Climate Change Mitigation: Case Studies from Poland

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CLIMATE CHANGE MITIGATION: CASE STUDIES FROM POLAND

Henryk Gaj
Maciej Sadowski

Susan Legro (editor)

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Advanced International Studies Unit
Pacific Northwest National Laboratory
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Foreword

The Advanced International Studies Unit (AISU) of Pacific Northwest National Laboratory developed a series of case studies from 5 countries 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 Polish approaches to mitigation. This research captures the essence of AISU's approach to environmental problem-solving. First, the following report addresses an applied, global policy issue. It also focuses on policy tools that enhance economic well-being. Finally, it provides a first-hand analysis from experts in the host country being studied.

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William U. Chandler
Director, AISU

For further information about the work of AISU, contact:

Advanced International Studies Unit
Pacific Northwest National Laboratory
901 D St., SW Suite 900
Washington, DC 20024 USA
Telephone: 202-646-5242
Fax: 202-646-5233
Internet: http://www.pnl.gov/aisu

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Introduction

Poland's economic fortunes were similar to those of other transition economies in the late 1980s and early 1990s: a declining gross domestic product (GDP) accompanied by rapidly rising inflation and unemployment. The effects of the economic crisis on energy use were dramatic. Primary energy consumption in Polish industry fell by 28 percent between 1989 and 1993. Reduced industrial output was responsible for 27 percent of the decrease, and economic restructuring was responsible for the remainder. While the overall energy intensity of the Polish economy decreased during the economic crisis, Polish industry actually became more energy intensive during the same period.

In June 1992, Poland signed the United Nations Framework Convention on Climate Change (FCCC) with over 150 other countries. Poland ratified the FCCC in July 1994 and became a party to the FCCC on October 26, 1994. In early 1995, Poland provided its National Report to the FCCC Secretariat and then presented the report to the First Conference of Parties in Berlin.

By ratifying the FCCC, Poland accepted the same obligations as other Annex I countries. The most important of these obligations is, *"... returning by the end of the present decade to earlier levels of anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol ..."* (Article 4, paragraph 2a). The year 1990 was generally indicated as the reference year for the emission stabilization (Article 4, paragraph 2b). Countries with Economies in Transition were allowed by the Convention to apply *"... a certain degree of flexibility ... with regard to the historical level of anthropogenic emission of greenhouse gases ..."* (Article 4, paragraph 6). Poland made use of this option and adopted 1988 as its reference year.

As part of the U.S. Country Studies[1] process, a Polish team of experts identified and analyzed 50 technological greenhouse gas abatement options for various sectors of the economy (see Appendix II for a summary of these options). Implementing all 50 options could reduce greenhouse gas emissions by 187 million metric tons of CO_2 equivalent for the year 2030, or 30 to 40 percent of Poland's reference case emissions.

[1] The U.S. Country Studies Program, which was announced by President Clinton in 1992, provides technical and financial support to 55 countries for climate change research. The abatement study was conducted as a part of Poland's Strategic National Action Plan (SNAP).

Case Study 1: Geothermal Energy in Poland

Background

Poland has a long tradition of using its geothermal waters for therapeutic purposes, but in the late 1980s, usage expanded when a geothermal energy program was launched. Geothermal water has been studied in four geothermal provinces in Poland, and an estimate of the country's geothermal energy reserves is provided in Table 1.

Table 1. Geothermal Energy Reserves in Poland

	Area (thousand km^2)	**Water Resources** (km^3)	**Energy Resources** (million toe)
Polish Lowlands Geothermal Province	220	6,200	32,500
Fore-Carpathian Geothermal Province	20	400	1,600
Carpathian Geothermal Province	10	100	700

A special company, the Polish Geothermal Association (PGA), was created to oversee geothermal energy development. The PGA is currently assessing Poland's geothermal potential, and it cooperates with other institutions to design complete geothermal plants with heat distribution systems.

Approach

Two PGA projects have been financed to date. Polish funds for the projects have been provided by the Polish state budget through the Committee for Scientific Research and the National Fund for Environmental Protection and Water Resources. The World Bank has also provided financing for the projects.

In 1993, an experimental geothermal heat plant was completed in Banska-Bialy Dunajec in the Podhale subbasin of the Carpathian province. Hot artesian water (2.6 MPa) is recovered from a bore hole in karst limestone from the Triassic and Eocene Periods. After flowing through a heat exchanger, the water is returned to the reservoir through a complementary recharge well drilled about 1 km away. Captured heat is used to dry wood, heat greenhouses, and warm the water in a local fish hatchery. Since 1995, the project has also provided heat to nearly 200 farmers in remote areas of the region.

In 1996, another geothermal heat plant was completed in Pyrzyce (near Szczecin), in the northwest part of the Polish Lowlands Geothermal Province. Here, heat is extracted from water derived from Liassic formations using two wells with doublets. The 50-MW geothermal heating system, which is also linked to gas boilers for peak seasons, serves approximately 14,000 inhabitants. Figure 1 lists several of the basic characteristics of the two projects.

Figure 1. Characteristics of PGA Projects in 2 Polish Towns

Plant Characteristics	
Banska-Bialy Dunajec: Number of Wells: 2 Depth: 2,500 m Flow: 70 m^3/h Temperature: 80 ^{0}C Salinity: 3 g/l	Pyrzyce: Number of Wells: 4 Depth: 1,700 m Flow: 400 m^3/h Temperature: 64 ^{0}C Salinity: 100 g/l

Several follow-up projects are also planned. For example, four additional wells are planned for the area surrounding the existing geothermal plant at Banska-Bialy Dunajec. All of the new wells will be double recharging wells. Heat exchangers and distribution pipelines will be constructed to supply hot water to the Bialy Dunajec, Poronin, Zakopane, and Nowy Targ townships; home to approximately 70,000 potential customers. The geothermal heating system will be linked to gas boilers that operate in the winter during peak demand for heat. The project's cost is estimated at approximately $170-180 million.

A plant based on 70 ^{o}C geothermal water extracted from Liassic rocks is being built at Skierniewice. The supply well has already been sunk and the recharge well is nearing completion. The plant will serve a municipal heating system and the nearby Institute of Horticulture greenhouses. A third plant is being built at Mszczonów that will use water from a Lower Cretaceous formation. Again, gas boilers will supplement the heat supply during peak demand. Finally, an existing well is being deepened from 700 to 2,000 meters at the Cieplice Spa in order to build a small geothermal plant (4 to 5 MW) for heating the spa premises and expanding its hydrotherapy facilities.

