on policy tools that enhance economic well-being. Finally, they provide first-hand analysis from experts in the host country being studied.

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Introduction

The Czech Republic signed the Framework Convention on Climate Change (FCCC) in October 1993. The first National Communication of the Czech Republic for the FCCC was submitted in September 1994. The Czech Republic agreed in the communication to undertake efforts to reduce greenhouse gas (GHG) emissions and to meet the requirement of stabilizing emissions at or below 1990 emission levels by the year 2000.

Meeting this goal appears viable primarily because of a sharp downturn in the economy in 1990 and in subsequent emission levels. Several additional projections have confirmed the prognosis for emissions given in the National Communication.[1] All of the studies reach the same conclusion: at present levels of economic growth, levels of GHG emissions in the Czech Republic by the year 2000 will be at least 10 percent below 1990 levels.

The projections of rapid economic growth published two years ago increasingly appear over-optimistic. Although several changes have occurred that might affect emissions levels, such as delays in completing the Temelin nuclear power plant, these changes do not threaten compliance with the Czech FCCC obligation for the year 2000. It is expected that any concerns about failure to meet the specified levels for the year 2000 will disappear by the end of 1998.

These findings have had both positive and negative effects on the Czech Republic's position on emissions reduction issues. On one hand, they have enabled the country to take an active role in international negotiations and cooperation, because meeting FCCC obligations will not pose additional demands on the federal budget. On the other hand, the Ministry of the Environment has lost any basis for justifying the inclusion of emissions reduction programs in the state budget, since the primary mandate of the convention can be met without special climate-focused projects. The Czech Republic is currently considering measures which could result in an average annual reduction of 3.3 million tons of CO_2. Most of these reductions would be gained through changes in the energy tax system.

[1] Ministry of Industry and Trade, *Energy Policy of the Czech Republic* (1996) Prague.

Case Number 1:
A Federal Energy Efficiency Program

Background

In 1991, the Czech and Slovak Federal Republic passed Resolution No. 132/91 (Czech Government Resolution No. 252/91) to reduce the demand for power in the Czech economy. The resolution created a federal strategic program to support the development and dissemination of energy-efficient materials and technologies. Reducing demand for power was also mentioned as a strategic goal of the government's 1991 power policy, which was described in "Principles of the State Participation in Reducing Fuel and Power Consumption in Buildings and Flats." The federal program included the establishment of a consulting network, financial support for insulation in buildings, installation of information and control devices, implementation of demonstration projects, and interest-free loans for renewable and non-traditional power generation projects.

Following the separation of the Czech and Slovak republics in 1991, the new Czech federal government created a program called the "State Participation in Reduction of Power Consumption Program." Since 1993, the program has fallen under the jurisdiction of the Czech Ministry of Industry and Trade, which revises the program on an annual basis. The program focuses on reducing demand for primary energy; reducing environmental pollution; reducing price subsidies for home heating; and reducing the amount of state funds needed to cover operating costs in schools, medical facilities, and other public institutions.

Approach

The state program essentially offers direct financial support in the form of grants for up to 40 percent of the total investment costs of an energy-saving project. The level and type of support has varied from year to year. The program is announced on a nationwide basis once a year by the Czech Energy Agency (CEA), which operates under the auspices of the Ministry of Industry and Trade and is responsible for energy efficiency in the Czech Republic. Applicants for support submit their requests and project documentation to the CEA, where a tender is held. Recipients of support may be individual households, municipal bodies,[1] entrepreneurs involved in heat and electricity generation, and owners of residential buildings.

The number of applicants has increased each year, even when the program has not been advertised widely. This high level of interest has meant that it is not possible to meet all

[1] Examples of municipal projects include investments in schools, hospitals, municipal office buildings, recreational facilities, and service facilities.

requests. In 1996, for example, the number of requests for support through the program totaled roughly $35 million; the total available was only $6.8 million. At the same time, the number of applicants eliminated during the selection process (for not having filled out their forms properly or not providing all the necessary information) has decreased steadily. While 50 percent of all applications were rejected for the aforementioned reasons in 1995, the figure was 25 percent in 1997.

In 1995, rough estimates for necessary investments in energy-saving measures for homes in the Czech Republic were between $2 billion to $4 billion. From this figure, it is obvious that great potential exists for expanding the program. In the upcoming 5 to 10 years, plenty of appropriate energy-saving projects are available to capture some of this potential. If the program were to expand from private homes to the industrial sector, its dimensions would be much larger.

Considering the size of the Czech Republic, the results of the program are quite significant. The CEA program has had a positive impact mainly because Czech residential properties require a great deal of renovation in both buildings and heating systems. Financing for energy-saving projects is limited, however, by heat subsidies, which lower the amount of savings that can be realized from a project, reducing return on investment.

Improving the Czech economy through state support for investments in energy efficiency is a secondary goal of the program. Dissemination and publication of the results of the projects also contributes to increased public awareness in energy efficiency issues, which may help to replicate demonstration projects without direct government support.

Monitoring and evaluation are integral parts of the state grants program. The technical and economic criteria defined in the project goals are an integral component in gaining the provision of state support. They also provide a basis for inspections carried out during the course of project implementation, and for the follow-up evaluation. The CEA has recently strengthened the self-monitoring system that tracks project implementation by providing systematic feedback. The feedback network includes basic project documents (technical calculations, energy invoices, measured data, energy audit), detailed questionnaires, and special surveys of program participants, including applicants who were not selected for program support.

From 1991 to 1994, state support for energy-saving measures was provided in three ways: 1) general support for building insulation and information and control installations, 2) support aimed at selected demonstration projects, and 3) a combination of the first two methods for renewable and nontraditional energy projects. In 1995, grants were made according to the demonstration project model; i.e., the selection procedure assessed expected project contributions. However, the CEA continued to support some general measures, such as insulation and control systems.

The division of resources between two types of projects illustrates some fundamental differences of opinion concerning the best approach for the program. The government is still unclear as to the kinds of projects it would like to support. Some officials believe that the program should support only progressive, high-tech measures; others support funding for traditional measures with proven results. Program administrators (and the CEA) tend to be more in favor of the former approach, while other experts in the energy sector are inclined toward the latter.

In the 1995 program, the CEA emphasized progressive, cost-effective, and replicable technological solutions. The 1995 projects' contributions toward these goals can only be evaluated on the basis of the projected parameters because results will be available only after the first heating season following the completion of construction in the spring of 1998.

Table 1. 1995 CEA Project Profile

Measure	**Number Installed**	**Cost** (thousands)	**Energy Saved** (GJ/yr)	**Number of Housing Units**	**Savings per Apartment**	
					(GJ/yr)	%
Weatheri-zation	63	$3,000	100,000	6,300	16	49%
Metering and Controls	23	$1,700	270,000	38,000	7	22%
Gas Boiler Plants	8	$130	3,300	300	11	34%
Other[2]	3	$120	2,600	200	12	37%
TOTAL	97	$4,950	375,900	44,800	--	--

When considering specific costs, comprehensive measures are preferable from both a technical and demonstration point of view. Therefore, support for demonstration projects, including insulation, metering, and controls is the most effective. If the program incorporates new, progressive technologies, it will cover a smaller number of projects. On the other hand, if the program involves traditional technologies, it will have a broader reach.

