Ministry of the Environment

Geothermal Energy Systems Assessment

THEMATIC REPORT

– A Strategic Assessment of Technical, Environmental, Institutional and Economic Potentials in Central and Eastern European Countries

Volume 1: Main Report

DANCEE

Danish Cooperation for Environment in Eastern Europe
Ministry of the Environment

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Abstract
„This thematic report is a strategic assessment of future potentials for geothermal energy systems in Central and Eastern European Countries (CEECs). The analysis includes technical, environmental, institutional as well as economic issues of relevance for future utilization of this renewable energy source in the CEECs. The study provides recommendations on how to increase environmental impacts and benefits in return for project investments".

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Environment, Central and Eastern Europe, DANCEE, CEE, CEECs, Geothermal, Energy, Renewable

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DANCEE
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Contents

1 Acronyms

CEECs	Central and Eastern European Countries (including Russia and Ukraine)
CHP	Combined Heat and Power
DANCEE	Danish Cooperation for Environment in Eastern Europe
DEPA	Danish Environmental Protection Agency
DHS	District Heating Systems
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
GE	Geothermal Energy
GEF	Global Environmental Facility
GESA	Geothermal Energy Systems Assessment
GIA	Geothermal Implementing Agreement
IEA	International Energy Agency
IFI	International Finance Institutions
kW	Kilowatt – a measure of power
kWh	Kilowatt hour – the energy consumed by using 1 kW for one hour
NAMR	National Agency for Mineral Resources
NERA	National Energy Regulatory Authority
NEFCO	Nordic Environment Finance Corporation
NIB	Nordic Investments Bank
Mtoe	Million tonnes of oil equivalent
MW	Megawatt – equals 1 000 kilowatt
MWh	Megawatt hour – the energy consumed by using 1 MW for one hour.
RE	Renewable Energy
SAP	Strategic Action Plan
SCB	Social Cost Benefit
TFC	Total Final Consumptions
TOE	Tonne of oil equivalent – 1 toe = 41,868 GJ or 1 toe = 10^7 Kcal
TDS	Total Dissolved Solids
TPES	Total Primary Energy Supply
UNEP	United Nations Environmental Programme
WB	World Bank

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3 Foreword

Despite considerable and admirable effort, the Central and Eastern European Countries (CEECs) still face serious environmental problems related to their heating sectors. This is mainly due to the fact that most CEECs continue to rely heavily on conventional and polluting energy sources such as lignite, coal and heavy fuel-oil for heating purposes. However, an increasing awareness and interest in converting to renewable and non-traditional energy sources are emerging in the region, strongly encouraged by the international community; e.g. in the negotiations on EU accession and through related international financial support programmes.

Within the CEECs, geothermal energy is considered to be one of the most promising local energy sources. Geothermal water is found in significant quantity under ground in the CEECs, where it for decades has been used for recreational purposes. Presently, geothermal energy also aspires to become an important future energy source for heating purposes. Since geothermal energy is an environmentally friendly energy source, conversion to geothermal energy systems may contribute significantly to reduce current negative environmental effects from the heating sector.

In view of this, the Danish Environmental Protection Agency (DEPA) commissioned *Kvistgaard Consult (KC)* to prepare a strategic assessment of economic, environmental, technical and institutional potentials of geothermal energy systems in the CEECs. The study was carried out by KC from April to December 2001 and included desk research as well as visits to geothermal project sites in the CEECs. An International Workshop on "The Future of Geothermal Energy in the CEECs" held on 8-9 October 2001 in Copenhagen, was also part of the study. The workshop was attended by important geothermal stakeholders from the CEECs, as well as by delegates from main international financial institutions and from Danish companies and institutions.

An important conclusion from the workshop as well as from this study, is that the CEECs possess highly promising environmental and technical potentials for further development of geothermal energy systems for heating purposes. However, the study also emphasises that in future, more attention should be paid to institutional and policy issues, when selecting geothermal projects for financing. These latter issues are deemed of crucial importance in order to ensure project sustainability and to make geothermal projects more attractive to potential investors. The geothermal workshop in Copenhagen indeed confirmed that geothermal energy represents an encouraging emerging market within the CEECs, when the right framework and conditions come into place.

DEPA, through the DANCEE programme, has throughout the 1990's initiated and/or co-funded 6 geothermal projects in the CEECs. It appears from this study that the experiences generated by these projects generally are positive. Danish know-how and technologies transferred to the geothermal projects have been a crucial factor in obtaining good results. In this regard, the Danish low-temperature district heating system has been demonstrated to be unique and relevant for export to the CEECs in relation to geothermal projects. Low-temperature systems represent an integrated and efficient utilization of energy resources in all stages from production, via distribution, to the end-user. Furthermore, lower network temperatures than historically applied in Central and Eastern European DH-systems is a basic prerequisite for economic exploitation of the relatively low-temperature geothermal resources in the CEECs.

I believe, that with this study DEPA moves forward to present a coherent strategic approach for future development of geothermal energy potentials within the CEECs using the lessons learned through the first years of investments. The study points out concrete action proposals to be considered by DEPA, but also invites broader, international concerted actions. The study represents an important first step on the path to a more focused and integrated development of geothermal energy potentials in the CEECs, - involving national as well as international players. It is, however, also obvious that more steps will need to be taken in order to create conditions for a real and sustainable "take-off" of the development of the geothermal energy potentials. This, in turn, will contribute to produce larger environmental impacts and benefits in return for the invested funds.

It is my hope that this DEPA-initiated study will be used, and that it will be a source of inspiration in the CEECs. Furthermore, I hope that it will mark the beginning of a new era of enhanced development of geothermal energy in the CEECs to the benefit of the environment.

Mr. Karsten Skov
Deputy Director General
Danish Environmental Protection Agency (DEPA)

4 Introduction

4.1 The DANCEE Programme

Established in 1991, as part of Denmark's environmental assistance to Central and Eastern Europe Countries (CEECs), the DANCEE programme is administrated by the Danish Environmental Protection Agency (DEPA) within the Danish Ministry of Environment. The overall objectives of the DANCEE programme are

- To contribute as much as possible towards protection of the environment and the nature in CEECs and to limit regional and global pollution
- To support democracy and market-based economic development in an environmental friendly manner
- To promote transfer of environmental knowledge and of environmental protection technology from Denmark to CEECs

In 2001 the total DANCEE programme budget was 600 million DKK (approximately 80 million USD), making Denmark one of the largest bilateral providers of environmental assistance to Central and Eastern Europe, both per capita and in relation to GDP. Currently DEPA, through the DANCEE programme, implements projects (investment or technical assistance projects or a combination of both) in twelve CEECs.

4.1.1 The Danish Model

An integrated part of the DANCEE programme support is to promote transfer of environmental knowledge and environmental protection technology from Denmark to CEECs. The effort and experiences generated by Danish geothermal experts have proved very useful in several CEECs, where GE sources have been integrated into CEEC district heating systems. Know-how and expertise from the Danish district heating sector has successfully been transferred to demonstrate new technologies and more efficient heating systems, - including geothermal energy technology for heating purposes.

Denmark developed this system, including its technologies and institutional requirements (building insulation standards, subsidies for renewable energy, high taxes on fossil fuels, energy planning of zones for use of natural gas, others zones for biomass, etc.) as a response to the energy crisis in 1970s. At that time Denmark was an energy importer, but has now turned to be a net exporter of energy through a targeted energy policy aiming for efficient energy production based of multiple sources, distribution and use.

While the temperatures of Denmark's underground water resource are moderate and the Danish geothermal experience focus on a single geothermal plant, the Danish geothermal expertise must be understood in this broader context, including a wide range of projects abroad. A handful of Danish companies have worked comprehensively with energy efficiency in geothermal energy planning and implementation. These companies made a pioneering effort in the geothermal plant in the Danish town of Thisted, and are now pursuing geothermal prospecting in Copenhagen.

The characteristics of the Danish concept of geothermal energy utilization, are the low temperature requirements achieved through absorption heat pump technology. Further cost efficiency is achieved by targeting a load segment (both over time and in a mix with other energy sources), where the geothermal energy complement waste incineration and substitutes gas. Finally, heat from the summer period is to be stored for use in winter.

This experience – and the continued verification of considerable reservoirs of hot water present in the underground of several CEECs - inspired DEPA to explore the idea that a strategic and targeted effort through the DANCEE programme could imply an increased utilization of the geothermal potential with positive economic and environmental impacts[1].

DEPA wants projects selected not only on the basis of technical and environmental data, but also as a result of a strategic process, involving policy, socio-economic and institutional analyses. In this context it is essential to what extent the political structures and the administrative, economic and legal systems of today's CEECs are conducive to development of GE. Further, questions regarding the possible complementary roles of private and public capital, of loans versus grants and the role of the state relative to the role of regional authorities and local governments are important.

4.2 Geothermal Energy Systems Assessment in the CEECs

DEPA commissioned *Kvistgaard Consult (KC)* to identify the most important features of the prevailing framework for geothermal energy development and to prepare a strategic assessment of economic, environmental, technical and institutional potentials of geothermal energy systems in the CEECs.

The Geothermal Energy Systems Assessment (GESA) in the CEECs was carried out by KC from April 2001 to December 2001. It included desk research, country and project evaluation and identification missions. The project did also include orchestration of an "International Workshop on the Future of Geothermal Energy in the CEECs", held in Copenhagen (Denmark), 8th – 9th October 2001.

The products of the GESA project can be listed as follows:

Volume I : Geothermal Energy Systems Assessment (GESA): A Strategic Assessment of Technical, Environmental,

[1] The Pyrzyce project was evaluated in 1998 by an independent consultant and was assessed to be fulfilling project objectives very satisfying as well as contributing considerably to DANCEE programme objectives, including positive environmental impacts primarily in terms of substitution of coal based heating. Although DANCEE has found this and other geothermal projects successful, they were launched on an individual basis as separate projects initiated from a bottom-up approach. Contrary to the current approach, they had not been selected and launched as a result of a top-down strategic process.

Institutional and Economic Potentials in CEECs : ***Main Report***.

Volume II : Geothermal Energy Systems Assessment (GESA): ***Country Profiles and Case Studies***

Volume II.A : Geothermal Energy Systems Assessment (GESA): ***Country Profile - Poland (including case studies).***

Volume II.B : Geothermal Energy Systems Assessment (GESA): ***Country Profile - Romania.***

Volume II.C : Geothermal Energy Systems Assessment (GESA): ***Country Profile - Russia.***

Volume II.D : Geothermal Energy Systems Assessment (GESA): ***Country Profile - Slovakia (including case studies).***

Volume II.E : Geothermal Energy Systems Assessment (GESA): ***Country Profile - Ukraine.***

Volume II.F : Geothermal Energy Systems Assessment (GESA): ***Non-Focus Country Profiles - Bulgaria, Czech Republic, Hungary, Latvia and Lithuania (including case study).***

Further to these two Volume's, an Executive Summary of the Main Report has been prepared as a separate document and a Strategic Action Plan (unpublished) has been prepared for DEPA.

4.3 Methodology

Carrying out the GESA project, Kvistgaard Consult (KC) followed a methodology dividing the project into 4 basic components:

1) A retrospective study, including an evaluation of 8 geothermal investment projects (case studies). The case studies are in turn comprised of both on site evaluation during project visits and desk analysis of existing information on each project.

2) A prospective study, based on country missions to the five DANCEE focus countries (Poland, Slovakia, Russia, Ukraine and Romania) and desk research.

3) An international workshop on the future of geothermal energy in the CEEC.

4) A Strategic Action Plan (SAP), based on material collected from various sources, including some actual project proposals received during country missions.

In the process of carrying out the GESA project, some retrospective and prospective activities have been undertaken simultaneously. The outputs from the retrospective study in terms of *lessons learned* have provided the analytical and theoretical foundation for the establishing of a set of technical, economic, environmental and political-institutional assessment *criteria*. These criteria should in future be considered as a part of ex-ante analyses performed prior to approving allocation of donor funds for geothermal project activities in the CEECs. For the purpose of illustration, this set of criteria has been applied to visualize how a *best practice* geothermal project may look.