Project Evaluation

Project Costs

The geothermal plant in Banska-Bialy Dunajec cost approximately $1 million. Additional funds were spent for peripheral purchases, such as district heating system components and greenhouses. The geothermal heat plant in Pyrzyce cost $8 million, and the district heating system cost $9 million. The pay-back period for this investment has been estimated at 6 years.

Project Benefits

A major environmental benefit resulted from the two PGA projects--a reduction in air pollution by avoiding fossil fuel combustion. Table 2 estimates emissions reductions in the PGA projects.

Table 2. Emissions Reductions from 2 PGA Projects

PGA Project	Sulfur Dioxide (SO_2) Reduced per Year	Nitrous Oxides (NO_x) Reduced per Year
Banska-Bialy Dunajec	10 Mg	3 Mg
Pyrzyce	190 Mg	50 Mg

The projects also produced climate benefits. In Banska-Bialy Dunajec, emissions reductions were estimated at 4,300 tons of CO_2. In Pyrzyce, 25,000 metric tons of CO_2 reduction were attributed to geothermal energy and approximately 30,000 metric tons of CO_2 reduction were associated with complementary gas boilers.

How This Project Could Be Expanded

Poland's geothermal energy potential is estimated at 40 PJ/year, or approximately 6 percent of total heat consumption. Several other plants are planned for the near future to extract hot water from Jurassic and Cretaceous rocks. Detailed plans already exist for projects in the Polish Lowland towns of Zyrardow, Inowroclaw, Mogilno, Kruszwica, Bydgoszcz, and Pultusk. Water from Jurassic and possibly also Devono-Carboniferous formations has also been targeted in the Fore-Carpathian Geothermal Province in Tarnów.

A certain level of subsidies (approximately 30 percent of investment costs) is required to make geothermal plants economically effective as compared to traditional heating systems. These subsidies can be preferential credits or direct grants. On the other hand, district heat is still subsidized in Poland. In the current system, heat subsidies implicitly support the use of fossil fuel and discourage investment in nontraditional sources of energy. After Polish energy markets are fully liberalized, geothermal energy may become a competitive supply option in the heating sector. If the external environmental costs were considered, geothermal energy would be advantageous even in current energy markets.

In addition to the existence of subsidies for heat from fossil fuels, the other major barrier facing geothermal projects has been a lack of investment capital for project development. According to the Polish government, this lack of capital was the primary reason geothermal energy was only recently considered a viable source of heat. The World Bank loan to develop geothermal energy resources in Poland, therefore, was a necessary catalyst for implementing the PGA projects.

Case Study 2: Building Public Awareness through a Training Project

Background

The wasteful use of energy in Poland is the legacy of its previous system of central planning. Poland's ability to increase its energy efficiency will determine the country's ability to improve its economy and environment. About 50 percent of Poland's huge potential for energy savings can be found in small and mid-size cities. Thus, municipal governments have jurisdiction over decisions affecting these savings.

Unfortunately, municipal officials frequently lack awareness and knowledge of modern energy management methods that could capture these savings. A large and urgent need exists to educate and train these officials in effective energy management practices. An educational initiative was organized several years ago to address this need. The project was sponsored by the European Phare-TEMPUS program.[2]

Approach

Initially, three Phare-TEMPUS courses were conducted in Polish universities: 1) a postgraduate course on energy and environment at the University of Mining and Metallurgy, 2) a course on environmentally-friendly energy production and utilization at the Technical University of Gdansk, and 3) a course on energy planning at Jagellonian University.

The project team then received a Phare-TEMPUS "Complementary Measures" grant to extend the program and offer a series of training seminars on energy efficiency to municipal decision-makers. The new program was structured so that graduates of the first three projects were able to contribute to the new seminars. Figure 2 lists the Phare-TEMPUS project partners in the original three courses and the follow-on seminars for municipal officials.

Figure 2: Phare-TEMPUS Project Partners
Polish Network of Energy Cities (**PNEC**)
European Energy Cities Network
Portuguese Centro de Estudos em Economia da Energia dos Transportes e do Ambiente (**CEEETA**)
Polish Foundation for Energy Efficiency (**FEWE**)
University of Mining and Metallurgy
Jagellonian University of Kraków
Technical University of Gdansk
French Agence de l'Environnement et de la Maitrise de l'Energie (**ADEME**)

[2] Phare-TEMPUS: The Phare Program is an assistance program for Eastern European countries that was established in December 1989 by the Council of Ministers of the European Union; the acronym refers to the program's original focus (Polish-Hungarian Assistance in Restructuring of Economy). TEMPUS stands for the Trans-European Co-operation Scheme for Higher Education, a multicountry initiative under Phare.

The main objective of the new seminars was to "create or increase the environmental awareness of the local government of ***small and medium-size cities*** in Poland related to energy production and use." The project partners proposed to meet this objective by holding 17 training seminars in different parts of Poland. Each seminar dealt with one of the following topics:

- "Strategic Energy Planning at the Municipal Level" – These seminars provided trainees with basic, practical knowledge on identifying, designing, and implementing energy efficiency projects.
- "Possibilities of Financing Energy Efficiency" – These seminars introduced the legal framework for financing investments related to energy production, distribution, and use at the city level. Financing for energy efficiency projects was the primary topic of discussion, and examples of cost-benefit analyses were provided.
- "Energy Saving in Lighting" – These seminars described state-of-the-art technologies in energy-efficient lighting, including street lamps and compact fluorescents. Discussions about structuring lighting efficiency projects included case study presentations and tips on calculating pay-back periods.
- "Heat Saving Potential and Measures in Buildings" – These seminars focused on the technical aspects of efficiency projects such as auditing methods, relevant technologies, and financial analyses sensitive to current trends in the Polish economy.

Graduates of the previous three Phare-TEMPUS courses formed a pool of qualified instructors that served as the primary source of teaching staff for the seminars. Another important resource was the administrative capabilities and contacts of the Polish Network of Energy Cities (PNEC), an association of nine municipalities promoting sustainable energy policies. The Polish Foundation for Energy Efficiency (FEWE) also contributed its expertise in planning and implementing the training.

Of the 17 seminars, four focused on strategic planning, four on financing, five on heat savings, and four on efficient lighting. The seminars attracted 978 participants, exceeding the organizers' goal of 800. Participants from more than 200 different municipalities attended 200 lectures.

Most of the training sessions were presented by Phare-TEMPUS training course graduates (33), university or other scientific or research institute representatives (58), and consultants or industry representatives (43). Representatives from federal and local governments, banks, and utilities as well as 15 foreign lecturers also spoke.