[2]A combination of the above measures.

The CEA also provided support to renewable and nontraditional energy projects from 1991 to 1995 (see Table 2). The most promising projects received interest-free loans. The CEA selected the projects by evaluating reliability and technical and economic parameters. Results from previous years formed the basis for the 1996 project selection criteria.

Table 2. Renewable Energy Project Profile[3]

Year	**Number of Projects**	**Loans** ($ million)	**Electrical Capacity** (MW)	**Heat Capacity** (MW)	**El. Prod.*** (GWh/yr)	**Heat Prod.*** (GWh/yr)	**Total Invest-ment Cost** ($ million)
1991	84	1	11	1	40	3	7
1992	33	1	2	0	10	0	2
1993	81	1	7	2	20	10	4
1994	75	1	9	3	30	10	10
1995	59	1	6	4	30	20	5
Total	**332**	**5**	**35**	**10**			**28**

As of July 1996, 160 small water power plants, 11 thermal pumps, 56 cogeneration units, 7 wind power plants, 5 solar devices, 3 biogas units, and 1 wood-combusting boiler were in operation. The 243 units installed through the renewables program have a capacity of 20,000 kW_e and 8,500 kW_t and are expected to produce 70 million kWh_e each year. Facilities producing 30 million kWh_t have already been implemented, and the rest of the equipment is expected to be in place by the end of 1997. Unfavorable weather conditions during the first half of 1997 caused delays in several of the projects.

In 1996, $6.8 million was allocated from the state budget for power-saving programs. Under a new strategic approach to the program, which incorporated experience from previous project years, the 1996 program was divided into categories by the type of energy consumption and production involved in the proposed projects. In addition to the original program priorities, categories were added for industrial efficiency and energy audits for small- and medium-size businesses. An additional program is aimed at forming an effective network of consulting centers. The centers will provide free services to the public, producing informational databases, distributing technical and popular publications on energy, and organizing educational campaigns around energy efficiency and environmental protection.

[3]These figures are projected values that are then refined according to actual production figures.

The applications submitted to individual programs were assessed by area of interest and estimated energy savings. The amount of support was determined by the data provided by the applicants. In comparison to 1995, applications for energy efficiency projects increased by approximately 50 percent.

An analysis of the effectiveness of the 1996 CEA program showed that it reflected national priorities. Program organizers added consulting and education categories to the 1997 program to influence future attitudes of power consumers and increased the budget to $10 million.

Categories for the 1997 grants program included the following:

- Reduction of energy consumption (including heat and hot water) in households
- Reduction of energy consumption (including heat and hot water) in school buildings
- Reduction of energy and heat consumption in health care facilities
- Implementation of energy efficiency measures in public buildings
- Implementation of renewable energy projects and cogeneration in municipal systems
- Improvement of energy supply systems for housing estates
- Implementation of energy efficiency measures and renewable energy projects in the transportation and agriculture sectors
- Promotion of informational, consulting, and educational programs that focus on energy efficiency and environmental quality.

Program Evaluation

The Czech government has justified its participation in these programs by citing the potential to reduce power consumption in the municipal sector. Increased efficiency could reduce power consumption in this sector by 30 percent, saving 84,000 terajoules (23 billion kilowatt hours) annually.

Economic Benefits:

Energy efficiency programs conducted from 1991 to 1995 have resulted in average annual savings of 1,000 terajoules. A total of 11,000 terajoules of energy have been saved since the program's inception. The program also reduced heat consumption in public buildings by 2 percent in 1992, 1 percent in 1993, and 4 percent in 1994.

Energy efficiency projects in the housing sector have reduced the need for federal energy subsidies, albeit modestly. For example, subsidy savings have been estimated at roughly $89,000 for 1996, or an amount equivalent to about 4 percent of the grants issued during the same year. Savings from reduced operating costs for two state-run and state-subsidized institutions (a school and a hospital) totaled $400,000 in 1996.

Environmental and Climate Benefits:

A reduction in primary energy consumption, particularly fossil fuels, reduces the environmental burden on the environment as a result of fuel combustion. The environmental contributions of the CEA program can be expressed by power savings, fuel mix, and the adverse environmental impacts of the fuels (see Table 3).

Table 3. Reductions in Major Air Pollutants from the Program

	Particulate Emissions	**SO_2**	**NO_x**	**Ash**	**CO_2**
Emission factor (kg/TJ)	1,400	2,300	500	25,000	97,000
1991-95 Total (metric tons)	24,000	40,000	7,600	423,000	1,640,000

How This Program Could Be Expanded

It is very difficult to estimate the degree to which this program and its concepts could be expanded. At present, the upper limit of the budget could approach an estimated $35 million. With a larger budget, the number of projects, as well as the administrative costs, would increase. Therefore, it is important to preserve the rules presently followed in selecting good projects as well as ensuring an optimal number of program participants.

Assuming the present profile of subsidized projects was maintained, a hypothetical expanded budget of $35 million could generate up to 7,000 terajoules per year in energy savings. Returns for lowered emissions can be expanded linearly, so it would be possible to save roughly 7 times the amount of CO_2 emissions listed in Table 3.

Parallels exist between this program and The National Program on Healing the Atmosphere (PHA), which gave a total of $200 million over a four-year period (the PHA is discussed in Case Number 2). The CEA program, however, was organized differently than the PHA and involved working closely with district offices and local governments. Some early reviews of the PHA program indicate that it is very difficult to administer such a large program while maintaining expertise and objectivity.

Support for renewable-resource projects is more commercially oriented, and it is much more important to ensure the cost-effectiveness of these projects. They nonetheless merit increased support under the CEA program.

The CEA energy efficiency program has been important even during the Czech Republic's economic difficulties. Need for efficiency programs has remained strong, and there has been a lack of available financing from sources outside of the CEA. The energy efficiency

program should be expanded, but with certain changes, such as a move toward more loans and fewer grants. Furthermore, the program should assist applicants with identifying financing for their projects from outside sources, such as investment funds and commercial banks. The program should also expand to cover energy efficiency projects in the industrial sector.

The CEA program is included in Czech state energy policy until the year 2000. Political pressure to preserve this program and encourage its expansion is likely to increase because of current increases in the price of energy. Pressure is likely to increase further after the value-added tax (VAT) on electricity, gas, and heat increases from 5 percent to 22 percent on January 1, 1998. Increased state budget revenues in this area could (and, in our opinion, should) lead to budget increases for the program.