The same criteria have been applied in the process of producing a *Strategic Action Plan (SAP)*. The SAP includes a *long list,* as well as a *short list*, of potential geothermal investment projects for DEPA to consider. From the short list three potential projects, proving particularly promising and ready to be implemented shortly, have been selected and *Terms of Reference* prepared.

While 12 Central and Eastern European Countries have been considered for this study, main attention has been given to analyse conditions in the five countries defined by DEPA as DANCEE focus countries: Poland, Slovakia, Russia, Ukraine and Romania. The remaining countries, the non-focus countries are 1) already phased out of the DANCEE programme (Hungary), 2) currently in the process of being phased out (Czech Republic) or 3) subject to DEPA geothermal project funding (Bulgaria, Lithuania and Latvia) but to a lesser extent than the focus countries. Belarus has not been included in the study and Estonia has not been further considered due to the country's lack of geothermal potential.

As part of this GESA project, an International Workshop on "The Future of Geothermal Energy in the CEECs" was held on 8th and 9th October 2001 in Copenhagen. The workshop, hosted by DEPA, was attended by governmental representatives as well as project stakeholders from all 10 CEECs covered by this study. Moreover, delegates from main international financial institutions as well as from Danish Ministries, companies and investments funds attended the workshop.

Conclusions and recommendations from the workshop complemented the findings of the analytical work, and they have been fed into the overall process and formulation of a coherent and comprehensive approach to future development of GE potentials in the CEECs, building on concerted and strategic action. Workshop proceedings, including presentations, programme and participants list, have been prepared and handed out to the participants.

4.3.1 Methodological Note on Statistical Data

Most national and international organisations base their energy studies and surveys on data from the International Energy Agency (IEA) and use the same methods as the IEA for collecting and aggregating data and information. When it comes to geothermal energy data and the CEECs, the IEA data-sets, however, are often yet to be completed or even provided. When dealing with energy related statistics, KC has therefore relied on data from a variety of sources, but still with an emphasis on the IEA.

During the data collecting period KC used, besides IEA statistics, articles, maps, books and the internet. KC has also compiled data material from visits to the CEECs. Data from such an array of different sources are not always comparable. It is important therefore, to note the difference between data/information from the well systematized IEA statistical publications and complementary data/information collected from unique and primary sources with focus on specialized knowledge within the field of geothermal energy.

4.4 Structure of this Report

This report is Volume I of the products prepared by KC as part of this assignment. The report is structured as follows :

After this brief introduction, a short general description of geothermal energy follows (Chapter 5). The chapter introduces some technical, institutional, economic and environmental issues of particular relevance for geothermal energy development.

Chapter 6 contains a *Retrospective Analysis*, based on experiences so far from DEPA funded geothermal projects as well as from other geothermal projects in the CEECs. A list of *lessons learned* from the projects are presented and transformed into a *best practice* project design, to be used as a guiding instrument for selection of geothermal projects for financing in the future.

A *Prospective Analysis* of the five DANCEE focus countries (Poland, Russia, Romania, Slovakia and Ukraine) is presented in Chapter 7 with a view to technical, institutional, economic and environmental potentials for future development of GE projects in these countries. A comparative analysis is done in order to determine similarities and differences between current conditions for project implementation in the five countries.

In Chapter 8 the report moves towards a strategic approach where concrete *DEPA (DANCEE) action proposals* are formulated to support future geothermal development in the CEECs. The proposals are formulated in view of DEPAs current and potential role as a strategic international key player in relation to geothermal energy development in the CEECs.

In Chapter 9 concluding remarks are presented.

It should be emphasized that this report does not necessarily express the opinions and viewpoints of the Danish Ministry of Environment.

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5 Geothermal Energy Potentials

> ”The market for direct uses of geothermal energy has extensive potential in European countries (…) Opportunities both to extend this usage and to develop related businesses exist, especially in CEECs, where large centralized DH systems already exist which mainly use conventional fuels” (EU Blue Book on Geothermal Resources, 1999).

5.1 Background

Covering about 0.13 per cent of the worlds energy demand, geothermal energy (GE) currently plays a marginal part in our energy supply. However, there are indications that the potential for exploitation of GE in Europe is currently facing unprecedented focus and interest from investors and policymakers alike. The EU Bluebook on Geothermal Resources (1999) foresees an average global growth rate for GE of 10-15 per cent over the next three decades, provided that the energy market develops favourably in terms of prices, regulations and environmental incentives. Other forecasts envisage an increase to 1 per cent of the world total by 2020, based on a projected 4 per cent annual growth in geothermal electric production and 10 per cent annual growth in geothermal heat energy (Ahmadzai 2001).

Geothermal energy is the heat of the earth. This heat is not evenly distributed over the earths' surface, but geothermal energy potential exists in most parts of the world. In a classical sense, regions of geothermal potential are conventionally perceived as being characterized by plate tectonic boundaries (or hot spots), where molten rock is left at a depth of 5-20 km beneath the earth's surface[2]. Here the molten rock releases heat that can drive hydrological convection, which in turn forms high temperature geothermal systems at shallower depths of 500-3 000 m. Areas of geothermal interest may also exist away from plate tectonic boundaries however. These areas have a higher natural heat flow than the average crust and groundwater will bring up heat from high temperature localities along fracture zones, concentrating heat in shallow reservoirs[3] (approx. 200 m.) or discharging heat in form of hot springs; - geysers.

Within the same type of geothermal resources, temperature levels vary from 50-350 °C. Furthermore, geothermal resources can also be either dry, mainly steam, a mixture of steam and water or just water. In order to extract geothermal heat from the earth, water is the transfer medium. Hot water penetrates rock, dissolve minerals and carry them along. The water may also contain various gases – SO_2, CO_2 etc. If the water is artesian, bringing it to the surface will require little or no pumping. Recently technologies to extract energy even from hot dry rock resources have also been developed.

As geothermal energy resources have now been documented to be plentiful and the technology required is mature, future utilization of geothermal energy

[2] Molten rock is rock that is melted. This can happen in various ways. See i.e. Rayner et al., 1998

[3] Low and intermediate temperature reservoirs will typically be located at app. 200-1 500 metres depth.

is determined by a combination of technical, environmental, political/institutional and economic factors and decisions.

5.2 Technical Potentials of Geothermal Energy Systems

It is the type and quality of a geothermal reservoir in addition to temperature and water conditions that determine the type of technology suitable. The condition of the geothermal source and the best available technology, when combined, determines the potential technical use of a geothermal energy resource.

The table below lists the basic technologies available. The most common use of low temperature geothermal energy is direct use.

Table 5.2-1 Types of Geothermal Energy Systems

Reservoir temperature	*Reservoir fluid*	*Technology commonly chosen*	*Common use*
High temperature >220°C	Water or steam	• Flash steam • Combined (flash and binary) cycle • Direct fluid use • Heat exchangers • Heat pumps	Power generation Direct use
Intermediate temperature 100-220°C	Water	• Binary cycle • Direct fluid use • Heat exchangers • Heat pumps	Power generation Direct use
Low/intermediate temperature 50-150°C	Water	• Direct fluid use • Heat exchangers • Heat pumps	Direct use
Low temperature 20-50 °C	Water	• Heat pumps	Direct use

Source: www.worldbank.org (modified)

It is of paramount importance to any geothermal project to examine all technical factors that will influence project performance because each geothermal plant will be unique.

5.3 Economic Potentials of Geothermal Energy Systems

> ”The market for direct use applications only exist when resource and demand are coincident. This is why geothermal resources are only used where there is a large local energy demand” (EU Blue Book on Geothermal Resources, 1999)

The technological and geo-political development trends mentioned earlier has introduced a dynamic factor which will alter the future of GE. This factor will change conventional economic comparisons between different energy technologies and cause a reversals in the order of these. Along with the fact that variability is great for GE due to local conditions (including well drilling and well productivity), this means that economic analysis and economic forecasting of GE investments is both complex and challenging. Still, however, the basic approach to analysing GE investments is a matter of estimating the amount of energy to be produced by a system over its technical lifetime, relative to the capital and operational costs.

The economics of GE plants are characterized by high initial investments costs and very low operating costs. As far as the latter is concerned, some plants are known to have run for decades with only minor servicing. Bronicky expects fast track financing of private sector geothermal projects and recognition of their real value, to provide opportunities for new geothermal projects worldwide (Bronicky 2000).

An increasingly important economic factor and parameter in calculating the economic feasibility of GE, is the extent to which a market exists for CO_2 emissions in the country of operation. With the Kyoto Protocol and Berlin agreement, the motivation for investors in highly industrialized countries to effectively buy CO_2 quotas by investing in GE, is rapidly increasing. This parameter is of a magnitude that will significantly influence the cost-benefit calculations of a GE investment.

In the terminology of development banks, this means that GE projects may be seen as "bankable". Supporting this perspective, the Energy Carbon Facility under the Joint Stock C. of Russia, represents a pioneering approach in striving to translate the concept of carbon credits and joint implementation into reality on Russian ground, applying the concepts to geothermal energy development[4]. Also the UNEP-GEF "Technology Transfer Network" is working on turning emission benefits into a real competitive advantage for geothermal energy.

Currently, it is broadly considered that the economic value of geothermal energy is highly underestimated. Geothermal energy is often compared to other sources of energy, where externalities are excluded. To the extent such externalities will be internalised, through green taxes and new regulation, geothermal energy will become more competitive. According to some studies, external costs of conventional energy systems may be up to ten times greater than those of renewables.

5.4 Environmental Potentials of Geothermal Energy Systems

Environmental potentials refer to the geothermal potential in terms of environmental costs and benefits, - the latter including the reduction of emissions.

Environmental impacts of geothermal energy are generally positive. The following environmental potentials can be listed:

- GE plants require smaller area compared to most conventional energy sources.
- GE produces no or little air and water pollution. In terms of carbon dioxide emissions, the gas emissions from district heating systems, using low-temperature geothermal resources and fossil fuels, are for

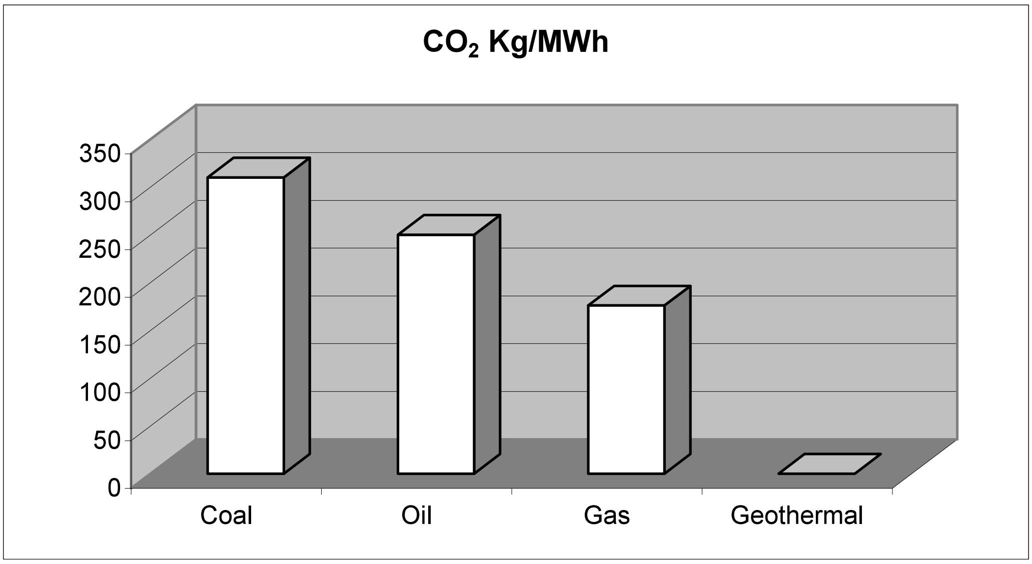
[4] This was demonstrated in a presentation at the international workshop on the future of geothermal energy in CEECs, by Yuri Fedorov: Joint implementation of Global Climate Change through Geothermal Energy Cooperation. 9. October 2001, Copenhagen.