Project Evaluation

Project Cost

The cost to implement the entire project was $100,000. The cost was relatively small considering the scope and potential effects of the project. Nonetheless, it would have been extremely difficult to find an in-country sponsor for the project because of a shortage of federal funds at the time.

Project Benefits

Economic savings resulting from the project are difficult to quantify. Nevertheless, estimates of the potential reduction in electricity demand from projects depending on improved energy management at the municipal level exist. For example, average annual savings from street lighting programs could total 6.7 GWh, or a 1 percent reduction in Poland's total electricity consumption.

Although it is difficult to measure changes in the level of environmental awareness quantitatively, most of the trainees learned to understand and define energy efficiency issues more effectively. In addition, there were several other indicators that the Phare-TEMPUS project leveraged improvements in Polish municipalities:

- Several cities participating in the training approached FEWE and PNEC asking for help in commissioning an energy master plan for their municipalities. At least 10 cities have commissioned such studies and several have completed them.

- Municipal officials trained at the seminars have attracted foreign and multilateral funding for energy efficiency projects in their cities. Examples include demand-side management projects in Elk, Chelmno, Zywiec, and Nidzica, a Dutch project in Tychy and Chelmno, and another international project in Trzcianka. Several cities began to modernize their street lighting as result of the contacts established during the seminars including Lublin, Bialystok, Brzozów, Skwierzyna, and several municipalities in the Bialystok region.

- PNEC's membership increased from 9 to 31 cities as a result of the program. Several new member cities have already appointed energy officers. The seminars created a community of about 30 officials who became acquainted during the seminars and have maintained their network of contacts. PNEC will fund periodic meetings of those people.

The institutional resources chosen for this project were effective. PNEC was a particularly reliable and useful partner; their involvement was crucial to the success of the seminars. Contributions from local heat and power utilities were also very important. The involvement of individual mayors and high-ranking local officials was also critical, as was the experience and knowledge of project consortium member from countries in the European Union.

The training project can be improved in several ways. For example, less emphasis can be placed on using advertisements to find training candidates. This can be done by utilizing regional legislatures (*sejmiki samorzadowe*) and local governments and their organizations, such as the Regional League (*Liga Krajowa*), which co-organized the very successful seminar in Czêstochowa. In addition, project administrators can address city councils directly or larger groups of interested city councilmembers or administrators. Follow-up activities in Pyskowice and Nowy Rybnik will use this approach in the near future.

One unexpected benefit of the project was free publicity for energy efficiency issues. The Phare-TEMPUS project received extensive coverage in the Polish media with almost no effort on the part of the project administrators. Stories on the project appeared in the weekly magazine for municipal administrators, *Wspólnota*, and on approximately 20 radio broadcasts and 4 regional TV programs.

Media interest in the subjects covered by the seminars is likely to continue.

Barriers to Implementation

The primary barrier in energy management training and networking in Poland before the Phare-TEMPUS project was a lack of funding for educational programs. Current needs far outstrip available funds in the national budget. Funding is not even available for cost-effective and inexpensive projects, such as Phare-TEMPUS, because state funds must be allocated to urgent concerns, such as health services, primary education, and national security. Therefore, the Phare-TEMPUS seminars required external financing. As the Polish economy recovers from the recession, the infrastructure created with the help of the Phare-TEMPUS funding and other similar sources of support will be able to be sustained with the use of increasing in-country financial resources.

A logistical barrier to implementation was recruiting candidates for the seminars. Although the projected number of trainees exceeded the number projected, the project organizers put an enormous effort into recruiting candidates. The organizers sent several thousand letters and faxes followed by telephone calls. They also distributed 2,500 posters, and made announcements in the media. The time and resources spent on this effort greatly exceeded the organizers' expectations.

The main reason for the sharp decrease in interest in training programs was the variety of courses offered in the spring of 1996. Many of these courses offered poor quality training by ad-hoc private commercial companies. Municipalities received dozens of course offers weekly, which as a rule ended up in a wastepaper basket without being read. Without the personal contacts and institutional support of PNEC and contributions by its member municipalities, the entire project might have failed.

How This Project Could Be Expanded

The Phare-TEMPUS project was given high marks by participants. Several participants suggested expanding the effort to involve more municipalities. The materials from all 17 seminars are being compiled into a four-volume manual for use by municipalities. PNEC is seeking funds for editing and publishing the manual.

The program has also created core group of trainers within PNEC. In particular, the energy officers of Bielsko-Biala and Tychy will lecture at the forthcoming seminars following the present training project. In addition, PNEC and Energy Cities Europe have applied for a "Complementary Measures" grant to continue training efforts, strengthen the PNEC, and provide specific in-depth training to the 20 most active participants in the municipal energy management seminars. PNEC has proposed to form a core team of municipal energy consultants from those active participants that would work in other Polish cities under the auspices of PNEC.

PNEC and its Portuguese partner, CEEETA, are also seeking support to extend the training seminars to Ukraine and Poland's other eastern neighbors. Representatives of the city of Lvov, Ukraine who participated in two of the municipal training seminars, have expressed a strong interest in this initiative. Representatives of other cities in Ukraine and Lithuania have also become interested in the project. PNEC has a unique advantage because of a regional similarity in languages (for Ukraine) and a common knowledge of Russian (for Lithuania).

Efforts are also underway to work with new constituencies in Poland. PNEC is also working with FEWE and *Liga Krajowa*, a training seminar co-organizer, to extend the training seminars to rural communities, where energy problems differ from those in the current target area of small and mid-size cities. PNEC has applied for a two-year “Complementary Measures” grant for this purpose. The project has even spurred the development of programs funded from in-country sources. For example, PNEC and the University of Mining and Metallurgy are organizing an extramural postgraduate course for municipal energy officers that will provide in-depth training in sustainable energy. The course will last for an entire academic year. PNEC has also organized follow-on activities.

The sharp increase in PNEC membership (from 9 to 31) has strengthened the organization financially and institutionally. PNEC will continue the training using its fund-raising capacity and teaching potential. The cooperation with experts from FEWE and academics from the University of Mining and Metallurgy during the project guarantees that energy management programs will continue even after the Phare-TEMPUS project ends.