Similar measures could further increase energy savings in the Czech Republic. For example, reducing the depreciation period for energy efficiency technologies provides an incentive to invest in this area. This measure would modify Czech income tax law to put certain equipment into special depreciation categories. Equipment that produces or delivers heat energy and is installed as part of a building (such as boiler units and exchanger stations) is associated with the building. As a result, the equipment is put into a category with a 45-year depreciation period. Yet the operational lifetimes of this equipment do not exceed 10 to 15 years. Similar problems occur when the owner of a facility is not the same as its operator (the heat suppliers). In this case, heat production and supply is paid for and carried out as a service. Auditors conduct a technical evaluation of the building while the equipment is being installed, and the structure then depreciates as a whole. Changes in the tax code would motivate equipment operators to take advantage of depreciation methods and install more efficient equipment, resulting in in reduced CO_2 emissions.

A fund for energy efficiency projects could also be established that could be used in conjunction with commercial project financing to support investments in energy-saving measures. The goal of the fund would be to guarantee energy efficiency project financing through loans repaid from energy savings and set standard banking procedures for this financing mechanism. The fund would also address current problems with investing in energy efficiency on a wider scale, including lack of experience, low confidence in energy-saving technologies, and difficulties with finding suitable guarantees. The CEA, which has experience with similar programs, could ensure the proper administration of the fund. The preparation of an energy audit would be a precondition for obtaining support. However, establishing this fund would require a certain change in the guidelines for financing budgetary organizations.

The successful operation of a fund in the Czech Republic for a period of several years would start a tradition of investing in energy efficiency. The investment procedures verified by the fund could be transferred easily by several banks, and the principles used to

govern project finance in the energy efficiency sector could be used in all sectors of the economy. The stability of the Czech economy will be essential, enabling investors to make the transition from short-term, risky investments with short pay-back periods to strategic, long-term investments. If the fund finds and verifies paths to investing in energy-saving technologies, this field will remain attractive to investment capital.

Case Study 2:
The National Program on Healing the Atmosphere

Background

On July 9, 1994, the Czech parliament decided to use a portion of the State Property Fund to reduce regional pollution. The National Program on Healing the Atmosphere (PHA) was created to accomplish this task. The program was not designed to support climate-related goals, but GHG reductions have been realized as a secondary benefit of program-related activities.

Approach

The PHA was designed to improve the quality of the atmosphere in cities and municipalities. High-priority measures include replacing the combustion of brown coal, briquettes, and coal sediment with natural gas, electricity, or other more environmentally friendly sources of energy for apartments and industrial equipment requiring up to 50 MW of power.

About 60 percent of the PHA's funds is used for grants; the remainder is used for loans. Any legal entity can apply for support from the PHA, including municipalities, cities, and private businesses and individuals who apply through their municipality. Certain groups are limited to certain types of assistance; that is, businesses are eligible to receive loans, but not grants.

Grants can cover up to 40 percent of total project costs; however, the amount of the grant must not exceed $800,000. Grants may be obtained by both individuals and legal entities for environmentally friendly heating and hot water for apartment units. In centrally-heated apartment buildings, the grant money available for individual apartments may be aggregated up to a maximum output of 200 kW.

Loans are granted to businesses and to nonbusiness entities when applying for support for commercial activities. Businesses may receive loans only for measures related to end-use energy consumption. The PHA loans are interest-free, with a maximum term of 5 years. Payments can be delayed for up to 5 years, but the total period of time from approval to payment must not exceed 7 years. Loans are offered for up to 70 percent of project costs and can be offered concurrently with subsidies. Applicants must prove, however, that they can provide at least 20 percent of the project costs from their own or other sources.

Program funding may be used for the following activities:

1. Projects that improve air quality by converting from coal to natural gas, electricity, or other more environmentally sound methods for supplying heat and hot water to households
2. Projects that reduce air pollution from stationary sources with outputs of up to 50 megawatts
3. Construction of gas distribution systems or connections to city or local gas distribution systems
4. Construction of renewable energy plants with outputs of up to 50 MW to replace coal-fired plants

The program has also established criteria for evaluating the applications that adhere to these guidelines. The measures qualifying for financial support will depend on the priorities of regional air quality programs. These programs are administered by regional authorities and associations, which receive some assistance with project preparation from the Ministry of the Environment. Project selections are therefore based on the following criteria: 1) the concentration of pollutants in the project area, 2) expected local effect on the air quality, and 3) the relationship of the measures to the optimal use of local energy production capacity.

Priority is given to projects with a low ratio of capital to emissions reduced. Projects may also be given priority if they decrease emissions to a level well below legal limits and coordinate with existing regional energy and clean air initiatives. The PHA does not support measures that involve facilities producing more than 50 MW of heat. In addition, the PHA does not offer grant measures that are individually subsidized from the state budget. Equipment built with the support of PHA funds may not be transferred to a different entity free of charge.

The PHA allocated $200 million for investment. The funds are being transferred gradually to the State Fund for the Environment: $30 million was released in 1994, $75 million was released in 1995, $70 million was in 1996, and $25 million will be released in 1997.

Approximately 95 percent of the PHA funds have been spent to help Czech towns and districts convert to natural gas heating. More specifically, finances are being steered toward constructing medium- and low-pressure pipes for natural gas. Municipal offices receive these grants. A small percentage of funds--approximately $7 million--has been earmarked to help repair small domestic boilers. This initiative provides up to $700 per boiler to be distributed by municipal offices. The rest of the money has been earmarked for the construction of a distribution network for electric home heating.

Most projects combine both available forms of financing--40 percent of the project costs is covered through loans and 40 percent through direct grants. According to the information

available at the time of this review, there have been no problems with loan payments during the program.[1]

Project Evaluation

Because the program is continually being worked out and projects included in the program are predominantly in the construction phase, it is very difficult to determine the benefits of the program. Another complicating factor is the large number of projects included in the program and the relatively weak value of data on individual projects. Therefore, it is possible to provide only a rough estimate of program benefits. Table 4 lists the funding amounts allocated under the PHA.

Table 4. Total Support Pledged for PHA Projects as of June 30, 1996

Conversion of Household Heating Systems	Gas, Heat, or Electric Conversions (mains, boiler plants)	Total
$7 million	$160 million	$167 million

Of the total program budget, 40 percent is distributed as interest-free loans, and 60 percent is distributed as one-time grants. Environmental benefits of PHA projects are presented in Table 5.

Table 5. Emissions Reductions Resulting from the PHA Project

	Emissions Reductions for Major Pollutants (tons/year)				
	Ash	SO_2	NO_x	C_xH_y	CO
Total	35,000	43,000	5,000	15,000	64,000

[1] Note that the program has only been in existence for a short period of time and has had only one type of creditor--municipal offices.

Climate Benefits

It is difficult to calculate reductions in CO_2 emissions provided by the PHA, because these emissions are not monitored in the program and are difficult to estimate from PHA project materials. However, the program offers enough information to make some crude calculations.