GE only a fraction of that from fossil fuels. The CO_2 emission from GE plants is in many cases insignificant, compared to heating systems based on coal, oil and gas (see figure 5.4-1 below).

- In addition to reducing the greenhouse effect, other positive impacts of GE (generating no combustion) are reduction of "other" air pollutants known to cause acid rain and respiratory diseases.

Following the Kyoto Protocol geothermal energy plants may well pose themselves as attractive investments for foreign investors wishing to buy "greenhouse gas" emission quotas.

Figure 5.4-1 Comparison of CO_2 Emissions from Coal, Oil, Gas and GE



Source: EU Blue Book on Geothermal Resources, 1999, page 24

5.5 Political/Institutional Potentials of Geothermal Energy Systems

The political/institutional context refers to the prevailing framework conditions like policy initiatives and programmes to promote geothermal energy and or alternative sources and regulatory issues included.

The operation of GE plants have generally been governed or influenced by local and national regulation. This include energy and policy initiatives, programmes and regulatory framework.

Although the national political context is still the main factor in determining geothermal energy development in the CEECs, EU laws and policies are for a range of the CEECs becoming a major factor in relation to energy and environmental strategies.

With the EU approximation process, decentralization and division of responsibility for implementation of energy and environmental policies are also becoming a subject of greater importance. With this goes factors such as capacity and resource allocation between the different political levels in order to manage these often rather complex issues.

In relation to concrete geothermal project implementation, issues related to the project management set-up and project ownership are of particular concern. Potentials will here be reflected in the involvement of central project stakeholders and political actors.

6 The Retrospective Analysis

6.1 DANCEE Geothermal Project Activities in the CEECs

During the past 9 years DEPA, through the DANCEE programme, has initiated and co-funded 6 geothermal energy projects in Central and Eastern Europe. A co-funded USD 12 million project in Pyrzyce, in the western part of Poland, was the first demonstration project. In addition, projects have been launched in Zakopane in the southern part of Poland, in Kleipéda (Lithuania), in Ziar nad Hronum and Kosice (Slovakia) and in Decin (Czech Republic).

In total, DEPA has invested more than USD 9 mill. in geothermal projects in the CEECs (see table 6.1.1). This investment, in turn, generated co-funding, adding up to a total of USD 148 million from international finance institutions and national sources. From an environmental point of view, these geothermal projects hold large potentials for reduction in emissions of, in particular, CO_2.

Tabel 6.1-1 DEPA Investments in Geothermal Projects 1993-2001

Baltic region	Lithuania	Russia[1]	Poland	Slovakia	Romania	Ukraine	Czech Rep.
1992 DEPA: 875 000 USD Geothermal Study	1996-2001 DEPA: 2.5 mill USD Co-funding: 16 mill USD Klaipéda, (Production 530 TJ/y; expected saving in CO_2 emission: 51,900 t/y)	1994 DEPA: 56 250 USD Explorative Study, Kaliningrad Region	1993- 2001 DEPA: 3.3 mill USD Co-funding: 112 mill USD Zakopane: (Production: 1,000 TJ/y; expected saving in CO_2 emission: 210,000 t/y) Pyrzyce: (Production: 670 TJ/y; expected saving in CO_2 emission: 69,000 t/y)	1995-2000 DEPA: 1.5 mill USD Co-funding: 8 mill USD Ziar nad Hronum: (Production: 713 TJ/y; expected saving in CO_2 emission: 72,000 t/y) Kosice: Phase I	1997 DEPA: 85 000 USD Feasibility Study	1996 DEPA: 75 000 USD Feasibility Study	1996-2000 DEPA: 1.1 mill USD Co-funding: 12 mill USD Decin, (Expected saving in CO_2 emission: 25,000 t/y)

1: Danish Energy Agency (DEA)

6.2 DANCEE Projects

The following section presents a brief synthesis of each of the project evaluations performed under the GESA. These syntheses are based on case studies treated in full length in Volume II. In this presentation, the focus is limited to the effectiveness, impacts and sustainability of each project.

6.2.1 Zakopane, Podhale (Poland)

6.2.1.1 Effectiveness

Even though the Podhale project has just recently been commissioned, it can be concluded that the project activities so far have demonstrated efficient project management and planning. The local geothermal company, Geothermia Podhalanska S.A., has succeeded in attracting approximately 100 million USD to the project from different donors and institutions, national as well as international.

DEPA's support to the project is relatively small compared to the total budget (see table 6.1.1). The grant has, nevertheless, been of crucial importance to the project, due to its more flexible and complementary character. Moreover, visits by Polish project management and staff to the Danish geothermal plant in Thisted has been important in demonstrating technical issues, as well as Danish working mentality and efficiency.

As part of the initial project planning phase, consumer data was collected through a market survey. To estimate the economic fundament for the project, the data has also been used to develop a unique tariff model that can be adjusted according to market development. Moreover, sales and marketing functions have been established within Geothermia Podhalanska S.A., as well as tools for financial analysis.

6.2.1.2 Impacts

The success and impact of the geothermal project in Podhale has proved to be an important catalyst for further development of geothermal activities in Poland. In Southern Poland, the Malopolskie Voivodeship has now defined further development of geothermal energy sources as a main priority in the region. The Voivodeship has to this end initiated concrete geothermal project activities, and close working relations have been established with the Geothermal Laboratory in Podhale in order to prepare a more strategic regional approach to geothermal energy.

The impact of the projects technical and institutional/organisational experience, has already been very encouraging. Polish experts have shown capacity to support geothermal project development in Slovakia as well: First in Ziar Nad Hronum as sub-advisors on technical and organisational issues, and currently in supporting the development of a geothermal project in the town of Tvrdosin near the Slovakian-Polish border.

Finally, the potential environmental impact of the Podhale project is expected to be huge, due to the rich potential for geothermal energy in Poland and the current energy structure in Poland, based on coal-fired, private heating systems.

6.2.1.3 Sustainability

Early economic calculations showed that the project would be economically sustainable, based on current energy prices and consumer market penetration. The current liberalization process in Poland, and the country's up-coming accession to the European Union, means a relative price development that favours geothermal energy to conventional energy sources.

Institutional components were initially given much attention in the Podhale project in order to establish a sustainable local institutional and organisational framework. It is the impression that the Podhale project is very efficiently anchored institutionally through Geothermal Podhalanska S.A. The company must be characterized as a modern, competitive company, focused on achieving further development and efficiency. Through training and practical experience, the company seems highly capacitated and prepared for future challenges.

In conclusion, it is clear from the experience so far from Podhale, that geothermal heat has gained institutional and political acceptance in the region and is considered an important sustainable regional energy source for the decades to come.

6.2.2 Pyrzyce (Poland)

Pyrzyce, a town with 13 500 inhabitants, was formerly provided with heat from 68 coal-fired heating centres. However, some years ago the municipality launched a green profile and, as part of this, it was expressed as a wish, that the coal-fired heat was to be substituted by a more environmental-friendly energy form such as geothermal.

6.2.2.1 Effectiveness

The Pyrzyce plant started operating in 1996 with two production and two reinjection wells. The plant is designed to extract up to 22 MW and produce 670 TJ/year, of which 368 TJ/year is geothermal heat and 302 TJ/year is gas. The consumers to be covered by geothermal heat were in first instance considered to be those living in flats with central heating systems. It has afterwards been learned that heat demand estimates based on coal production were too high, thus leaving the constructed plant in Pyrzyce with excess capacity. Therefore, an extension of the geothermal distribution area is currently being considered, where also private houses, industry and greenhouses are included.

For the extension of the project, funds have been applied from the Danish EKF (MKØ credit) to finance the purchase of pipes and heat exchangers for consumers. The extension is expected to commence shortly.

The Pyrzyce project had initially some re-injection problems related to un-cleaned pipes, but these problems were temporarily solved through cleaning. Re-injection problems may recur within a few years and another cleaning will probably be needed.

All in all, the effectiveness of the Pyrzyce project is considered to be high. The technical advisory services have been very satisfying and the project plant is fully operational. Moreover, the geothermal company, Geotermia Pyrzyce, is considered to be functioning in a professional and efficient manner.

Finally, it should be noted that the Pyrzyce plant is fundamentally based on Danish know-how. The project has resulted in Danish export of more than 37 million DKK. The export include pipes, heat exchangers and boilers.

6.2.2.2 *Impacts*

The heat from the geothermal plant in Pyrzyce replaces heat formerly produced in 68 coal-fired heating centres with a total annual coal consumption of 60 000 tonnes. Thus, the environmental impact of the project is tremendous. When operating at full capacity, it has been estimated that the yearly saving in emissions will be as follows:

- CO_2: 69 000 t/year
- SO_2: 1 158 t/year
- NOx: 242 t/year
- Particles: 241 t/year

Moreover, the project, being the first on-line geothermal project in Poland, has been an influential and positive example for the implementation of further geothermal projects in Poland.

6.2.2.3 *Sustainability*

It is considered that the sustainability of the Pyrzyce project is rather strong. Opposite to other geothermal project investments in the CEECs, which are still in the implementation phases, the Pyrzyce project has now for some time been demonstrating its functionality and profitability.

Even though relatively low gas-prices have occasionally challenged the economy of the geothermal plant, the trend in energy price development is now in favour of geothermal energy and could further improve the economic foundation of Geothermia Pyrzyce. Moreover, the economic numbers are expected to improve when the planned extension of the consumer base, and thereby a more efficient use of the plant capacity, has been effectuated.

6.2.3 Kleipéda (Lithuania)

6.2.3.1 *Effectiveness*

The effectiveness of the Klaipéda geothermal project has so far been well below the anticipated. Compared to the planned schedule for project implementation, the start-up of the geothermal plant under full capacity has been delayed for more than two years now and it is still uncertain when, and if, the plant will be fully operational. A mix of economic, institutional and technical problems related to the project implementation has been the reason.

A signed “Take or Pay” contract is currently under dispute between the geothermal company, UAB Geoterma, and the local district heating company, Klaipédos Energija, due to unwillingness by the latter to comply with the conditions for payment pursuant to the contract. This dispute is seriously jeopardising the economic fundament and the opportunities for future Lithuanian geothermal development.

The Klaipéda geothermal plant has suffered from continuous technical problems and has only been able to work at half capacity. A serious, continuing problem for the project plant is that a gradual increase of the injection pressure is deteriorating the injection capacity. Delay and problems related to installation and use of equipment have also prolonged the project implementation process and caused abruptions in the plant functioning.

Implementation of the World Bank project loan and the GEF grant initially caused some delay, basically due to internal Lithuanian institutional factors. Moreover, a planned and confirmed EU Phare grant of 850 000 EURO was suddenly withdrawn in August 1999. Consequently, equipment had to be re-procured pursuant to World Bank conditions, which caused a 5-months delay in the implementation.

Finally, manuals for plant operation were delivered to the project site with significant delay, which in turn has made it more difficult for the local staff to operate the plant. Reportedly, practical training in plant operation have been insufficient in order for local staff to operate the geothermal plant efficiently.

6.2.3.2 Impacts

Lithuania possesses interesting potentials for geothermal heat. It was expected that geothermal heat could be expanded to eighteen larger urban areas with existing heating networks. The savings, if all these 18 sites were to use geothermal energy, would be equivalent to around 300 000 tonnes mazut annually, or an import value of around 29 mill. USD.

So far, no real positive impact can be registered from the Klaipéda Demonstration Project into other potential geothermal project activities in the country. Such demonstration impact will probably require that a more convincing and reliable functioning of the Klaipéda project can be demonstrated.