Case Study 3: Industrial Restructuring as a Part of Macroecononmic Reform[3]

Background

Poland is an excellent example of a country where macroeconomic policies have had strong, indirect effects on the environment and greenhouse gas (GHG) emissions. Currently, the large potential for "costless" GHG reduction options in Poland could be realized in two ways: 1) restructuring the Polish economy, particularly the industrial sector, and 2) implementing GHG reduction options which are cost-effective under current policies. Industrial restructuring has already had a significant impact on GHG emissions, and it simultaneously addresses the economic inefficiencies of Poland's previous system of central planning.

Table 3. Key Factors Affecting Primary Energy Consumption in Polish Industry (PJ)[4]

Factors in Energy Consumption:	**1990**	**1991**	**1992**	**1993**
Production value	-370 (-24%)	-170 (-13%)	40 (+3%)	80 (+7%)
Structure of production	20 (+1%)	-20 (-1%)	-20 (-2%)	-10 (-1%)
Energy efficiency	130 (+8%)	30 (+3%)	-80 (-7%)	-70 (-5%)
Total change in energy consumption	-220 (-14%)	-150 (-11%)	-60 (-5%)	-5 (-1%)
Total energy use	1,300	1,200	1,000	1,000

Industrial energy consumption changed dramatically during the first years of the economic transition period in Poland. Table 3 illustrates the causes of this change, while Figure 3 below indicates the magnitude and scope of these changes.

An analysis of the changes reveals several trends. In 1990 and 1991, a decrease in direct energy consumption was achieved mainly due to a decline in economic activity. This decline was much greater than the decrease in energy consumption over the same period, leading to a decrease in energy efficiency. Energy consumption rates, remained relatively high for a country with negative GDP growth. Industrial production had dropped below optimized output levels, and Polish industry needed more than two years to adjust its production to vastly reduced demand and eliminate the most inefficient enterprises. In 1992 and 1993, energy consumption stabilized because increases in production were balanced by increases in energy efficiency.

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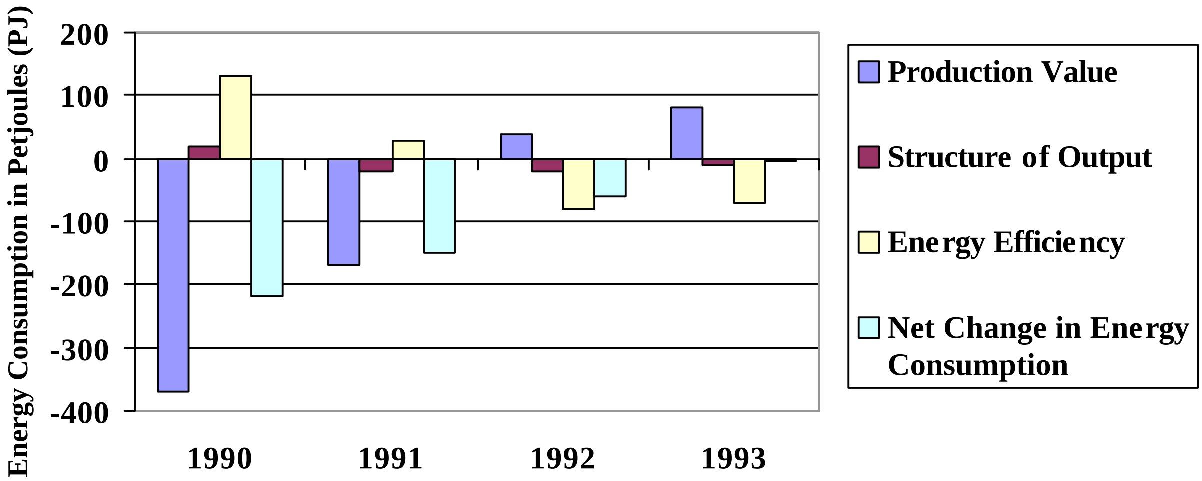
[3] After Pasierb et al. (1996).

[4] Changes are relative to the previous year.

Figure 3. Changes in Final Energy Consumption in Polish Industry, 1989-1993



Changes in consumption and improved efficiency resulting from a shift in the production profile from more energy-intensive to less energy-intensive branches were small (7 percent of the reduction in industry), but the trend is promising for the future. Overall, industrial sector energy efficiency improved in the 1989 to 1993 period, and the improvement continued in 1994 (Table 4). Continuing this trend would eventually lead to production at 1989 levels with much lower energy consumption.

Table 4. Key Factors Affecting Polish Industrial CO_2 Emissions (1,000 metric tons)

Factors in CO_2 Emissions:	**1990**	**1991**	**1992**	**1993**
Production Value	-47,800 (-24%)	-22,000 (-13%)	5,100 (+3%)	9,900 (+7%)
Structure of Production	-60 (- <1%)	-1,000 (-1%)	-2,100 (-1%)	-2,900 (-2%)
Energy Efficiency	18,400 (+9%)	6,000 (+4%)	-9,700 (-7%)	-7,900 (-5%)
Structure of Energy Carriers	-700 (- <1%)	-300 (- <1%)	-500 (- <1%)	-100 (- <1%)
Total Change in CO_2	-28,800 (-14%)	-15,400 (-9%)	-7,100 (-5%)	-700 (-1%)
Total CO_2 Emissions	172,000	157,000	150,000	149,000

Total GHG emissions from power and heat produced for industrial use decreased by 26 percent during the 1989 to 1993 period. The downward trend in GHG emissions continued throughout this period, despite an increase in industrial production towards the end of the period (by 3 percent in 1992 and by 7 percent in 1993). These figures indicate that changes in production structure and improvements in energy efficiency had begun to have an effect on energy intensity in industry.