Approximately 90 percent of the activities supported by the PHA focus on replacing brown coal used in small combustion units with natural gas. Table 6 provides an estimate of the increase in end-use natural gas consumption caused by the PHA. The PHA will reach approximately 10 percent of the market for conversion; estimated costs for complete conversion range between $2 billion and $4 billion.

Table 6. Estimated Annual Increases in Natural Gas Consumption because of the PHA

	1997	**1998**	**1999**	**2000**
Estimated Annual Increases in Natural Gas Consumption (million m^3/year)	400	900	1,400	1,600

This increase in natural gas use will reduce brown coal consumption. Table 7 provides an estimate of CO_2 emission reductions by calculating the amount of brown coal that will be offset by the use of natural gas. The calculations assume fuel heating values of 14 GJ/t for brown coal and 33 GJ/tm^3 for natural gas. The calculations also assume emission coefficients for CO_2 emissions of 101 kg/GJ for brown coal and 56 kg/GJ for natural gas.

Table 7. Estimated Climate Benefits from the PHA

	1997	**1998**	**1999**	**2000**	**Total**
Estimated Annual Reductions in CO_2 Emissions (metric ton/yr)	594,000	1,336,000	2,079,000	2,376,000	6,385,000

How This Program Could Be Expanded

Current research on changes in CO_2 emissions through changes in fuel use insufficient to determine the role of the PHA in reducing air pollution by lowering emissions. The available information does not differentiate between emissions from various sectors or categories of power sources. In addition, the program is limited to energy sources under 50 MW.

The size of the market for fuel conversion indicates that the PHA program could be expanded to two or three times its current size. Consider the Czech government's *Outline of Considerations for Climate Change*. Approximately 10 percent of all CO_2 emission reductions from fuel-switching can be attributed to the PHA. This reduction constitutes approximately 30 percent of all economically feasible emission reductions from fuel-switching until 2000.

Case Number 3: Using Waste Heat in a Municipal District Heating System

Background

The State Environmental Fund (SEF) is similar to the PHA program described in Case Number 2: it uses fines from polluters to fund environmental projects. SEF projects focus on air, water, soil, and biodiversity. Approximately $20 million has been earmarked annually for the program in the form of grants and loans for environmental protection projects.

One of the recipients of support from the SEF was a the town of Vratimov, a small town in Northern Moravia. Vratimov developed a project to use waste heat from a local steel mill to supply its district heating system.

Approach

This project replaced 15 coal boilers and an old gas boiler with a new district heating system in Vratimov. The total installed capacity of the district heating system is 16 MW, which covers maximum projected demand for heat with a substantial reserve.

The Vratimov project is unusual because a significant portion of the heat for the district heating system comes from waste heat generated at the Nová Hut steel mill in the city of Ostrava. Previously, the heat escaped unused into the atmosphere, and the water containing it had to be cooled in the factory's cooling towers. The old coal-fired district heating system covered approximately a third of Vratimov's households and several commercial, industrial, and public buildings in the town center.

Investments covered the installation of heat exchangers for the rolling mill, pumping stations and electrical equipment, 4 km of main conduits (arterial pipes), heat exchangers for buildings, and meters and controls. Investment totaled $2.8 million in 1995 prices.

The district heating system is owned and operated by the Teplo Vratimov, a limited liability company established in February, 1995 by the town of Vratimov and the Nová Hut joint-stock company. Teplo Vratimov has been responsible building and operating the system, as well as for purchasing and distributing heat in the town. The town of Vratimov and Nová Hut each own 50 percent of Teplo Vratimov.

Project Evaluation

Project Costs

The estimated investment costs of the entire project are $2.8 million. The investment cost per amount of heat consumed is estimated at $37/GJ per year if 75,000 GJ of heat are sold, or $55/GJ per year if 50,000 GJ of heat are sold. Estimates from the project's first heating season fall within this range.

Project costs for the waste heat facility were relatively high compared to other methods of supplying heat. On the other hand, the project has relatively low operating costs compared to other methods of producing heat because of its use of waste heat. The price of heat delivered from the district heating system is perhaps the best indication of its economic competitiveness compared to other projects. With heat consumption levels of 50,000 GJ, the average cost to supply heat from this project over the long term (including all costs, even from project financing and interest on loans) is around $15/GJ (in 1996 prices), assuming a 3.5 percent annual price increase.

Economic Benefits

Implementing the project has already saved approximately 100,000 GJ of primary energy annually in the form of fuel. The use of waste heat in the Vratimov project saved the following amounts of fuel:

- 1,800 tons of black coal
- 1,200 tons of coke
- 1,200 tons of brown coal
- 100,000 of natural gas.[2]

After completing the project, there were additional energy savings in end use. While this project was being implemented, the town installed heat meters and regulation devices in every building, including individual hot water meters and heat cost allocators for radiators in residential buildings. Other towns have seen average end-use energy savings of 10 to 15 percent after installing similar equipment. Households benefit directly from these measures, because they are able to influence their heating and hot water bills and have an economic incentive to conserve energy.[3] Metering allows the heat supply company to bill individual households based on their actual heat consumption.

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[2] The figures listed are data from 1994.

[3] Heating prices were calculated according to the square footage of the apartment and the number of its inhabitants before individual meters were installed.

Environmental Benefits

Vratimov, a town with 6,800 inhabitants, lies on the northern edge of the Frýdek-Místek district. This district suffers from some of the worst air pollution in the entire Czech Republic. The towns of Vratimov and Trinec are the two most polluted areas in the Frýdek-Místek district. Vratimov directly borders Ostrava to the north. Ostrava, a large industrial city, has experienced even more environmental damage than Frýdek-Místek and has been designated as the most polluted area in the entire country. Tables 8 and 9 provide an overview of the program's impact on air pollution and GHG emissions.

Table 8. Emissions Reductions in Vratimov from the Waste Heat Project

Pollutant	**Previous Emissions in Vratimov** (metric tons)	**Emissions after the Project** (metric tons)	**New Emission Levels as % of Original Levels**[4]
Particulates	140	80	55%
SO_2	170	120	72%
NO_x	30	20	59%
CO	300	300	93%
C_xH_y	70	70	91%

Table 9. Reduction of CO_2 emissions from the Waste Heat Project

Fuel	**Amount Reduced**	**Saved CO_2 emissions**
Black Coal	1,800 metric ton/yr	4,800 metric ton/yr
Coke	1,200 metric ton/yr	3,400 metric ton/yr
Brown Coal	1,200 metric ton/yr	1,300 metric ton/yr
Natural Gas	100,000 m^3/yr	200 metric ton/yr
Total		**9,700 metric ton/yr**

Roughly 80 percent of the heat demand is met by waste heat from the rolling mill at Nová Hut. During work interruptions at the mill, the heating plant at Nová Hut will cover heating demands from the system. The use of a waste-to-heat source in the rolling mill does not require any additional fuel consumption, nor does it increase the production of emissions. However, the supply of heat from the Nová Hut co-generation plant to the

[4]Emissions figures have been rounded, but original percentages have been maintained.

town of Vratimov will increase the total annual emissions of the plant by 3 tons of SO_2 and 1 ton of NO_x. These emissions are released from a smokestack at a level of 750 feet. Therefore, the dispersion of pollutants in the surrounding area is more diffuse than under the coal-fired system, which used low chimneys located in the center of Vratimov. The improved dispersion holds even during temperature inversions.