6.2.3.3 Sustainability

The sustainability of the Klaipéda project is threatened by a range of factors. First of all, the project lacks local (political) support. At the local level, the project is very much considered a governmental prestige project and not a project implemented to benefit the area. Obviously, Klaipédos Energija (KE) does not feel much incentive to buy the geothermal energy from the state-owned company, unless it is offered at competitive prices. From an isolated local point of view KE would prefer to buy energy from local suppliers and not from the state, in order to support local development and employment. Continuing technical problems on the project plant and considerable delays in project activities have added to local frustrations regarding the geothermal project.

The economic/financial sustainability of the project will depend on the outcome of the dispute between UAB Geoterma and Klaipéda Municipality/Klaipédos Energija. Project delay has already limited income generation for UAB Geoterma and put pressure on the economic balance. If UAB Geoterma does not receive revenue for the provided heat, the company will move into a serious financial situation and its future would depend on economic support from the Lithuanian Government.

Another factor that will influence the economic sustainability is the recent development on the energy market in Klaipéda. The delay of the geothermal project has allowed other, competitive energy suppliers to enter the market (including one company offering heat from wood burning). Therefore, obviously there is a risk that UAB Geoterma in the future will not be able to sell produced heat at the anticipated prices. During the consultants' interviews it was emphasized by Klaipėdos Energija that they will require guarantees that the geothermal project plant is a reliable energy supplier before they will consider relying on geothermal energy.

6.2.4 Kosice (Slovakia)

6.2.4.1 Effectiveness

The ongoing Kosice Project (Phase I) is found to be undertaken effectively. This assessment is based on a comparison of DANCEE inputs, project objectives and the results achieved so far. Full completion of the project as a whole, as currently designed and proposed by Slovakia, will require around USD 60 mill.

The project (phase one of two phases) covers equipment for erection of a pilot plant and technical assistance to the project. Phase I, completed in year 2000, includes testing, elaboration of technical solutions, contracts with local stakeholders, establishment of Geoterm Kosice investigation of existing installations, district heating systems and plants and identification of investors. The project design, based on extensive geological and geophysical tests carried out by the Slovak company Slovgeoterm, was examined and found to be thoroughly designed and timely performed.

The so-called "inhibitors", used to protect geothermal equipment from corrosion and scaling, has been tested for possible negative impact on the environment. It was found, that the inhibitors used are classified as "non-toxic", and that these are used in low concentration. In terms of temperature and dissolved minerals, the water is in accordance with the decree of the environmental department of the regional office in Trnava.

Studies under the project has confirmed that the town of Košice has an extensive central heating system which supplies 60 000 households. The geothermal heat exchangers are connected to the heating system, and can replace more than 1/3 of the heat conventionally produced by coal and gas. In terms of technology and transfer of "know how", on a competitive basis and locally delivered, much equipment delivered to the project was produced by Danish (daughter) companies. Equipment for the pilot plant was purchased and delivered in early 2000 and by mid 2000 the pilot plant was in operation, and various technical tests were being made.

6.2.4.2 Sustainability

In terms of *financial/economic sustainability*, the existing district heating company TEKO (the Slovak electricity company) has some expensive loans related to nuclear power. The electricity company, therefore, will not likely be expected to be able to invest in renovating the parts of the TEKO plant, which is 30 years old and needs, renovation.

Gas has become increasingly expensive, from 2 SEK/m^3 when the project began to 5 SEK now, and a planned price at 10 SEK/m^3 within the next three years, thereby increasing the economic potential for substitution of gas with geothermal energy.

In terms of *organisational* sustainability, Slovgeoterm is assessed as a professional and solid geothermal company. Owned by one of Slovakia's major companies (the Gas Company, SPP, a Joint Stock Company owned by the Slovak Government, planning to sell 49 per cent of shares to the private sector), Slovgeoterm has a record of successfully concluded and currently operational geothermal projects such as the Galanta Geothermal Plant.

In terms of *institutional* and *political* sustainability, the (pilot) project has demonstrated its foundation on local commitment and stakeholder ownership by obtaining consent for prolonged mining and construction permits from a host of local authorities. In addition, discussions with TEKO has been conducted in constructive fashion and have included technical and economic analyses and prognosis of heat price development until 2005 and beyond. A *letter of intent* have been signed between TEKO and Slovgeoterm, implying that based on the 2000 price of 150-200 SEK/gigajoule, the payments by TEKO for geothermal heat will follow the inflation.

Build as a demo project, the new part of TEKO is a state of the art CHP plant. While an existing CO_2 problem is to be solved by reinjection, the high level of CO_2 in the water will remain a critical point requiring attention. In terms of *technological risk*, a current technical obstacle is thus the character of the geothermal fluid. It has been deemed absolutely necessary to solve all corrosion and scaling problems before any major investment.

6.2.5 Ziar Nad Hronum (Slovakia)

6.2.5.1 Effectiveness

It is not possible, really, to assess the effectiveness of the project, since the project was closed down before it was ever concluded. The drilling of the first production well was completed at the beginning of 1999, but unfortunately, the drilling hit a so-called "chimney". Geologists concluded that the first well can be used neither as production well nor as re-injection well. Deviation from the well would not be possible due to the shape of the "chimney". The investment in the first production well, therefore, has been lost.

While financing and drilling another alternative production well remained an option for some time, a competing natural gas project, based on a gas fired boiler plant in the vicinity of the existing ZSNP coal fired boiler, won approval in the town of Ziar. This effectively stopped the geothermal project and left it without hope of a revival any time soon.

The feasibility study forecasted a high economic viability with a financial rate of return (FRR) of up to 15.3 per cent and an economic rate of return (ERR) of up to 36 percent. Since natural gas prices increased from 3.6 SEK/Nm^3 (August 2000) to 4.1 SEK/Nm^3, this would have made utilization of the geothermal energy resources located in the Ziar nad Hronom area further economically viable.

6.2.5.2 Impacts

The impacts of the *Ziar nad Hronum* geothermal project will not surface, since the project will not materialize. In terms of environmental impacts, the Ziar geothermal project was expected to generate a heat production up to 713 TJ/year, with emissions of CO_2 decreasing with approx. 72 000 tonnes/year.

In quantitative terms based on a coal reference scenarios reductions imply between 7,816 and 101,800 tonnes of CO_2 per year.

6.2.5.3 Sustainability

Despite an April 1999 project document, confirming wishes by the City of Ziar nad Hronum to implement the geothermal project including a letter of intent from the Mayor of the city, and the formation of the geothermal district heating company, the fate of the Ziar Geothermal project was determined when a competing project won the approval of the city administration.

By early October 2000 it was clear that the geothermal company (ZSNP Geothermal S.R.O.) was financially very weak or even bankrupt and not capable of financing further geothermal work, let alone paying for the drilling performed. A new company - ZSNP Energia S.R.O. – was formed, and on 18 October 2000 it was announced that ZSNP Energia S.R.O. had signed a contract for establishing a combined heat and power plant (gas turbine) for the production of 800 TJ heat per year, budgeted at SEK 160 million. The town of Ziar is not among the shareholders in Energia.

6.2.6 Decin (Czech Republic)

6.2.6.1 Effectiveness

From a “geothermal” point of view, the Decin project is an example of a composite project, where geothermal energy is integrated with other sources of energy into a single project. The DEPA input into the geothermal dimension of this project was in the form of an initial grant for technical exploration of the geothermal potential in the Czech Republic and a subsequent grant to the two Danish companies (DONG A/S and Bruun & Sørensen).

In partnership with two Czech companies, TERMO Decin and Aquatest, the two Danish companies performed production tests and then implemented and integrated the geothermal component into the gas fired CHP. The geothermal water has thus been utilized for improvement of the district heating and the hot domestic water supply to buildings serves approximately 1 600 flats. The quality of the geothermal water in Decin meets the requirement of the Czech standard for drinking water and serves as such.

The geothermal component substitutes prior use of lignite fuel. With the CHP plants, the distribution systems were modernized in different ways, including by means of a pre-insulated two piped system. The housing blocks were equipped with individual substations, which take care of the preparation of secondary district heating water and hot domestic water. This project includes both a CHP plant based on gas engines, peak load boilers, heat storage tank and a modernisation of the distribution network. And, of course, the project includes use of the geothermal energy available in the subsoil.

Based on the Decin case study as a whole, including the number and pace of analyses performed, all indications point to a geothermal project component that has been very effectively established and integrated into a CPH modernization project.

6.2.6.2 *Impacts*

The energy savings of the geothermal project component, compared to the old system are:

- 12 300 GJ/year of heat savings due to utilization of geothermal water of 32 °C instead of cold drinking water having a temperature of 10 °C.
- 6 900 GJ/year by eliminating heat losses in the hot domestic water circulation between the central heat exchanger units and the buildings.
- 4 000 GJ/year are saved due to the individual temperature control in the compact heat exchanger units.
- 260 MWh/year of power by eliminating hot domestic water circulation pumps.

The total energy savings of the project are thus more than 50 per cent compared to the old system for preparation of hot domestic water from cold drinking water.

As far as the green house effect is concerned, it is only about 30 percent compared to the old coal fired sources, and regarding the three other environmental effects the improvements are even better. In terms of emissions, the following savings estimates apply:

- CO_2 25 000 t/year
- SO_2 354 t/year
- NOx 52 t/year
- 545 tonnes particles/year
- 5 000 t flying ashes/year

6.3 Summing Up the DANCEE Project Experience

Opposite to the Oil-Gas sector, where establishing a new project is a standard procedure, GE projects have tended to be a matter of starting from scratch each time. Partly, this difference is natural due to the variability in natural conditions from site to site. One may well argue, however, that a more "standardised" approach in exploring and implementing GE projects would be desirable. This part of the GESA report represents an ambition to provide a foundation for such an approach, building on lessons learned from geothermal projects already implemented in the CEECs.

Visits to project sites and interviews with project stakeholders have produced a series of *lessons learned* from the DANCEE projects implemented so far. These lessons are categorized and listed in the box below. Some of the lessons refer to several or all projects, but in cases where the lessons are more project specific, the particular reference project(s) is (are) indicated.

Box 6.3-1: General Lessons Learned from DANCEE Projects

General Lessons

- Direct use of geothermal energy in CEECs has been shown so to be feasible under present conditions.
- National and local capacities for geothermal project implementation vary considerably within and between CEECs. Consequently, prior to project implementation national/local capacities should be assessed carefully.
- Designing an optimal geothermal energy project is a complex task.
- It may be useful to phase geothermal projects (Pyrzyce and Kosice).
- The geothermal industry is homogenous, small and disbursed.

From the consultants' visits to geothermal project areas throughout this study, a general experience is, that the most successful projects are typically implemented in regions where local people were aware of GE and its potential prior to project implementation and did support the general project idea. A second general point to be made is that, due to the great complexity of geothermal projects, some flexibility is needed in order to carry out a geothermal project in the most adequate way. This can be done through a division of the project into phases, as it has already been done in some of the projects. Finally, but important, the geothermal industry is still small and without really strong suppliers. This, of course, is related to the fact that geothermal energy projects represent a rather new market and that demand for project equipment still is limited.

6.3.1 Economic Lessons Learned from DANCEE Projects

In box 6.3-2 some central economic lessons from the DANCEE projects are listed. It has been quiet evident that the existence and availability of national co-funding mechanisms helps to attract international project financing. However, small projects, ranging typically between USD 1 and 5 million, are often very difficult to obtain funding for, since they are considered to be too big for local financing only and too small for major IFIs and donors to get involved. Moreover, CEEC stakeholders generally consider IFIs to be bureaucratic to co-operate with, and the process of obtaining IFI loans/grants is deemed to be extremely time consuming and a rather complex task. In this context, DEPA funding is praised for being much more flexible and "user-friendly".