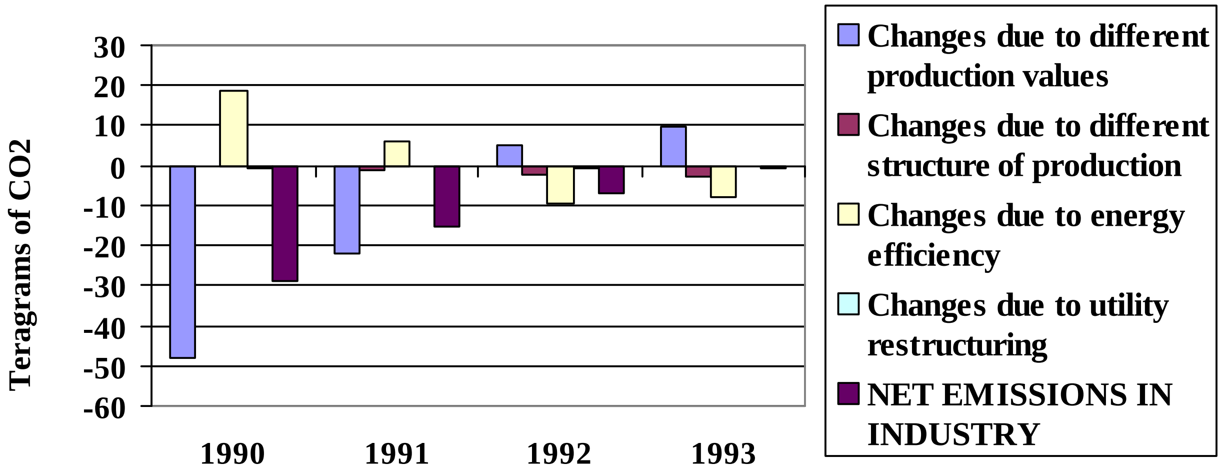


Figure 4. Changes in Carbon Dioxide Emissions in Polish Industry, 1989-1993

An analysis of changes in GHG emissions shows that emissions trends are similar to direct energy consumption trends. The energy carrier profile in the industrial sector did not change much, and thus had no effect on GHG emissions. Structural changes in industrial activity started to become an important factor in 1992, and its significance grew in subsequent years. A trend toward autonomous energy efficiency improvements also began in 1992.

Approach

FEWE developed and analyzed GHG emissions abatement scenarios for two scenarios for the industrial sector: *stagnation* and *baseline*. The *stagnation scenario* assumed economic growth with the production structure and energy intensity frozen at centrally planned levels. The *baseline scenario* assumed economic growth with changes in the production structure of industry but with energy intensity frozen at 1988 levels.

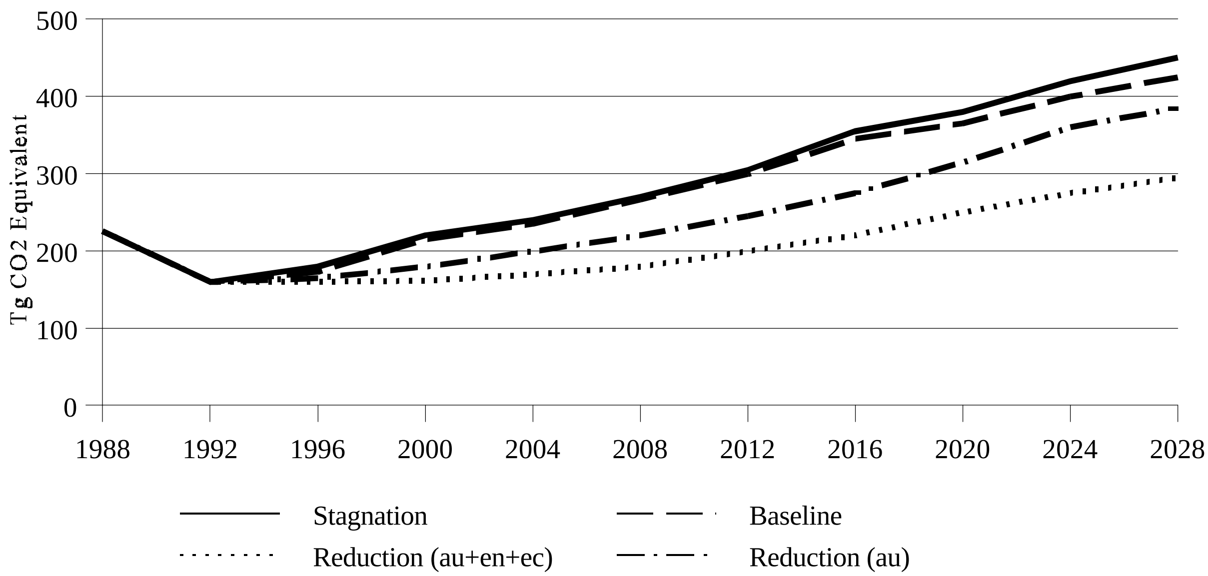
FEWE then divided the wide variety of GHG emissions reduction options in industry into three groups: (1) autonomous measures, 2) energy consumption-related measures, and 3) purely GHG-oriented measures. Figure 5 illustrates the impact of these options on industrial GHG emission reductions.

- *Autonomous measures (au):* These measures conserve energy and limit emissions by modernizing and restructuring Polish industry. A comparison of energy intensity in the steel, ammonia, cement, and paper industries in European Union countries versus Poland shows significant potential exists to reduce GHG emissions in Poland simply by improving industrial technologies. In Poland, steel production is more than 40 percent more energy-intensive than in European Union countries.

- *Energy measures (en):* Energy measures include quasi-technologies, or technologies that are applicable across various sectors of industry. Improvements from quasi-technologies can be realized by reducing energy costs with highly efficient boilers, pumps, electrical engines, and ventilators. Other technologies such as co-generation and energy management systems also reduce energy losses. In addition, highly efficient gas-steam combined cycle technologies for power production may also reduce airborne pollutants and GHGs.

- *Greenhouse gas emission reduction measures (ec):* These measures primarily focus on replacing solid fuels with hydrocarbon fuels (such as *inter alia* conversion of coal to gas-fired boilers, production of power and heat in industrial power generation plants in associated cycles with an increased use of natural gas). Gas and residual fuel comprise 41 percent and 5 percent, respectively, of total emissions. Changing this fuel mix through measures such as fuel-switching could potentially decrease GHGs in this category.

Fig. 5. GHG Emissions Forecast for Industry for Selected Scenarios through 2028.



Project Evaluation

These forecasts show a large role for programs that have an indirect effect on GHG emissions. Emissions reductions that are directly related to GHG reduction measures play a relatively small role in the total amount of GHGs reduced over time. It is reasonable to assume that the entire autonomous (au) category, and approximately 50 percent of the energy (en) category are comprised of no-regrets measures, or measures that reduce GHG emissions while providing significant economic and social benefits. No-regrets measures could have an emissions reduction effect of 100 million tons of GHGs by 2030, which is almost 20 percent of industrial emissions under the stagnation scenario.

Project Benefits

Polish macroeconomic policy since 1989 has led to the following changes and results:

- Introducing market mechanisms and liberalizing the economy, resulting in a gradual reduction in subsidies for heavy industry (metallurgy, hard coal sector); energy prices now tend to be defined by the market;
- Restructuring the regulatory system so direct regulations have given way to indirect regulations, enabling the government to encourage energy efficiency without damaging self-regulating market mechanisms;
- Restructuring Poland's export profile (Poland traditionally provided the Soviet Bloc with unfinished goods) to focus on countries in the European Economic Community; the change provided automatic incentives to improve the efficient use of energy and other natural resources; and
- Privatizing Polish industry, leading to diversified ownership and new companies that could compete in domestic markets and abroad.