The block boilers that were replaced in Vratimov had chimney openings at the rooftop level of the majority of the surrounding residential buildings about 50 feet above the ground. However, this is only about half the height of the four directly neighboring eight-story residential buildings, which house approximately 400 residents. Shutting down the 16 old boilers and eliminating their emissions drastically improved air quality in this area, which is the most densely populated part of Vratimov.

How This Program Could Be Expanded

The SEF, which provided assistance to Vratimov, is similar the CEA energy efficiency program and the PHA (see Case Numbers 1 and 2) in that many additional projects could be implemented if funds were available. The basic problem with the SEF is the fact that the growing number of successful environmental projects has reduced the number of polluters paying fines into the fund. The SEF's success may be its own worst enemy--as the environment improves, pollution fines (the primary source of revenue for the fund) shrink.

The opportunity to use waste heat in Vratimov was relatively unique among SEF projects. Most projects in the program focused on conversion to natural gas. However, there have been several project proposals for using industrial waste heat to generate savings in municipal heating systems.

Overcoming Barriers

One of the most serious impediments to investing in heating systems is the presence of heat subsidies for Czech households. Currently, the federal government provides direct heating subsidies to owners of residential buildings. However, proposals exist to phase out these subsidies over a three-year period. The elimination of heat subsidies would correspond with the introduction of social support programs targeted at individual households. The price of heat would be further regulated (cost-based regulation), and owners of residential buildings would pay the demonstrated supply costs.[5]

[5] Czech Ministry of Finance ruling, Article 01/96.

Direct grants are another way to encourage investment in efficient district heating systems. Grants can be used to offset the cost of energy efficiency projects in residential buildings connected to district heating systems. If an energy audit shows a potential for savings, the owner of the building should be entitled to state funding to realize this potential. The results of an energy audit could serve as the basis for obtaining state support.

Conclusions

Measures to Reduce Emissions

In the past, the positions of the Czech government, and therefore of the Czech Ministry of Environment, were affected mainly by efforts to carry out economic reforms. Any expenditures burdening the state budget were difficult to approve and frequently became a source of conflict within the government. Therefore, the Ministry of the Environment avoided budgetary requests for climate-related expenditures unless expenses were negligible or the program could be justified easily on economic grounds.

The Czech Republic must increase its level of engagement in international efforts and leverage public support for environmental issues to implement GHG reduction measures. The National Climate Program of the Czech Republic has been one means of taking a more active stance towards climate change issues. The program was established in 1992 and has focused primarily on research, education, and information dissemination. The National Climate Program also supervised the Czech Country Study, which was financed primarily by the United States. The study provided valuable information to officials at the Ministry of Environment, and the Czech public. The National Climate Program also initiated several proposals for future programs to reduce GHG emissions.

Overcoming Barriers that Transcend Specific Sectors

The low tax rate on energy in the Czech Republic was based on the theory that easy access to cheap materials and energy was a necessary condition for the successful development of modern society. This concept has since been discredited. In the long-term view, low energy prices for end users can cause serious environmental damage. The advantages of artificially low prices are outweighed by adverse environmental impacts, which primarily affect future generations. Proposed increases in energy taxes are currently blocked by social policies.

All energy sources should be subject to a full value-added tax (VAT) of 22 percent, which is the general tax rate specified by Czech tax law. They should not be subject to a 5 percent tax (the preferential tax rate specified by Czech tax law). The 5 percent energy tax should be reserved for renewable energy sources meeting all environmental protection guidelines.

Introducing taxes on hydrocarbon fuels and energy consumption will give consumers an incentive to use raw materials and energy more efficiently. These new energy taxes are designed to shift the tax burden from the workforce to consumers of nonrenewable fossil fuels. These taxes would represent an extremely wide-ranging systemic change in the Czech economy that could be introduced without having to analyze changes in economic

behavior. Policy-makers, however, would have to ascertain whether the intended behavioral changes actually ensued and adjust the level of the tax if necessary.

Another potentially effective measure would be to grant tax exemptions for gains on municipal bonds. Czech income tax regulations specify that interest on bonds is taxed at a rate of 25 percent.[6] This tax, which is paid directly by the remitter, also applies to municipal bonds. Exempting municipal bonds from income taxes would make more investment resources available for municipal infrastructure projects. A portion of the gains on capital bonds could be invested in projects to reduce CO_2 emissions such as municipal conversion to natural gas, energy efficiency projects in residential and public buildings, and the construction of energy-efficient buildings such as retirement homes and hotels.

Many of these measures will probably not be included in the next version of the National Communication to the FCCC because of the reluctance of the Czech government to burden the state budget with expenditures that could slow economic reform. Nevertheless, information on these measures and the their potential exists should the opportunity arise. It is understandable that the quantification of the effects of individual measures is highly controversial. A long-term statistical baseline for these calculations does not exist. Any estimate of the actual effects of reducing emissions must be continuously updated.

Implementing the proposed measures is largely a political question. At the same time, it is clear that the policy of underestimating environmental problems is not the concern of the government cabinet, but to a large degree develops from economic possibilities and public opinion. Widespread popular support for a clean environment is quickly overshadowed by concerns about economic costs. Few Czechs are willing to pay for environmental measures--they consider environmental quality to be an automatic right rather than an issue that the government should address at the expense of taxpayers. It will be necessary to continuously raise the consciousness level of the public regarding environmental preservation and local responsibility for the global environment.

The following barriers hinder the further development of climate protection programs in the Czech Republic:

- Global environmental issues do not hold an important position in the governmental decision-making process.
- Difficulties with economic restructuring leave little room for other problems in government discussions.
- Political decisions are often based on a short-term perspective, while issues with long-term benefits are often postponed.
- Problems associated with the environment and with energy efficiency are treated

[6] Czech Government, *Article 586/1992 Sb. of the Czech National Council* (November 20, 1992).

separately by the Ministry of Environment and the Ministry of Industry and Trade, respectively.

- Expenditures on the environment and energy savings are not coordinated--the SEF handles environmental expenditures, while the Ministry of Industry and Trade handles energy efficiency expenditures.
- The government is already spending large amounts of money to improve local air quality by reducing emissions of SO_2 and ash, making it difficult to approve additional programs.
- The Czech coal industry and companies involved with coal production form a powerful political lobby.
- Project developers must contend with a shortage of financing with longer terms of repayment (8 years or more).

Most of these barriers are gradually being eliminated, but such changes occur very slowly. Cooperation on climate issues at the international level is slowly increasing because of the Czech Republic's obligations under the FCCC. Continuing these international cooperative efforts will be critical to accelerating the development and acceptance of additional Czech programs and policies that benefit the global climate.