Relative low cost of fossil fuels in general, and natural gas in particular, means that currently only the "best" geothermal resources can compete economically with existing, conventional, energy sources. The loss of hydrocarbon reserves and the emission of CO_2 from burning of gas and/or other hydrocarbons, is not a prioritised environmental problem in all CEECs and, consequently, clear economic incentives for GE are lacking. In such CEECs it may be difficult to obtain significant private/national financial support for geothermal plants and international funding (donors, IFIs) is therefore needed in order to demonstrate opportunities for cost efficient CO_2 reductions from geothermal plants.

Box 6.3-2: Economic Lessons Learned From DANCEE Projects

Economic Lessons

- The existence and availability of national co-funding mechanisms helps to attract international project financing (Zakopane, Podhale).
- Relatively low cost of fossil fuels in general and natural gas in particular means that currently only the best geothermal resources are competitive from the viewpoint of contemporary private investors.
- Existing mechanisms for obtaining (international) loans and grants for geothermal projects are, by the CEEC stakeholders, claimed to be very time consuming and bureaucratic. In this context, DEPA funding is, however, praised for being much more flexible and "user-friendly".
- Direct use of geothermal energy for heating in CEECs is feasible. Current development trends are expected to improve these conditions and may serve to promote geothermal energy use.
- The potential market for direct use of GE exists when there is *short distance from resource to user* and *local demand*. This means that the most suitable markets for geothermal energy are district heating applications – including horticulture and fish farming situated near the reservoirs and plants. The use of a geothermal *Cascade System* may further improve the economic efficiency of geothermal plants.
- In places where heating distribution networks and boreholes already exist, project costs are significantly lower.
- Lack of payments from DH consumers for energy use is affecting most geothermal projects in the CEECs, and represents a serious thread to the economic foundation of the projects.
- High costs of new drillings, and the risk related hereto, represent an important barrier for project implementation (Ziar Nad Hronom).
- Small projects, ranging typically between 1-5 million USD, are often the most difficult to obtain funding for since they are considered to be too big for local financing only and too small for major IFI's and donors to get involved (Southern Poland).
- Currently, in some CEECs the loss of hydrocarbon reserves and the emission of CO_2 from burning of gas and/or other hydrocarbons is not a prioritised environmental problem and, consequently, clear economic incentives for GE are lacking. In such CEECs it is seen as difficult to obtain financial support for geothermal plants, and international funding (donors, IFI's) is therefore needed, in order to demonstrate opportunities for cost efficient CO_2 reductions from geothermal plants.

The most suitable markets for GE are where district heating applications – including horticulture and fish farming – are situated close to the reservoirs and plants, and in areas where costumers in general can be expected to pay for their use of energy. The use of geothermal *Cascade Systems* may further improve the economic efficiency of geothermal plants. The need for new drillings often represents a significant economic risk for the projects, particularly if the quantity and quality of the geothermal water resources identified by the drillings shows up to be well below the expected levels.

6.3.2 Environmental Lessons Learned from DANCEE Projects

Box 6.3-3: Environmental and Technical Lessons Learned from DANCEE Projects

Environmental and Technical Lessons

- Environmental effects of geothermal projects supported by DEPA have been significant in terms of reduced emissions, in particular, CO_2.
- Technical problems (related to drillings and project equipment) can significantly delay project implementation and, in the case of demonstration projects, seriously affect local geothermal project confidence (Klaipéda).
- While CEECs have demonstrated high local capacity to develop and implement geothermal projects, transfer of (Danish) know-how has so far proven to be a crucial factor in achieving successful project results.
- Geothermal plants should be dimensioned with future, and not current, energy consumption in mind, accounting for more energy efficiency and energy saving measures (Kosice and Pyrzyce).
- In the CEECs comprehensive geological data for geothermal energy development is now available, and much technical research and analysis have been made.

In box 6.3-3 the main technical and environmental lessons are listed. Not all of the DEPA-funded geothermal projects are fully operational yet, but significant reductions in emissions of SO_2, particles, and CO_2 in particular have nevertheless already been obtained. Geothermal projects have therefore so far shown to be good investments from an environmental point of view.

On the technical side, it has been found that problems related to drilling and project equipment can delay project implementation significantly. In the case of demonstration projects, this can seriously affect local confidence in GE. Moreover, it is of crucial importance that geothermal plants will be dimensioned on the basis of expected *future* energy demand, taking possible implementation of energy efficiency and energy saving measures into consideration. Some geothermal plants today operate with excess capacity because they were dimensioned based on base-line rather than prospected energy demand.

Inputs from Danish sector experts have been an important factor in achieving successful geothermal project results so far. However, it must also be recognized that the CEECs have demonstrated high and increasing capacity to support project planning and implementation. It has also been found that comprehensive geological data for geothermal energy development is available in the CEECs, and much technical research has been done.

6.3.3 Political/Institutional Lessons Learned from DANCEE Projects

Box 6.3-4: Institutional Lessons Learned from DANCEE Projects

Institutional Lessons

- It is important to clarify *institutional structures and ownership rights* related to project implementation between state, regional/local authorities and private companies to minimize risk for disputes and disagreements after project start up (Klaipéda, Kosice and Ziar nad Hronum).
- In the field of environmental protection and renewable (geothermal) energy, responsibilities often overlap between ministries and public institutions in the recipient country.
- The establishment of *geothermal shareholder companies*, involving also the municipalities in question, to be responsible for project implementation has shown to be an effective way to obtain project commitment and sustainability.
- *Local project involvement,* including financial and political responsibility and commitment by local authorities, institutions and consumers, is crucial for project success.
- Efficient support on *project management/organisational issues* is essential in order to create sustainable, local capacity but also to secure smooth project implementation on all levels. More focus is required on how to establish a supportive relation between the local project office (project plant) and foreign firm(s) contracted for project management/organisational support (Klaipéda).
- Potential for conflicts of interests with alternative energy suppliers of heat should be assessed prior to project implementation (Ziar nad Hronom and Klaipéda).

Box 6.3-5: Policy Lessons Learned from DANCEE Projects

Policy Lessons

- While national CEEC policies have generally not been concerned about the realisation of national geothermal energy potentials, regions with proven geothermal resources often demonstrate strong political interest in favour of geothermal energy.
- DEPA (DANCEE), and the Danish Experts contracted, has a good reputation in the CEECs from their involvement in geothermal project activities, as well among local stakeholders as among other international geothermal "players".

In box 6.3-4 and box 6.3-5 the main institutional and policy lessons learned from the DANCEE projects are listed. It is important to clarify *institutional structures and ownership rights* prior to project implementation between state, regional/local authorities and private companies to minimize risk for disputes and disagreements after the project has begun. In the field of environmental protection and renewable (geothermal) energy, responsibilities often overlap between Ministries and public institutions in the recipient country.

National CEEC policies have generally not been very concerned about realising national GE potentials. Regions with proven geothermal resources, however, often demonstrate strong political interest in favour of GE. It is therefore deemed essential that local and regional levels will be involved early in the project process through financial and political responsibility and commitment by local authorities, institutions and consumers. The establishment of *geothermal shareholder companies* has shown to be an effective way of obtaining project commitment and sustainability.

DEPA (DANCEE) and the Danish experts contracted are well regarded in the CEECs, - both among local stakeholders and between international geothermal "players". In this regard, the Danish support on *project management/organisational issues* is considered essential in creating sustainable local capacity, but also in securing smooth project implementation on all levels. Additional focus is however required on how to establish a supportive relation between the local project office (project plant) and foreign firm(s) contracted for project management/organisational support.

6.4 Other Project Experiences

In addition to the DANCEE projects, two other geothermal projects in the CEECs, involving other sources of financing, have been visited and assessed through this study, namely the Galantaterm (Slovakia) project and the Mszczonów (Poland) project.

6.4.1 The Case of Galantaterm (Slovakia)

6.4.1.1 Project Investment and Feasibility

With its wells drilled under a (1972-99) state programme, the Galantaterm plant and company is in effect a result of a complexity of "projects". Co-owned by NEFCO and the Icelandic company *Orkuveitor* (earlier known as Heitaveita), the Slovak Gas Company (SPP), Slovgeoterm, the City of Galanta[5] and Orkustofnun (Iceland), the Galanta "project funding" is equally complex. Galanta was carried out partly based on a loan from NIB, taken through SPP. Further, the NEFCO is a co-investor, and local sources of finance – from the city to local companies – have invested in the enterprise. As a consequence, an assessment of "economic efficiency" is not attempted within this case study. Instead, other lessons are pursued.

As a result of the Galanta geothermal station, the conventional boiler station in the town hospital (coal based) could be closed. The conventional station consumed 6200 t of coal annually and produced 330 t SO_2, 36 t NOx, 159 t

[5] According to law, the wells belong to the town of Galanta – thus the ownership construction with the town as co-owner

CO_2 and 600 t breeze. The charges in terms of pollution fees were 156 000 SEK. The consumption of gas in the boiler station, on the habitation „Sever“, was decreased from 3 mil Nm3 to 1.2 mil. Nm3 of gas. This is equivalent to a decrease in emissions in the order of 60 per cent against the earlier situation in the state (Takacs – Grell, 2000). Thus, the project brought substitution of conventional heating in an estate with 1,243 flats (earlier heated by gas) and at a hospital (earlier heated by solid fuels – lignite).

6.4.1.2 Project Assessment

In 1996 the first geothermal heating plant, with a capacity of 8 MW, in Galanta town was installed. With its 2 geo-wells of 20 MW from 78° C hot water, Galantaterm today heats up approximately 1 300 flats and a hospital.

In terms of environmental benefits, the two geothermal wells have proven sufficient to provide enough heat until outside temperatures goes below +2°C, in which case gas is used to add heat to the circulation water. The project therefore has eliminated emissions from solid fuels and reduced emissions from gas. On the potentially negative side, the so-called “inhibitors” used, are classified as “non-toxic”, and being instead classified as “waste water” (in accordance with the decree of the environmental department of the regional office in Trnava). 537 008 m^3 of water at 9 – 16° C flows into a river.

In terms of financial/economic sustainability, SPP is paying back the loan to NIB. Galantaterm, however, is not able to pay SPP, because Galanta State Hospital does not pay the full amounts charged for supplying heat to the hospital. This situation, of course, represents a major problem to Galantaterm. Already, the State Hospital has accumulated a large debt, and currently only pays SEK 600 000 of the SEK 1.5 million billed monthly. As 51 per cent of Galantaterms production of hot water (and some steam) goes to the Hospital, and 54 per cent of Galantaterm´s income comes from the hospital, this problem is significant. So far, however, Galantaterm has been able to survive and function stable, because the city-owned flat-building enterprises do pay their bills.

In terms of *technological* sustainability, it has been possible to solve all technical issues so far. Interestingly, a potential has been identified for further improving the environmental sustainability of the operation by re-injecting the water now discharged (there seems to be an unexploited potential for further improvements, by way of re-injecting the warm water into the reservoir, instead of into the river Váh).

Galantaterms organisational set-up has proved stable and functional and the company has demonstrated good working relations with both national and international project counterparts – the latter including the Nordic finance institutions and Icelandic companies.

In terms of institutional and political sustainability Galantaterm has initiated negotiations with the Ministry of Health, but has so far only been given “promises”. The future of Galantaterm will very much rely on to what extent recent laws reforming the energy market will be enforced. For instance, by 1998 a law stipulated that if gas prices went up by more than 10 per cent, the government would be obliged to increase the prices charged to consumers. As for the year 2000, however, heat suppliers in Slovakia were not allowed to increase their prices charged to consumers, despite the fact that gas prices had increased over 1999.

6.4.2 The Case of Mszczonów (Poland)

6.4.2.1 Project Investment and Feasibility

In August 1996, research and development was started in order to investigate the scope for development of a geothermal project plant in Mszczonów by reconstructing an existing old, closed well. A 4.1 km well, drilled in the 1970s, was adopted for exploitation purposes. The geothermal aquifer is located in the Lower Cretaceous sandstone, which contains high quality drinking water (Total Dissolved Solids (TDS) are less than 1g/l). The capacity of the geothermal/gas plant was dimensioned to 7.5 MW, hereof 2.3 MW stems from the geothermal plant, the rest would be absorbed from heat pump and gas. The geothermal plant uses 40° C water discharged by a single well for both heating purposes and drinking water production.