How This Program Could be Expanded

Political parties and candidates in Poland are determined to continue the reforms started in 1989. Nevertheless, each group in power faces numerous constraints. Increased unemployment and the reluctance of workers to relocate to regions with new jobs are two formidable obstacles to reform.

In Poland, the next major target for macroeconomic policy is the hard coal sector. The threat of social unrest in coal-mining regions due to a reduction in employment is a very real possibility. Policies to overcome this barrier should be directed at improving the infrastructure of affected communities. This emphasis may improve the chances of acceptance of a given set of reform policies. Sample policies could include: 1) restructuring the local education system to train workers for high tech industries, 2) creating jobs in branches of higher processing industries and in the service sector for the coal region, and 3) creating interesting job opportunities and an infrastructure for moving workers to new regions within Poland. Implementing these policies will be costly, and the federal budget is limited. Therefore, a system of incentives will be critical to building support for restructuring.

Conclusions

Capturing the Potential for GHG Reductions in Poland

Significant reductions in GHGs can be achieved by correcting the structural inefficiencies in the Polish economy that were inherited from the previous system of central planning. Many of these reductions can also be captured by using economic policies that are not necessarily related to climate issues.

Reducing GHG emissions through the options outlined in this report appears to be cost-effective even in the absence of special climate policy measures. The case studies indicate that part of the potential for emissions reduction in Poland will be achieved through existing economic development and environmental protection programs. However, further reductions would be contingent upon special climate policy measures, which may cause the Polish economy to incur additional costs. With the proper climate policy mix, CO_2 emissions will not exceed 1988 levels[5] until the year 2030. In fact, this scenario is seen as the most probable baseline scenario for the country's medium-term development. If Poland restructured its economy more quickly, the country could theoretically stabilize emissions at a lower level.

<u>Barriers to Climate-Friendly Programs in Poland</u>

The costs of economic transition and associated restructuring have created difficult problems for the Polish government. Unemployment in noncompetitive economic sectors is a painful social problem. Coal mining, metallurgy, and agriculture are unable to compete in international markets, yet shutting down or dramatically reducing these industries would be politically and socially untenable. The Polish government has had to set a pace for structural change that will keep the country on track for acceptance into the European Union while still maintaining social acceptance. In this situation, imposing additional economic burdens on society because of climate policy commitments is politically unfeasible.

<u>Measures that Could Expand Climate-Friendly Programs</u>

External benefits from implementing GHG mitigation policies may balance economic costs to a large extent, and Polish society should be made aware of these benefits. Information campaigns and educational programs should be provided to improve public awareness. The Phare-TEMPUS project is a perfect example of this type of activity.

Improving financing mechanisms for climate change mitigation is very important for implementing mitigation policies. For example, revenues collected in the form of carbon taxes could be redirected to offset other taxes such as direct income taxes. These types of mechanisms might reduce the macroeconomic costs of climate policies substantially.

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[5] Poland chose its 1988 emissions levels as a baseline when becoming a party to the FCCC.

International cooperation is another important factor in climate policy implementation. Such cooperation is allowed by the FCCC and is well known under the name of Joint Implementation (JI) or Activities Implemented Jointly (AIJ). Poland has a positive attitude toward these initiatives. Criteria for JI projects have been established and approved by the Polish government. In addition, a JI Secretariat was created in 1996 to facilitate the process of approving projects.

Disseminating information on state of the art technologies that reduce GHG emissions is another important international issue for Poland. The Greenhouse Gas Technology Information Exchange (GREENTIE) network, which was organized under the auspices of the International Energy Agency and the Organization for Economic Cooperation and Development in response to the FCCC, is a good example of an international technology transfer program. Poland belongs to the GREENTIE network and has access to all relevant information.

Comments by Maciej Sadowski, Center for Climate Protection[6]

The case studies presented in this chapter were chosen from a long list of measures undertaken by government, industry, local communities and non-governmental organizations (NGOs) to improve energy efficiency in different sectors of the Polish economy. In general, these activities are divided into several groups: heating systems modernization, fuel switching, waste heat utilization, renewable energy, public transportation improvements, and building insulation.

The first case study represents activities related to renewable energy. In addition to geothermal energy, wind energy generators and solar collectors have been installed in Poland, mainly at farms and orchards. Poland's new energy law assures free access to the national electric power grid system for renewable energy producers.

Building public awareness in demand-side energy efficiency is another way to reduce the emissions intensity of energy production. One problem is that the degree of awareness is low; education programs could play an important role, especially for younger generations in nurseries, schools, and universities. Therefore, each initiative undertaken by government agencies or NGOs is significant in increasing understanding of energy efficiency issues for future energy consumers.

Some energy-saving measures are undertaken directly by industry or the energy sector, where decision-makers have a solid understanding of the role of energy efficiency in production cost competitiveness. In nonindustrial sectors, the problem is more complicated. The good will and awareness of decision-makers is insufficient to implement no-regrets measures without financial incentives. This situation explains why households, municipalities, public transportation authorities, and other groups who do not deal with production have not been able to make significant progress. Without external assistance (either from the Polish government or from international groups), mitigation measures may create burdens that could cause social stress and threaten economic growth.

[6] Professor Sadowski is the head of the Climate Protection Center at the Polish Institute of Environmental Protection.

Bibliography

Aleksandrowicz, I. (1995) "Gas Management at Municipal Dumping Sites" *(in Polish).* In *Ekonomia i Srodowisko* No. 2 (7), 1995, Bialystok

Broniewicz, E. (1994) *CO2 Emission Fees and Bio-absorption Rent (in Polish).* Seminar on Legal and Economic Mechanisms of GHG Reduction. Technical University of Bialystok and the Institute of Environmental Protection, Warsaw

Czaja, S. (1994) *Strategy of Protection of the Atmospheric Air against GHG Pollutants: Role of the Economic and Financial Mechanisms (in Polish)* Seminar on Legal and Economic Mechanisms of GHG Reduction. Technical University of Bialystok and the Institute of Environmental Protection, Warsaw

Drozyner, J. and B. Poskrobko (1995) "New Economic Instruments for Controlling GHG Emissions" *(in Polish).* In *Ekonomia i Srodowisko* No. 2(7), Bialystok

Echo-Policy (1992): *Ecological Policy of Poland.* Ministry of Environmental Protection, Natural Resources and Forestry, Warsaw

Energy Law (DRAFT) (1996) Polish Parliament, Warsaw

Fiedor, B. and S. Czaja (1995) "Ecological Tax on Fuel" *(in Polish).* In *Ekonomia i Srodowisko* No. 2(7), Bialystok

Gaj, H. (1995) *Modelling Impacts of Measures in the Polish Country Study.* Eastern European Regional Workshop on GHG Emission Inventories, Budapest

Gaj, H. (1996): *Assessment of the Joint Implementation in Poland.* Pacific Northwest Laboratory, Washington

Gaj, H. and J. Marousek. (1996) *Joint Implementation in Poland and the Czech Republic: Government Perspectives.* International Partnership Report, Vol. 2 No. 3, USIJI, Washington, D.C.