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Appendix

Overview of Recent Economic and Energy Trends

After a drop in GDP in the early 1990s, the Czech economy turned around and has been growing rapidly since 1995. The annual rate of inflation has stabilized under 10 percent. In 1996, the annual adjusted rate of inflation from January to October was 8.9 percent. The rate of unemployment continues to be low. The average rate of unemployment in the Czech Republic is 3.2 percent. As of September 30, 1996 the highest unemployment rates were found in the following regions: Most (9.1%), Karviná (7.7%), and Louny (7.3%).

The biggest economic problem over the past two years has been the foreign trade deficit. This trend in the foreign trade balance is disturbing. The figure is significantly influenced by a low level of imports to the countries of Western Europe. The drop is partially compensated for by exports to Central and East European countries, particularly to Slovakia.

Total industrial production (in constant 1989 prices) increased by 9 percent in 1995 over the previous year. In absolute terms the level of production in current prices was 1.2 trillion CZK; in fixed prices, 528 billion CZK. In the course of privatization, there have been changes in the ownership structure of enterprises; the non-state sector currently accounts for 77 percent of industrial production. In the first half of 1996, the share of small- and medium-scale enterprises constituted 12 percent of this figure. In this respect, the industrial sector is beginning to resemble those of advanced market economies more closely.

Certain industries are also beginning to emerge as promising sectors within the Czech economy. These include the production of transportation-related goods, the coke and chemicals industry, oil refining, and other processing industries. These sectors are the main source of the increase in production; they are making gains in both output and productivity. As a result, these groups comprise 20 percent of total industrial production. Overall industrial production figures for 1989 to 1995 are listed in Table A1.

Table A1. Macroeconomic Indicators, 1989-1995

	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
GDP (CZK bil.) – current	525	567	717	803	923	1,037	1,138
GDP (%) in 1985 prices	110	108	93	87	86		
Industrial Production (current prices, CZK billion)						1,025	1,205
Foreign Trade Balance (CZK billion)						-21	-102
Level of Unemployment (%)						3. 2	2.9

Source: Statistical Yearbook of the Czech Republic ´95

Energy Intensity

Before 1989, high energy intensity was linked to the inefficient structure of production. From 1990 to 1995, fuel and energy inputs to the Czech economy decreased by 14 percent. However, the reduction in economic output meant that energy intensity in relation to GDP actually increased. This ratio began to decrease only after 1993. These trends are summarized in Table A2.

Table A2. Energy Intensity of the Czech Economy

	1990	**1991**	**1992**	**1993**	**1994**	**1995+**
Energy Intensity (MJ/CZK of GDP)	4.100	4.395	4.420	4.362	4.103	3.966
Index (%)						
--in relation to previous year	97.42	106.93	100.57	98.69	94.06	99.66
--1990 base year	100.00	106.93	107.54	106.13	99.87	96.50
	1990	**1991**	**1992**	**1993**	**1994**	**1995+**
Electricity Intensity (kWh/CZK of GDP)	0.123	0.134	0.139	0.142	0.142	0.142
Index (%)						
--in relation to previous year	100.42	108.94	103.73	102.16	100.00	100.00
--1990 base year	100.00	108.94	113.01	115.45	115.45	115.45

+Estimated

Source: *Energy Policy of the Czech Republic*–Draft (October 1996): 8.

Energy Balance

The energy balance for 1995 is presented in Table A3.

Table A3. Energy Balance, 1995 (PJ) – Preliminary Data

	Solid fuels	Liquid fuels	Gaseous fuels	Total fuels	Heat	Electricity	Total energy
Domestic natural resources	1209	6	8	1233	138	8	1369
Energy trade balance	-276	320	270	314		2	316
Drawing on inventories	29		-3	26			26
CR-SR balance	11	-5	1	7			7
Gross consumption of primary energy resources	973	321	276	1570	138	10	1718
Total losses						53	
Total end-use consumption	187	190	248	625	256	168	1049

Fuel Mix

The amount of hard coal produced in the Czech Republic dropped 32 percent from 1989 to 1995. The balance of imports to exports was over that period roughly -4 kilotons (kt). Brown coal and lignite exports decreased from the 10 kt to 6 kt, particularly with the effect of decreasing supplies to Slovakia. Black coal is primarily used for coke production, while brown coal is used to produce electricity. However, both are also used to households.

Crude oil is imported almost exclusively from Russia via Ukraine and Slovakia. The risk and vulnerability of these supplies have prompted the Czech government to secure additional sources by constructing a 215-mile pipeline from Ingolstadt (Germany) with a capacity of 190,000 barrels/day. Fuel oil is almost never used to heat households practically never comes into consideration because of prohibitively high prices

The Czech Republic has only a small amount of natural gas from domestic oil and coal beds. Other gases are predominately derived from solid fuels (coke, blast-furnace, generator gas, and town gas). This year, the production and distribution of town gas was terminated. Imports from Russia are the only significant source of natural gas in the Czech Republic. Because the gas pipeline from Russia also supplies Western Europe, the reliability of these supplies is not as risky as those with crude oil. The Czech government now purchases this gas with hard currency instead of through the earlier bartering system. Therefore, the amount of supplies is dependent on the country's foreign trade balance. While the gas supply is constant throughout the entire year, domestic consumption fluctuates, necessitating a series of underground storage facilities.

Electricity is produced from fossil, nuclear, and hydroelectric sources. In practice, the structure of electricity generation did not change much from 1989 to 1995. A more striking difference can be seen in comparison with 1985, where the composition was 93% from steam power plants and only 4% from nuclear sources. Environmental considerations have led to an effort to phase out the oldest and least efficient generating units, which burn high-sulfur brown coal. Temelín, a nuclear power plant now under construction, will have an installed capacity of nearly 2,000 MW. Assuming the originally planned shut-downs of obsolete units at steam power plants, the structure of electricity production would change to the following structure:

- 54% from steam power plants
- 11% from hydro-electric power plants
- 35% from nuclear power plants

Heat is the other significant source of energy for industry, households, processing, and conversion. The following summary is limited to centralized heating (in the form of steam or hot water). Heat distributed from heating plants primarily serves large housing developments. Heating plants are advantageous because they can increase the efficiency of energy conversion from roughly 30 percent for electricity production to 70 to 80

percent in a cogeneration system. For the most part, heating plants are constructed in the direct vicinity of housing developments; and therefore they generally burn higher-grade fuels.