Total project investment is 11 million Polish Zlothy (around 3 million USD). The shareholder company, Geothermia Mazowiecka S.A. (consisting of Mszczonów Municipality, National Fund for Environmental Protection/Water Management (Polish) and some smaller funds) has provided 7 million Zlothy for the project. The remaining funding has been provided by the Polish EcoFund (grant, 2 million Zlothy) and by Polish Banks (loans, 2 million Zlothy)

From Denmark equipment (mainly economizers and controlling/electrical equipment) and training (on project site) have been provided. The total value of the Danish component is 1.6 mill. Zlothy. Locally, there is overall satisfaction with the performance of the Danish companies involved in this project.

The energy market in Mszczonów is composed by a mix of flats, public buildings and industry, including a significant tax-free industrial zone. The district heating network in Mszczonów covers around 60 percent of the potential consumers in the town, including approximately 1,200 flats and public buildings (schools, medical centre etc). Based on consultations with consumer groups, and calculations, it was decided to dimension the geothermal/gas plant for the whole area, also including consumers who were using other heating sources (coal).

6.4.2.2 Project Assessment

The geothermal/gas heating plant in Mszczonów is fully completed and has been operational since May 2000. The project has successfully demonstrated how to convert an old abandoned well into a well-functioning geothermal production well. This is a very important experience, taking into consideration that thousands of these abandoned wells exist in Poland and that some of them could represent interesting potentials for geothermal energy.

The thermal energy provided by the district heating company in Mszczonów is 37,000 GJ per year, including 40 percent geothermal and 60 percent gas. The change of heat source, from coal to gas/geothermal, has had significant environmental effects. CO_2 has been reduced by 74.8 per cent, SO_2 by 100 per cent and NOx by 82.9 per cent. Moreover, it has been possible to cover project costs through national (Polish) funding that in turn has made the project more smooth and flexible and has facilitated a more rapid project implementation.

Due to limited funding potential and unfavourable development in relative energy prices, Geothermia Mazowiecka S.A. currently faces some economic difficulties which have prevented an extension of the consumer base to more than the 60 per cent originally covered. Moreover, new pipes in the town have been installed, and financed, by Geothermia Mazowiecka S.A. and this puts additional pressure on the company's financial resources.

Given that socio-economic conditions in Mszczonów are different from those in the Southern Poland, local project impacts (for instance, employment effects and changes in energy prices) are relatively strong here. The staff of 30 persons formerly employed by the district heating company has now been reduced to only 3 persons working on the geothermal plant. Since the area is severely affected by unemployment this has naturally caused some social dissatisfaction at local level.

The institutional set-up of the geothermal company (with only one municipality involved but as major shareholder) gives the project a strong local anchoring. From the early stages of project development the Mszczonów Municipality has played an active role, also financially, and the urban environment of Mszczonów has been improved by the geothermal project. Nice green areas have been created in the town with water posts with drinkable geothermal water in the centre.

6.5 Summing Up other Project Experiences

The Galantaterm case study demonstrates that exploiting geothermal energy in Slovakia is indeed feasible, given the proper conditions. At the same time, Galantaterm suffers from the general socio-economic conditions and developments currently affecting the Slovakian energy sector. This includes a situation where local consumers are currently not willing, or able, to pay their heating bills.

The Mszczonów project has demonstrated important lessons with regard to the use of closed wells and how to obtain local project financing and anchoring for small scale geothermal projects in Poland. However, regional socio-economic conditions, as well as national energy price policy, have to some extend affected the economic foundation of the project. As in other CEECs, the prospects (EU integration and further market liberalization) indicate more positive perspectives for future relative development of energy prices.

6.6 Selection Criteria for Best Practice Project Design

The experiences and lessons learned presented in the previous sections may be translated into a set of criteria to guide, govern and prioritize future efforts in the field of developing geothermal heat plants.

One may consider four different categories – technical, environmental, economic and institutional criteria (boxes 6.6-1-6.6-4) – which should all be carefully considered prior to GE project implementation. Technical project selection criteria's are shown in box 6.6-1.

Box 6.6-1 Technical Selection Criteria for GE Projects

Technical selection criteria should include:

- Heating distribution network and/or boreholes (existence, quality).
- Technical Data (availability and quality), including site conditions, water temperature, type and size of reservoir, flow rate and TDS, depth of resource, chemistry of the geothermal fluid, permeability of the resource.
- Local heat demand (current/future).
- Potential for integrating GE into a system of two or more energy sources.
- Technology options for the proposed geothermal plant.
- Infrastructure facilities and requirements (roads, port etc).
- Proximity of transmission lines (gas, oil).
- Existing human resource base, national/regional/local, public/private.
- National production of, or capacity to produce, GE equipment.
- Alternative systems.

The following factors (box 6.6-2) should be taken into account, in environmental analysis of geothermal prospecting.

Box 6.6-2 Environmental Selection Criteria for GE Projects

Environmental criteria include:

- Reduction of emissions.
- Water mining.
- Environmental economic incentives.
- Energy efficiency and energy saving measures (option for project co-ordination).
- Other environmental issues.

One important and a major finding of this strategic assessment performed is that *institutional factors* are of paramount importance for investments in geothermal projects to yield successful results. Thus, among the remaining barriers for implementation of geothermal projects are institutional problems, including some of regulatory and financial character.

The following factors (box 6.6-3) should be taken into account, in institutional analyses of geothermal prospecting.

Box 6.6-3 Institutional Selection Criteria for GE Projects

Institutional criteria should include:

- EU approximation process.
- National laws and policies.
- Local/regional policy/strategy on energy and environment priorities.
- Regional/local, political commitment and capacity, including e.g. any existing energy development plan, at the local government or municipal level, explicitly committing the local administration to develop geothermal energy.
- National energy policies providing a role for renewable energy in general and geothermal energy in particular.
- Instruments to promote relevant policy objectives and make them operational.
- Critical mass of stakeholders, both at the local, national and international level.
- Division of responsibilities between ministries and public institutions, as well as between different political levels (national/regional/local).
- Project management set-up.
- Project ownership.

The following factors (box 6.6-4) should be taken into account when determining economic potentials of geothermal projects.

Box 6.6-4 Economic Selection Criteria for GE Projects

Economic selection criteria should include:

- Total investment needs and risks[6].
- Internal rate of return (project).
- Consumer potential and pattern of consumption (current/future).
- Government risk sharing and insurance.
- Availability of national funding for project financing.
- International co-funding options (IFIs and/or donors).
- Relative national/regional energy prices (current/future).
- Degree and form of privatisation/liberalization of national energy markets.
- Socio-economic situation in project region.
- Market for CO_2 emissions (carbon credits, documentation).
- National/regional/local taxes or royalties, other indirect costs or subsidies.
- Economic potential for integrating GE into a system of two or more energy sources (e.g. peak load plants).
- Opportunity cost (of technical alternatives)[7].

[6] Risks should, in particular, include the risk related to first drilling.
[7] Direct quantitative comparison between GE and other renewable energy (RE) sources are complex, of course, both because of great variations between GE projects

The above lists should not be considered exclusive and other criteria might be relevant as well, reflecting the specific project context. However, the criteria included in the four boxes above have been identified through evaluation and assessment of DANCEE GE projects and should represent a minimum set of criteria to apply in selection between and assessment of project proposals.

The list of criteria and the lessons learned gives us the possibility to define a best practice project design. This design is presented in brief in the subsequent section.

6.7 Best Practice Project Design

Following the experiences with geothermal projects funded by DANCEE[8], a best practice or ideal project design may be characterized by the following traits (box 6.7-1 – 6.7-4). The specific content of the preconditions depends on the project context and should always be qualified in accordance with this. Technical parameters to be included in a best practice project is outlined in box 6.7-1.

Box 6.7-1 Best Practice concerning Technical Issues

Technical Issues:

- A heat distribution network is in place and of a good quality
- Boreholes are available and functioning or
- Good quality geothermal data are available, reducing risks for making empty boreholes.
- Water temperature high.
- Reservoir type and size adequate to expected market demand.
- Flow rate and TDS are acceptable
- Local technical capacity is adequate for management and implementation of GE projects.
- Up-dated heat demand (current/future) analysis is available.

Expected environmental benefits and impacts from geothermal projects are a crucial parameter for obtaining of donor funding and loans for project implementation. Main environmental parameters for best practice projects are listed in box 6.7-2.

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and because other RE sources currently also undergo rapid developments. One attempt to do this was done in the EU Blue Book (table 4.4 and/or 4.7, page 43,45).

[8] The experiences of other projects than DANCEE projects have also been fed into the list of preconditions for a best practice project.

Box 6.7-2 Best Practice concerning Environmental Issues

Environmental Issues:

- Significant environmental impacts locally/regionally and nationally/globally, due to substitution of polluting energy sources, and efficient energy distribution and use, have been foreseen.
- Implementation of national policies in recipient countries are devoted to reduction of greenhouse gasses and other pollutants.
- Geothermal systems must be in accordance with local/regional principles of sustainability.
- There is co-ordination with energy/environmental projects/programmes to increase impact of investments.

Economic parameters to be considered when selecting best practice projects are listed in box 6.7-3.

Box 6.7-3 Best Practice concerning Economic Issues

Economic Issues:

- Energy prices are liberalized, or clearly in the process to be so.
- Co-funding is available, nationally and internationally.
- A liquid local market for heat exists and is accessible, and up-dated market surveys are available.
- Local, financial commitment is in place.
- Feasibility studies have been or are being prepared.
- State guarantees are provided.
- State funding programme(s)/mechanism in support of renewable (geothermal) energy development, are approved and in operation.
- Complementary roles of private and public capital, loans versus grants synergic.
- Environmental and other hidden costs are explicitly accounted for in project proposals

Institutional issues are considered to be of crucial importance for project sustainability and impact and best practice projects should be based on issues listed in box 6.7-4.

Box 6.7-4 Best Practice concerning Institutional Issues

Institutional Issues:

- National laws are in place and support GE development.
- National laws and regulations on (foreign) investments and trade are in general support of GE development.
- Clear policies and strategies in support of renewable (geothermal) energy are in operation, or are to be implemented shortly.
- A suitable project management set-up is proposed.
- Project ownership is clearly defined.
- Capacity for project implementation exists at all critical levels, or can be created without major difficulties.
- GE is accepted and recognized locally as an alternative energy source (local population support).
- Decentralization of responsibilities is in place, in particular what concerns energy and environmental issues.
- Information channels between regions and government are working well.
- Clear responsibilities are defined between ministries and public institutions as well as between national/regional/local political levels, within the field of renewable (geothermal) energy and environmental protection. Preferable, there will be only one institution/organisation in the recipient country responsible for project preparation and implementation.

7 The Prospective Analysis

7.1 Geothermal Energy in the CEECs – Towards a Renaissance

Less than a generation ago, most CEECs had extensive budgets for geological research with a view to use geothermal energy. Many geothermal reservoirs were identified and exploitable reserves evaluated - though often with a view to recreational use. Wider applications of the underground hot water resources as an energy source for district heating were not considered, both due to high investment costs and artificially low energy prices.

The development of existing GE reserves in CEECs is still relatively modest. Comparing practical GE accomplishments in the last seven years across the CEECs, Cohut and Bendea (1999) conclude that these accomplishments were modest, and that despite assistance from West European countries – Denmark, France and Iceland and the EU - the projects took a long time and great effort. Importantly, however, Cohut and & Bendea also identified the major cause: the legal and financial changes experienced by the countries with their economy in transition.

While some new installations have been made recently in the CEECs, as the period of transition is gradually completed and taken over by an advanced degree of European integration, most existing district heating systems and plants still use older technologies. Most towns in CEECs are heated by district heating systems, based on coal or other fossil fuels, but the DH systems are often presented with major problems, including difficulties in attracting capital investments.