Graczyk, A. (1995) "Role of Environmental Fees and Funds in Stimulating More Effective Energy Consumption" *(in Polish).* In *Ekonomia i Srodowisko* No. 2(7), 1995, Bialystok

IEA/OECD. (1995) *Energy Policy - POLAND, Review of the 1994 Situation* OECD/IEA, Paris

IPPT PAN (1996) *Convergence of Energy Policies*, PHARE Project (draft working materials). ECN, The Netherlands (with co-operation of IPPT PAN, FEWE and CIE, Poland)

Kolodko, G. (1996) *Package 2000 - Strategy for Poland.* Ministry of Finance, Warsaw

Manne, A.S. and L. Schrattenholzer (1993) "Global Scenarios for Carbon Dioxide Emissions." In *Energy*, 18(12) December, 1993

Minerals and Energy Economy Basic Problems Research Centre. (1994) *Current State of the Environment and Sustainable Development Programme of Tatry, Podhale, Spisz, Orawa, Pieniny and Gorce Regions (in Polish)* Conference proceedings. Minerals and Energy Economy Basic Problems Research Centre, Kraków

Ministry of Environmental Protection, Natural Resources and Forestry. (1994) *Polish National Report to the First Conference of Parties to the United Nations Framework Convention on Climate Change*. Ministry of Environmental Protection, Natural Resources and Forestry, Warsaw.

Ministry of Industry and Trade. (1995) *Energy Policy Guidelines for Poland until 2010.* Ministry of Industry and Trade, Warsaw

Pasierb,S., K. Niedziela, and J. Wojtulewicz (1996) "Structural and Technological changes of GHG Emissions During the Transition Period in Polish Industry." In *Environmental Management,* Vol. 20, S 1, 1996
Poskrobko, B. (1994) *Expertise on financial mechanisms of FCCC (in Polish),* Technical University of Bialystok
Poskrobko, B. (1994) *Institutional aspects of GHG reduction mechanisms implementation (in Polish).* Seminar on Legal and Economic Mechanisms of GHG Reduction. Technical University of Bialystok and the Institute of Environmental Protection, Warsaw
Radecki, W. (1994) *Legal aspects of adaptation of the Polish economy to the requirements of the FCCC (in Polish).* Seminar on Legal and Economic Mechanisms of GHG Reduction. Technical University of Bialystok and Institute of Environmental Protection, Warsaw
Sadowski, M., (Editor). (1996) *Strategies of the GHG Emission Reduction and Adaptation of the Polish Economy to the Changed Climate*. Institute for Environmental Protection, Climate Protection Center, Warsaw
Sommer, J. (1994) *Legal instruments of GHG reduction stimulation (in Polish),* Seminar on Legal and Economic Mechanisms of GHG Reduction. Technical University of Bialystok and Institute of Environmental Protection, Warsaw
Szukalski, S. (1995) *The Methodological Approach of Macroeconomic Modelling in the Polish Country Study.* International Workshop on the Assessment of GHG's Mitigation Options. Warsaw, June 1995
Szukalski, S. (1996) "Essay on Social Aspects of the Polish Economy." Contribution to the *Energy Policy for Poland* PHARE project. ECN, Netherlands (with input from FEWE and CIE, Poland)
TEMPUS. (1996) "Training seminars on energy efficiency for municipal decision makers" - Project proposal and report. Polish Foundation for Energy Efficiency, Kraków
Wasiak, A. (1994) *Methods of CO2 emission reduction in Poland and implementation problems (in Polish).* Seminar on Legal and Economic Mechanisms of GHG Reduction. Technical University of Bialystok and the Institute of Environmental Protection, Warsaw
Wrzosek, S. (1994) *Administrative instruments of GHG reduction stimulation (in Polish).* Seminar on Legal and Economic Mechanisms of GHG Reduction. Technical University of Bialystok and the Institute of Environmental Protection, Warsaw

Appendix 1: List of Abbreviations Used in the Text

Organizations:

ADEME	French *Agence de l'Environnement et de la Maitrise de l'Energie*
CEETA	Portuguese Center for Studies in Economics and Energy of Transportation and Environment
EC	European Community
FEWE	Polish Foundation for Energy Efficiency
GEF	Global Environmental Facility
GREENTIE	Greenhouse Gas Technology Information Exchange
IEA	International Energy Agency
IFC	International Finance Corporation
NFEPWM	National Fund for Environmental Protection and Water Management
OECD	Organization for Economic Cooperation and Development
PGA	Polish Geothermal Association
PHARE	Polish - Hungarian Assistance in Restructuring of Economy
PNEC	Polish “Energy Cities” Network
TEMPUS	Trans-European Cooperation Scheme for Higher Education (EC Programme)
UCPTE	Union of Coordination of Production and Transmission of Electricity (Poland)
UMM	University of Mining and Metallurgy (Kraków, Poland)
USAID	United States Agency for International Development
USCSP	United States Country Studies Program

Other:

AIJ	Activities Implemented Jointly
CFL	compact fluorescent lamp
CHP	combined heat - power [production]
DH	district heating
DSM	demand side management
ESCO	energy service company
FCCC	[United Nations] Framework Convention on Climate Change
GDP	gross domestic product
GHG	greenhouse gas
GJ	Gigajoules (1 x 10^9 joules)
IRP	integrated resource planning
JI	Joint Implementation
mmt	Million metric tons (1 ton carbon = 1 megagram carbon)
Mtoe	Million tons of oil equivalent
PJ	Petajoules (1 x 10^{15} joules)