Energy Consumption Trends

In regard to energy consumption, it is envisaged that one of the biggest changes in fuel consumption over the next several years will result from switching from various fuel sources (primarily coal) to natural gas. The Transgas company estimates that demand for natural gas will approximately double from 1993 to 2005, with the heat generation and commercial sectors accounting for the biggest changes and more modest growth in the industrial and household sector.[1] Demand for gasoline is also expected to increase as household incomes rise and the level of cars per capita moves to average level of European OECD countries over the next decade (at present, the level of car ownership in the Czech Republic is about two thirds of European OECD country levels.)[2]

The medium- and long-term energy policies of the Czech government will focus on harmonizing standards in the Czech energy sector with those of the European Union. Practically speaking, this means a decrease in the country's dependence upon solid fuels (coal, coke, wood, etc.) from approximately 60 percent in 1996 to 40 percent by the year 2005. The electric energy sector will be primarily influenced by the following developments:

- Bringing the Temelín nuclear power plant on-line;
- Maintaining operation of the Dukovany nuclear power plant;
- Reducing the output capacity of coal-fired power plants to 25 percent below 1990 levels;
- Implementing desulfurization and denitration at power plants with an output greater than 6,000 MW, thereby meeting international obligations;
- Operating the electricity system according to UCPTE system conditions.[3]

Coal will also be gradually replaced as a source of heat, or will be increasingly used for cogeneration. Improvements are also planned for legislation, business conditions, statistics, and reporting standards in the energy sector in conjunction with the goal of bringing the Czech Republic up to European Union standards.[4]

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[1] "Energy Policies of the Czech Republic: 1994 Survey," *International Energy Agency*, OECD, Paris (1994): 133.

[2] Ibid., 188.

[3] "Energy Policy of the Czech Republic (proposal)," *Ministry of Industry and Trade*, Dept. 4020, (21 October 1996): 21.

[4] Ibid., 34.

Fuel and Energy Prices

Fuel and energy producers and suppliers, particularly those using a distribution network (gas, heat, or electricity), have a natural monopoly. In a situation where a supplier or producer of energy is also the owner or co-owner of the distribution network, it is necessary to put into place, at least for a transition period, certain regulatory measures to the degree that market forces are not in effect. The government body concerned with energy pricing is the Department of Finance, which gives rulings on prices and establishes a list of commodities with regulated prices. Only the Ministry of Industry and Trade may submit proposals to change regulated energy prices. Table A4 provides an overview of the energy price regulations currently in place.

Table A4. Current Energy Pricing System[5]

	Intra-Sector Regulation of Supply Prices			**Final Prices For:**	
	CEZ → Distribution Companies[6]	**Transgas → Distribution Companies**[7]	**Heat Plants and Distributors → Building Owners**	**Households**	**Other Customers**
Electri-city	Set by the Ministry of Finance since 1996			Tariff ceilings apply for the entire country	Tariff ceilings apply for the entire country
Gas		Price ceilings set for eight distribution companies		Tariff ceilings that vary by region	Price ceilings for eight distribution companies
Heat			Prices determined on a cost basis	Tariff ceilings that apply to the entire country	Prices determined on a cost basis

Note: CEZ (Czech Power Utility) is the main electricity producer in the Czech Republic. Transgas (Czech Gas Utility) imports and transfers natural gas.

At present, the government gives a subsidy of about 80 CZK for every GJ of heat consumed in households--a major disincentive to saving heat. The Czech Ministry of

[5] "Conference Proceedings AEM 'Price Regulation,'" *Association of Energy Managers*, Prague (21 March 1996): 5 (with modifications by the authors).

[6] Privatization of the energy sector in Czechoslovakia and, later, the Czech Republic resulted in the creation of CEZ (Czech Power Utilities) in 1992. CEZ controls approximately 80% of electricity generating capacity. Privatization also created 8 regional power distribution monopolies. See *International Energy Agency* (1994): 54-55.

[7] The gas distribution system in the Czech Republic was privatized in a manner parallel to that of the electricity sector, leaving Transgas as the central integrated transmission and supply company together with 8 regional distribution companies. See *International Energy Agency* (1994): 54-55.

Finance expects that heat subsidies will represent about 6.9 billion CZK from the state budget for 1996.[8]

The Ministry of Finance plans to impose an average 15 percent increase in maximum prices for gas and electricity for households through the year 2000.[9] Additionally, average electricity prices for the residential sector are expected to nearly double by the year 2000, thereby bringing them close to the level of those for the industrial sector.[10]

Fuel and energy prices are influenced by excise duties, value added prices (VAT), state grants and price regulations. Price regulations are implemented not only because of natural monopolies, but also for social and environmental reasons. Price regulations are implemented by either price capping or cost-based regulations. No price regulations affect coal, which is open to free- market forces. The only tax is a VAT charge of 5%. Gas prices are regulated by both price-capped and cost-based systems, differently for residential and other consumers. Table A6 provides a summary of energy prices related to a uniform heat equivalent.

Table A6. 1995 Fuel and Energy Prices ($/GJ)

Fuel/Energy	Residential Price	Other Customers
Brown coal (lignite)	1.81	1.66
Bituminous coal	1.73	1.51
Coke	3.16	3.50
Light fuel oil	5.61	5.61
Heavy fuel oil	2.79	2.79
Natural gas	3.09	4.10
District heat	6.14	9.27
Electricity	10.36	17.78

It is evident that brown coal and bituminous coal are the cheapest residential heating commodities and are thus used by the majority of the population (particularly low-income households) for heating purposes. Heavy fuel oil is not suitable, owing to a high sulfur content and the necessity of preheating prior to ignition. Coke is preferably used in limited areas with large population density, where it is partly subject to state or city subsidies. Light fuel oil prices are prohibitively high.

[8] "Heat Price Subsidies versus Support for Energy Efficiency," *new at SEVEn*, Vol. 4, No. 4 (October 1996): 1.

[9] "Conference Proceedings AEM 'Price Regulation,'" *Association of Energy Managers*, Prague (21 March 1996).

[10] "Conference Proceedings AEM 'Electricity Prices and Tariffs,'" *Association of Energy Managers*, Prague (10 April 1996): 29.

Energy Legislation and Policy

Energy legislation was first introduced in the Czech Republic following World War II. The strong role of the government was evidenced by the existence of the Ministry of Fuels and the Central Power Administration (and later the Ministry of Fuels and Energy).

The main differences between pre-1989 and post-1989 legislation concern changes in the structure of ownership and in the extent of state intervention. State intervention in the energy sector continues to be conducted through laws, decrees, and government directives. In the past, the main laws were as follows:

- Article 79/1957 Sb. on the production, distribution, and consumption of electricity (the electricity law)
- Article 67/1960 Sb. on the production, distribution, and utilization of gas for heating (the gas law)
- Article 89/1987 Sb. on the production, distribution, and consumption of heat (which replaced the decree of the Central Power Administration, Article 38/1963 Sb. on setting up and operating facilities for producing and distributing heat)
- Article 88/1987 Sb. on the State Energy Inspectorate (which replaced Article 64/1962 Sb. on increasing the range of the activities of the State Energy Inspectorate)

These laws were modified, updated, and supplemented by an entire array of decrees and government directives following the political changes in 1989. The aforementioned laws were aggregated in a single law, "Article 222/1994 Sb. on the activities and power of state administration in energy sectors and on the State Energy Inspectorate (the Energy Law)," which went into force on January 1, 1995. The Energy Efficiency Act, which has been under preparation since the beginning of 1995, has not yet been passed. Three bills have already failed to make it through the approval process.