From a point of view of GE prospects the existing heating infrastructure in the CEECs is an advantage but the current physical conditions of the DH systems often make GE project implementation less attractive. The CEEC district heating systems operate with relatively high temperature levels compared to, for instance, the temperatures used in the Danish DH systems. A major, and related, challenge to GE implementation in the CEECs is therefore to improve the local DH systems in order to be able to make efficient use of the existing low-temperature geothermal resources.

Indications are that geothermal energy for heating in the CEECs may be facing a renaissance. The reasons for this are many, here only a few main factors will be mentioned.

First, the ongoing process of transition in the CEEC from *planned to market economies* and the parallel *enlargement process* of the European Union have great implications for structural reforms within the energy sector, harmonization of environmental standards, energy prices and policies within the CEECs. The direction should be towards more favourable conditions for renewable energy development, including geothermal energy. At an indication of the scope of this potential it is the EU objective to double the share of renewable energy in energy supply during this decade.

Secondly, the past decade brought *new environmental treaties* and legislation affecting energy production and use. Consequently, renewable forms of energy are increasingly perceived as competitive compared to conventional sources of energy. The implementation of the Kyoto protocol is expected to influence the cost benefit equations of the energy sector strongly, as environmental externalities that used to be invisible in the conventional economic regimes, are now accounted for.

Thirdly, n*ew technological developments* have increased the number of countries, regions and locations with real potential for GE development. These advances influence the competitiveness of geothermal energy and may open up new applications for the same.

Fourthly, greater awareness and acceptance of GE by political decision makers, in particular at regional and local levels, are opening up new and stronger institutional support mechanisms for geothermal energy development.

These factors have renewed the focus on geothermal energy in the CEECs. Some additional traits making geothermal heat an attractive and competitive source of energy for the CEECs is revealed in box 7.1-1.

Box 7.1-1 Some Virtues of Geothermal Energy

- GE is a reliable and safe local energy resource, reducing especially SO_2, CO_2 and other emissions harmful to the environment and human health.
- GE may reduce a region's need for imported fuels.
- GE is a renewable source of energy reducing the need for fossil fuels
- Geothermal plants operate continuously, compared to, for instance, wind and solar sources.
- GE has an inherent storage capacity and thus does not require storage and transportation of fuels.
- Several CEECs have a long tradition for direct use of geothermal energy, mainly for recreational purposes.
- In the CEECs, district heating networks exist in many places, thus lowering the investment needs.

In the following, a brief summary is given of the analysis undertaken of the five DANCEE focus countries (Russia, Ukraine, Poland, Romania and Slovakia) regarding their capacity and potential for geothermal project development (Volume II of this study contains a more comprehensive profile of each focus country). First, in section 7.2, an overall overview of some central energy and environmental aspects is presented for the five focus countries. The sections 7.3-7.7 contain a more specific assessment of technical, economic and institutional factors determining geothermal capacities and potentials within each focus country. Finally, in section 7.8, a comparative assessment of the five focus countries is undertaken in order to compare technical, environmental, institutional and economic components related to geothermal energy development within these countries.

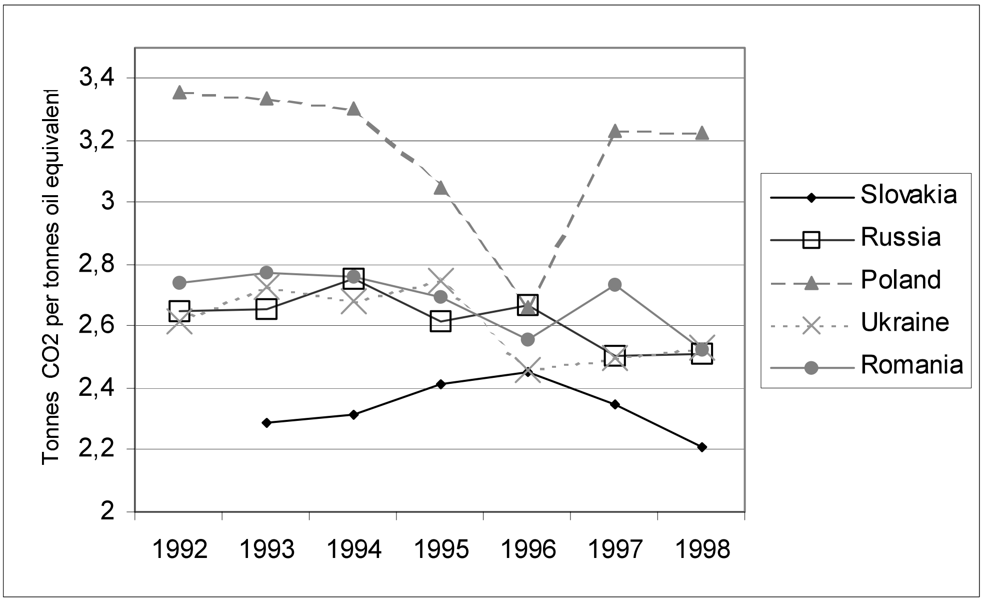
The following section is based on energy and environmental data from the Country Profiles, Volume II. The data covers the period 1990-99, which are the years from which the last official EIA figures were available, covering all countries in question. Even though some changes may have occurred since, the presentation here may still give a rough picture also of current conditions.

CO_2-Saving Potential – Fossil Fuel Analysis

In view of the Kyoto Protocol and related carbon reduction initiatives, CO_2 emissions have moved to the front line of energy and environmental projects and programmes.

Figure 7.2-1 shows the level of CO_2 emissions (tonnes CO_2 based on emissions from consumption and flaring of fossil fuels) per used energy unit (tonnes oil equivalents - TPES).

Figure 7.2-1 CO_2-Saving Potential – Tonnes CO_2 per Tonnes Used Energy (Toil Equivalents)

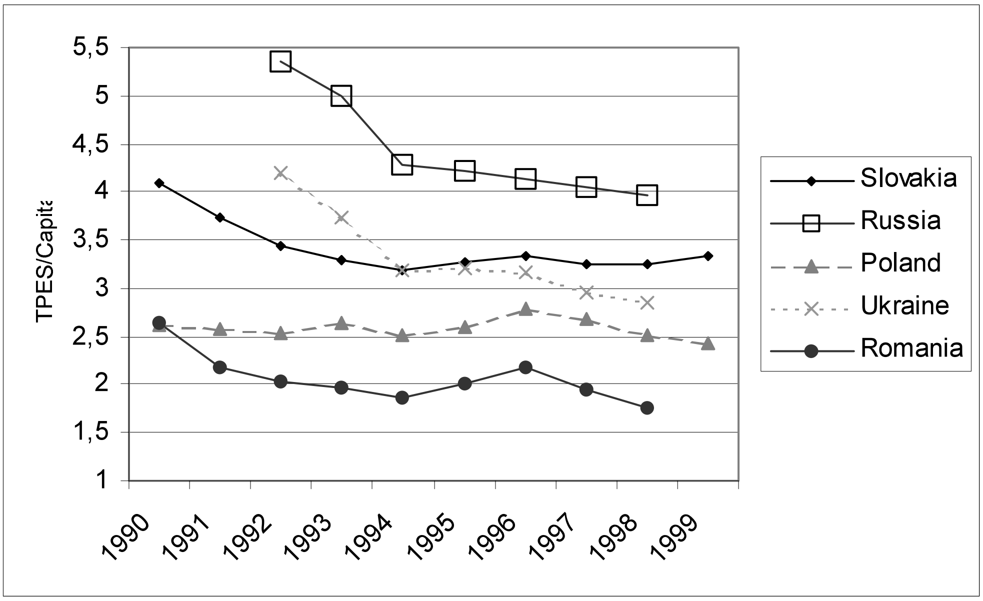


Sources: IEA, International Energy Agency, EIA, Energy Information Administration, http://fossil.energy.gov/international/romnover.html
Note: Data on CO_2 emissions are, in the case of Romania, collected from a different source than the other countries.

When looking at the five focus countries in figure 7.2-1, three clusters can be identified; Poland as one cluster in the high end, Romania, Ukraine and Russia placed close together in a cluster in the middle range, and then finally Slovakia placed significantly lower than the other countries.

Based on figure 7.2-1 alone, it is not possible to determine what causes this difference in CO_2 saving potential between the countries in question. It can either be due to a relative high/low level of CO_2 emissions per used energy unit or to a high/low level of energy use (TPES). Therefore, a closer look at the energy use and its composition will give a better insight in this issue.

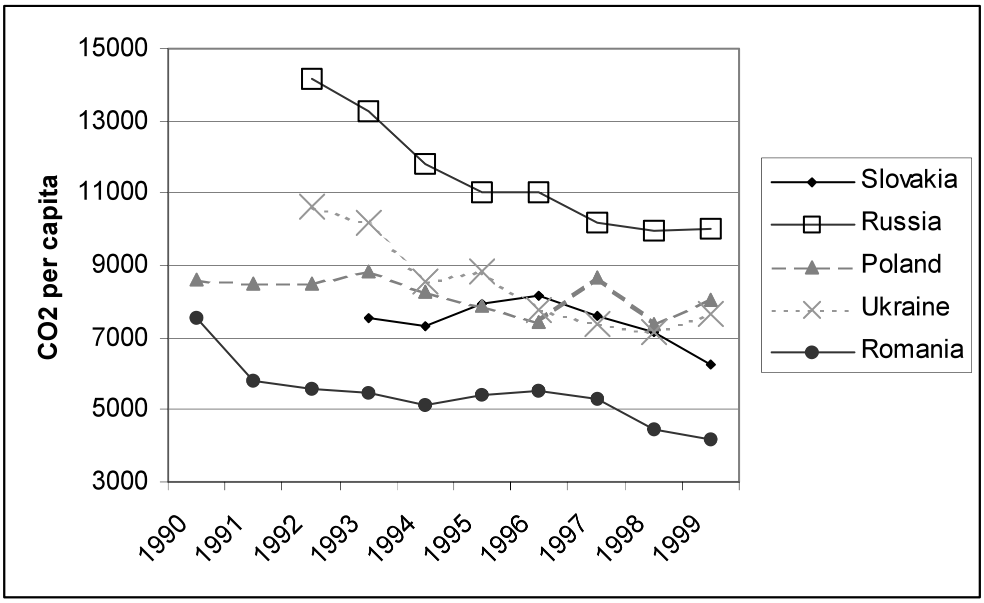
Figure 7.2-2 Annual Energy supply per Capita (toe per capita)



Source: IEA, International Energy Agency

Figure 7.2-2 shows that concerning annual energy supply per capita, Russia is placed in the top end and Romania at the bottom. In relation to figure 7.2-1, it is interesting to note that Poland turns out to have the second lowest energy supply per capita of the five focus countries. It is also important to note that a high national energy supply can be caused by a high energy consumption, as well as by a poor technological state of the 'energy system'. From figure 7.2-5 (energy efficiency) an indication of the technological stage on an aggregated level is given.