Appendix 2: Summary of Potential Mitigation Measures in Poland

GHG Reduction Options	Emissions Reductions ($Mton\ CO_2$ Equivalent)					Reduction Cost (Assuming a Tax of \$90/Mg CO_2)		
	Year							
	1990	**2000**	**2010**	**2020**	**2030**	**0**	**50**	**100**
Industry								
Efficient Lighting	0.000	0.273	1.468	1.631	1.631	-92	-97	-102
Monitoring Industrial Processes	0.000	0.182	1.468	1.631	1.631	-89	-94	-99
Efficient Electric Motors	0.000	0.427	3.194	3.549	3.549	-85	-90	-95
Improved Use of Industrial Steam	0.000	0.855	9.565	14.167	14.167	-84	-90	-95
Electronically Controlled Drives	0.000	0.072	2.862	3.181	3.181	-81	-87	-92
Blast Furnace Gas Turbines	0.000	0.431	0.431	0.431	0.431	-78	-82	-85
Industrial Management Improvements	0.000	8.030	11.146	14.859	17.833	-77	-81	-85
Modernization in the Steel Industry	0.000	11.134	11.134	11.134	11.134	-71	-74	-76
Heat Recovery in Boilers and Dryers	0.000	2.333	2.333	2.333	2.333	-56	-59	-63
Furnace Modernization	0.000	1.535	2.683	2.683	2.683	-48	-52	-56
Waste Heat Recovery	0.000	1.036	1.036	1.036	1.036	-45	-48	-51
Conversion to the "Dry Method" of Cement Production	0.000	0.640	0.640	0.640	0.640	-43	-46	-49
Generation of Electricity from Coalbed Methane	0.000	3.537	10.610	10.610	10.610	-42	-46	-50
Utilization of Converter Gas in Metallurgy	0.000	0.316	0.316	0.316	0.316	-41	-44	-47
Quicklime Production in Maertz Furnaces	0.000	0.444	1.110	1.443	1.887	-40	-42	-43
Modern Electrolysis of Zinc	0.000	0.032	0.032	0.032	0.032	-38	-42	-46
Efficient Industrial Equipment	0.000	9.058	9.058	9.058	9.058	-36	-40	-43
Fuel Switching (Coal to Gas) for Boilers with a Capacity of < 20 t/h	0.000	0.701	1.952	1.952	1.952	7	3	-1
Installation of Steam-Gas Turbines in Industrial Power Plants	0.000	0.866	0.999	0.999	0.999	33	30	26
Modernization in the Chemical Industry	4.277	4.947	6.472	8.50	9.764	56	54	52
Increased Use of Gas-Fired Cogeneration in Industry	0.000	1.595	4.262	4.262	4.262	199	195	191
Use of the Dry Extinguishing Method in Coke Production	0.000	0.908	1.258	1.258	1.258	199	195	192
Modernization of Refineries	2.217	2.858	5.109	6.408	8.313	225	222	220
Electrolysis of Aluminum with Sintered Anodes	0.000	0.072	0.072	0.072	0.072	228	224	220

GHG Reduction Options	Emissions Reductions (Mton CO_2 Equivalent)					Reduction Cost (Assuming a Tax of $90/Mg CO_2)		
	Year							
	1990	**2000**	**2010**	**2020**	**2030**	**0**	**50**	**100**
Total for Industry	**6**	**52**	**89**	**102**	**109**			
Household, Public, & Commercial								
Efficient Street Lighting	0.000	0.014	0.066	0.125	0.187	-165	-171	-177
Improved Control of Small C.H. Gas Boilers	0.000	0.132	0.686	1.022	1.217	-152	-158	-164
Efficient Commercial Lighting	0.000	0.083	0.350	0.912	1.611	-146	-152	-158
Efficient Lighting in Households	0.000	0.309	1.365	2.789	3.962	-139	-145	-151
Efficiency Improvements in Home Appliances	0.000	2.900	5.441	6.041	7.119	-102	-106	-110
Installation of Heat Meters to Bill Customers Based on Actual Use	0.000	0.728	3.221	4.405	5.147	-87	-92	-98
Thermal Insulation for Walls in Private Buildings	0.000	1.586	5.900	9.774	14.398	-86	-92	-98
Tightening Windows	0.000	3.447	3.447	3.447	3.447	-84	-87	-90
Thermal Insulation for Walls in Public Buildings	0.000	0.255	0.766	1.277	1.788	-74	-79	-85
Thermal Insulation for Roofs	0.000	0.057	0.226	0.354	0.407	-61	-68	-74
Fuel Switching from Coal to Gas, Solar, or Biomass	0.000	1.642	4.091	6.024	8.308	31	27	22
Improvements in the Efficiency of District Heating Boilers Efficiency to over >91%	0.000	0.813	2.129	2.811	3.222	76	74	73
Replacement of Windows	0.000	0.965	2.922	4.258	5.441	467	462	456
Total for Households, Public & Commercial	**0**	**13**	**31**	**43**	**56**			
Renewable Energy								
Fuel Wood for Households	0.000	0.112	0.464	1.333	2.647	-89	-96	-102
Use of Straw for Household Fuel	0.000	0.002	0.070	0.192	0.456	-86	-93	-100
Air Solar Collectors	0.000	0.081	0.504	1.017	1.155	-73	-91	-100
Rapeseed Biofuel	0.000	0.288	0.631	0.907	0.996	-48	-51	-54
Geothermal Energy	0.000	0.126	0.631	2.523	5.046	-26	-34	-42
Water Solar Collectors	0.000	0.286	1.450	4.351	5.153	13	5	-2
Biogas Plants	0.000	0.002	0.034	0.115	0.289	25	11	-3
Grid-Connected Wind Power Sation	0.000	0.040	0.200	0.400	0.500	48	42	36
Medium-Size Hydropower Stations	0.000	0.000	0.089	0.256	0.669	51	44	36
Ethanol	0.000	0.267	0.522	0.731	1.004	74	70	65

GHG Reduction Options	Emissions Reductions (Mton CO_2 Equivalent)					Reduction Cost (Assuming a Tax of $90/Mg CO_2)		
	Year							
	1990	**2000**	**2010**	**2020**	**2030**	**0**	**50**	**100**
Small Hydropower Station (<5 MW)	0.000	0.023	0.052	0.210	0.554	83	76	69
Large Hydropower Station (>50 MW)	0.000	0.230	0.130	0.620	3.722	119	111	102
Autonomous Wind Power Stations	0.000	0.000	0.004	0.013	0.035	147	139	131
Total for Renewables	**0**	**1**	**5**	**13**	**22**			