An energy policy for the Czech Republic was approved for the first time in February 1992. This document has undergone substantial changes since it was first approved. It has been affected by the division of Czechoslovakia into two independent states, the strengthening of relations between the Czech Republic and the European Union, the convertibility of the Czech crown, and economic growth trends. In addition, a significant number of energy companies were privatized, the prices of some commodities were deregulated, the Czech government voted to complete the Temelín nuclear power plant, and the oil pipeline from Ingolstadt was completed. All of these developments have made it necessary to rework energy policies. Unfortunately, modifications have not yet been approved by the government; recently the policy was once again returned to its developers at the Ministry of Industry and Trade.

Environmental Legislation and Policy

Environmental legislation is a complicated and opaque area. Environmental provisions appear in many different laws and decrees outside of the environmental field. In addition, environmental laws and decrees are frequently modified, supplemented, and

altered. The situation has been complicated by major political changes in 1989 and 1992, the establishment and closure of a federal committee for the environment (1990-1992), and the establishment of the Czech Ministry of the Environment.

Several directives concerning the environment existed before 1989, including:

- Article 130/1974 Sb. of the Czech National Council on state administration of water management;
- Article 35/1975 Sb. of the federal government on water-management regulation;
- Article 44/1988 Sb. on conserving mineral resources (the so-called mining law);
- Article 20/1966 Sb. on health care for the people, including regulations for the provision and creation of living conditions and on fines for violating these regulations according to Article 36/1975 Sb.;

A number of other provisions existed in areas ranging from air pollution monitoring and vehicle emissions to conservation of arable land. The main body of environmental law of the former Czechoslovak Socialist Republic was established in "Principles of the state conception of protecting the environment and natural resources" (Governmental Decree 226/1985). While a good number of regulations existed, they were promulgated in different time periods by different government bodies with little coordination, and exceptions were frequently made.

Current laws focus on economic mechanisms for supporting environmental protection an on penalties for non-compliance, including the following:

- Law on protecting the atmosphere from pollutants (Article 309/1991 Sb. and the subsequent Article 211/1994 Sb.);
- Law on the environment (Article 17/1992 Sb.);
- Law on the State Environmental Fund (Article 388/1991 Sb. of the Czech National Council);
- Law on state administration to protect the atmosphere and penalties for polluting it (Article 389/1991 Sb. of the Czech National Council, updated under Article 212/1994 Sb.);
- Law on waste (Article 238/1991 Sb. in Article 300/1994 Sb.);
- Law on state administration of waste management (Article 311/1991 Sb. of the Czech National Council, supplemented with Article 466/1992 Sb. of the Czech National Council);
- Law on protecting nature and the countryside (Article 114/1992 Sb. of the Czech National Council);
- Law on protecting agricultural land (Article 334/1992 Sb.);
- Law on forest management (Article 289/1995 Sb.);
- Law on the Czech Environmental Inspectorate (Article 282/1991 Sb. of the Czech National Council) and the aforementioned laws on protecting water resources, etc.

The tax code also specifies tax breaks for power generation from hydro and wind sources and for heat generation from heat pumps, geothermal, biogas, and biofuels. Business activities directed at protecting the environment receive are also eligible for subsidies and loans.

The State Environmental Fund of the Czech Republic offers grants and loans for waste-water processing plants, public sewage treatment facilities, gas conversion of boilers, and clean-up of old storage facilities. The state has also accepted a financial role in meeting environmental obligations in the privatization process. The revenues of the State Environmental Fund come primarily from fees and penalties for not meeting obligations to protect the environment or for environmental pollution. The financial sources come from fees and penalties for extracting water from streams and rivers and from underground sources, for releasing waste water into surface water, and for polluting the atmosphere. They are also made on the basis of a proclamation by the Czech Environmental Inspectorate.

Greenhouse Gas (GHG) Emissions

Emissions of particulates and gaseous pollutants have been monitored by the Register of Emissions and Atmospheric Pollution Sources (REZZO) since 1980.

An inventory of greenhouse gas (GHG) emissions was carried out for the first time for 1990, and it included both CO_2, CH_4, N_20 a CFC and precursory ozone creators (CO and NO_x). The inventory break-down was conducted in accordance with IPCC/OECD methodology, with the exception of chlorofluorocarbons (CFCs), which were not included in the methodology.

Table A6 Summary of Greenhouse Gas (GHG) Emissions, 1990-93

Emissions (Gg)	CO_2	CH_4	N_20	NO_x	CO	NMVOC
1990	163,209	888	26	863	695	311
1991	148,115	814	23	796	587	243
1992	134,179	768	23	770	522	234
1993	129,208	732	21	746	507	229

As Table A6 indicates, CO_2 predominates among GHG emissions. Not accounting for the carbon-absorbing effect of forests, the energy sector accounts for 97 percent of CO_2 emissions. While solid fuel use decreased, the share of CO_2 in that category was still greater than 70 percent.

The causes of the reduction in GHG emissions are interrelated. Lower industrial activity led to a lower consumption of fuels and energy. Another factor was the changing fuel structure and the reduction in solid fuel use. The drop in CH_4 emissions can be attributed to decreases in mining black coal, and thereby also methane and its partial utilization for

energy-related purposes, that is, there is an exchange of CH_4 emissions for those of CO_2. The absorbing capacity of forests in regard to CO_2 is a significant factor dependent on forest management. In the given years it increased from 1 percent to 4 percent. The transportation sector accounts for up to 6 percent of CO_2 emissions and up to 20 percent of NO_x emissions. This sector will come under increasing scrutiny both because it is expanding and because it is a cross-cutting sector with a very strong impact on environmental quality. Table A7 provides estimates of the potential for mitigating GHG emissions in the Czech Republic.

Table A7. Analysis of Selected Potential Mitigation Measures in the Czech Republic

Measure	Estimated CO_2 Reduction Potential	Estimated Cost to Federal Budget	Estimated Benefit to Federal Budget	Estimated Costs per Unit Saved
	(1,000t CO_2/yr)	($ million/yr)		($/t$CO_2$)
Eliminating Heat Subsidies to Czech Households	126	negative cost	127	Negative cost
Increasing the VAT on Energy to 22 Percent	2,000	negative cost	182	Negative Cost
Converting a Portion of Heat Subsidies to Energy Efficiency Subsidies	250	12	--	49
Supporting Mortgages for Energy-Efficient Buildings	120	12	--	96
Establishing a Fund for Energy Efficiency Projects	10	1	--	100
Facilitating the Leasing of Energy-Efficient Technologies	400	10	--	25
Providing Grants for Investments in Renewable Energy	270	18	--	65
Providing Grants for Afforestation Projects	1,860	5	--	3
TOTAL	6,038	58	309	

Sources for Material in Appendix

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