Figure 7.2-3 Kg CO_2 emissions per Capita[9]



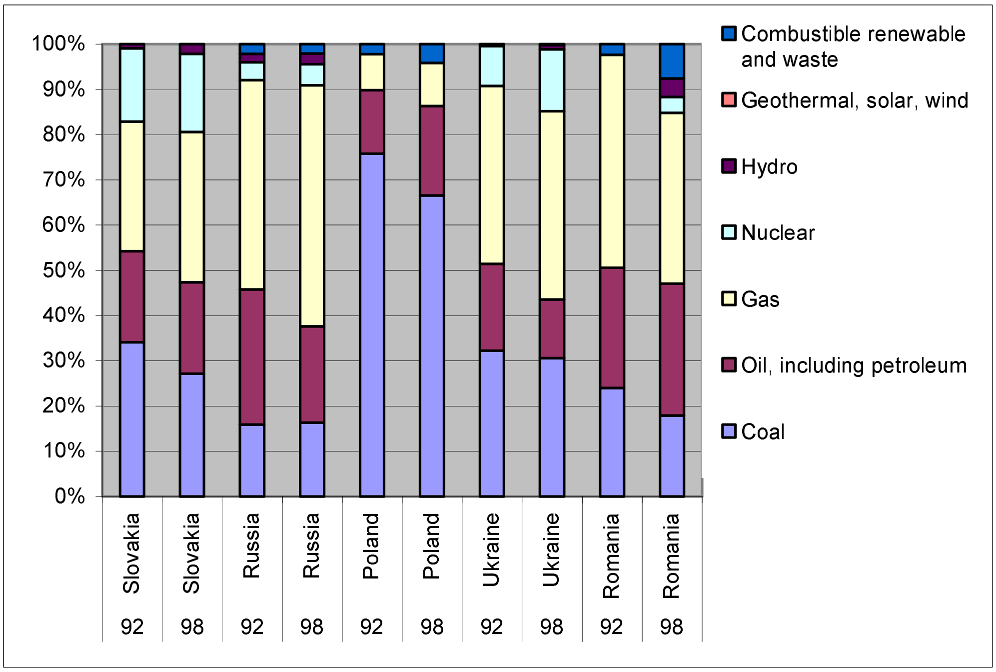
Source:
IEA, International Energy Agency
EIA, Energy Information Administration
http://fossil.energy.gov/international/romnover.html (Romania)

[9] Data for Romania are collected from a different source than for other countries. For 3 years data from the two sources overlapped and these years have been checked for comparability.

Figur 7.2-3 shows that Russia has by far the highest CO_2 emission per capita and Romania the lowest. This follows the trend from figure 7.2-2. However, it should be noted that Poland and Slovakia has changed position, which means that even though Slovakia has a significantly higher annual energy use per capita than Poland, CO_2 emission per capita in Slovakia is much lower than in Poland.

Levels of CO_2 emissions per capita are determined by how large a share of the energy supply comes from fossil fuels (coal, oil and gas) and the mix and quality of the fossil fuels used. Energy source composition for the five focus countries for the years 1992 and 1998 is shown in figure 7.2-4.

FIGURE 7.2-4: ENERGY SOURCES* 1992 –1998



SOURCE: IEA, INTERNATIONAL ENERGY AGENCY
* ENERGY SOURCES OTHER THAN THAT OF COAL, OIL AND GAS ARE BASED ON 'PRODUCTION' NUMBERS AND NOT 'PRIMARY SUPPLY'.

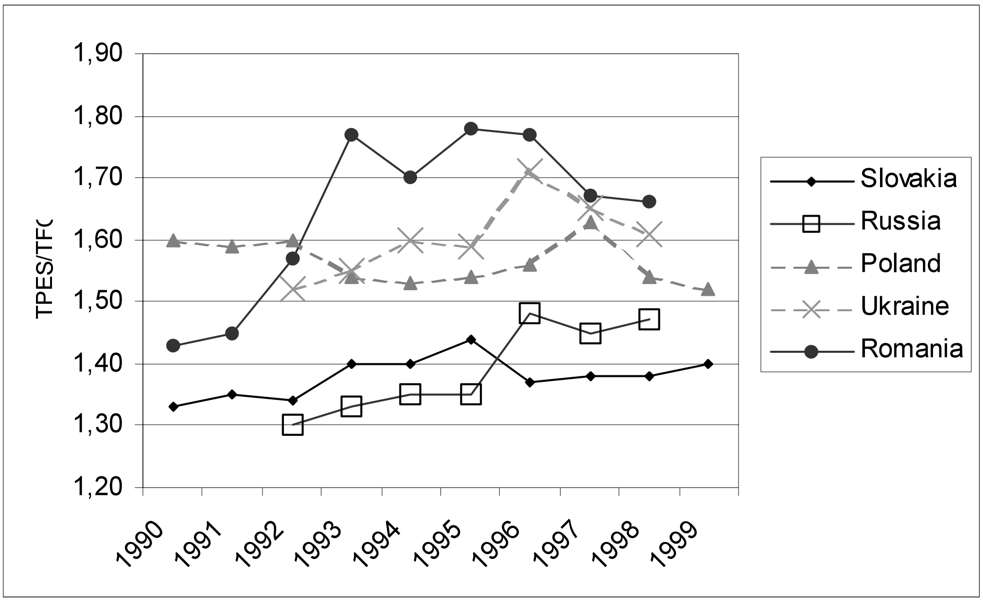
Figure 7.2-4 shows that Poland is the country with the largest share of energy supply based on fossil fuels, followed by Russia. Moreover, Poland is by far the country that depends most heavily on coal as fuel source. This partly explains the relatively high CO_2 saving potential in the country compared to the other focus countries. Another important factor is the 'purity' of fossil fuels. There exists, within the same type of fossil fuel (coal, oil and gas), significant differences between energy effect and related emissions (CO_2, SO_2, NOx etc.).

Slovakia is the country with the greatest share of nuclear energy, which can be related to a relatively low level of CO_2 emission rates, but Slovakia has also experienced an increase in energy supply based on gas and a decrease in coal which supports the link between a lower use of fossil fuels and a lower emission rate of CO_2.

Energy Efficiency

Energy Efficiency can be used to give an indication of how efficient a country is when extracting, converting, handling and distributing energy. The greater loss of energy 'along the way' the higher the ratio, and thus a more inefficient 'energy system'. Factors that influence this ratio are country size and population density (clusters), since these factors, among others, determine the applicability of district heating. But available technology and present available energy sources are also of importance.

Figure 7.2-5 Energy Efficiency



Source: IEA, International Energy Agency
Note: For OECD countries TPES and TFC figures are collected from table II.267 and II.291 respectively.
For non OECD countries, TPES and TFC figures are collected from table II.295 and II.361 respectively.

From figure 7.2-5 it is seen that the most energy efficient country is Slovakia – also being the smallest country with the biggest share of nuclear energy. Romania and Ukraine are categorized as being the most energy inefficient of the countries – in both countries it is characteristic that the energy distribution network is of very poor quality.

Among non focus countries, it should be mentioned that both Lithuania and Bulgaria experienced a worsening in energy efficiency throughout the decade of the 1990s, leaving both countries at an energy efficiency ratio of about 2.0 in 1998, or significantly higher than the focus countries. In comparison, the 1998-figure for Denmark was 1.3 while for the European Union countries as a whole the average value in 1998 was 1.4.

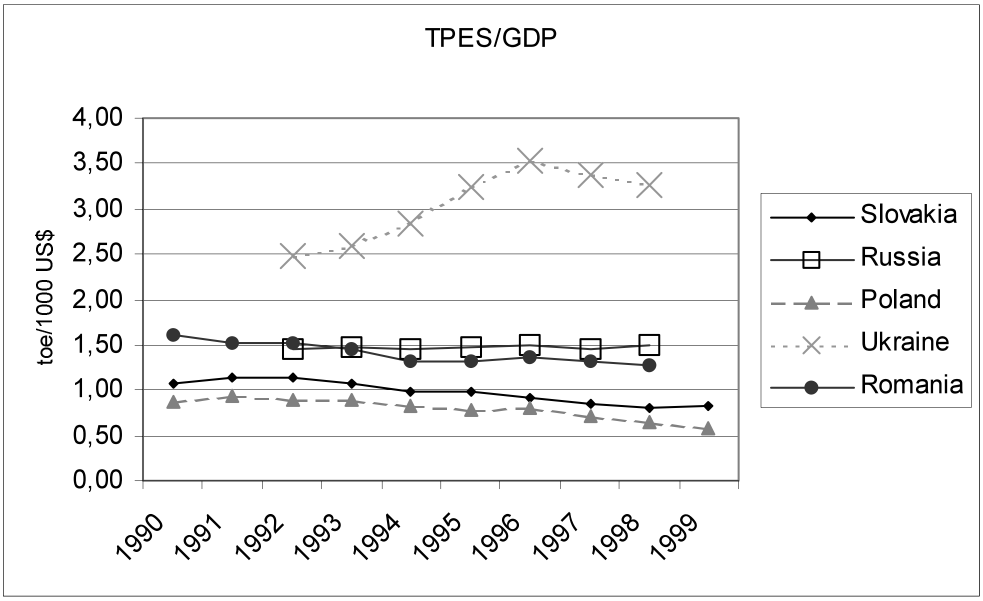
Energy Supply vs. Economic Growth

The current transition process in the CEECs, creating expectations of strong economic rebounds from these countries, increases the attention on the coupling between the economy (GDP) and the energy use – the energy intensity. The more energy intense a country is, the stronger incentives there should be to implement technologies and energy forms that will reduce negative environmental effects from expected increases in energy use.

Although, it should be kept in mind that for the CEECs, part of the energy structure is determined by the national industrial structures and therefore also subject to other policy decisions and considerations.

Ukraine is, according to figure 7.2-6, by far the most energy intensive among the five focus countries. Poland is together with Slovakia placed as the least energy intensive countries. Russia and Romania are also placed much lower than Ukraine, but at a significant higher level than Poland and Slovakia.

Figure 7.2-6 Energy Supply in Relation to Generation of GDP



Source: IEA, International Energy Agency

7.3 Country Profile Summary – Poland

7.3.1 Energy Policy and Strategy

In April 1997, the Polish parliament adopted a new Energy Law, defining principles for developing the national energy policy. The law went into effect in December 1997 and intends to ensure an efficient and rational use of fossil fuels in the country, taking into consideration environmental protection requirements.

The Government Economic Committee was required to pass "Guidelines on Poland's Energy Policy Through 2020." This document was adopted in February 2000 and spells out long term energy forecasts and action plans for the Polish government. The key objectives include: increased security of energy supplies, requiring diversification of sources, increased competitiveness for Polish energy sources in domestic and international markets, environmental protection, improving energy efficiency and reducing energy-related emissions.

A strategy on renewable energy was endorsed by the Polish Council of Ministers in September 2000 and it sets a target of 7.5 per cent of primary energy to come from renewable sources by 2010, compared to a level of 2.5 per cent today. The renewables taken into account in this Strategy are biomass, wind, solar, geothermal and hydro. The general impression and response from specialists and institutions involved in the renewable energy sector in Poland is that the strategy document is a good initiative from the government, but with regard to the detailed predictions and assumptions it needs to be not only corrected, but completely re-worked or even re-prepared.

7.3.1.1 State-Owned Energy Enterprises - Privatisation and Regulation

Although ongoing, the process of restructuring, including privatisation, of the Polish energy sector has been slow due to political obstacles from trade unions and other groups. Some state-owned companies have been transformed into state-owned joint stock companies (Polish law does permit 100 per cent foreign ownership of most corporations). However, the Polish state has intended to maintain a key role in certain strategic sectors such as energy and transportation.

The government wants to complete the privatisation of the 17 power plants, 19 power and heating plants and 33 energy distribution firms by the end of 2002 (by March 2001, two power plants and six power and heating plants have been sold). Coal and steel industry restructuring is expected to be completed by the end of 2001 and the energy sector will be open to competition by about 2004.

7.3.1.2 Energy Prices – Level of Control

One of the objectives of the Energy Law was to free energy prices and make the market fully competitive. Currently, the Energy Regulation Agency controls energy prices and acts to protect consumers from excessive price rises until the market becomes fully competitive. This arrangement has been criticized from various sides since it does not permit prices to rise to reflect real costs and is thereby functioning as a subsidy for some (polluting) energy forms, such as coal.

7.3.2 Geothermal Energy in Poland

Poland has already obtained important experiences from geothermal project implementations in the country. Generally, those experiences are of a positive nature and certainly act as a catalyst for further geothermal project implementation in the country.

After having passed the demonstration project phases with significant financial project support from donors and international financial institutions, a main challenge is now how to proceed with projects, financed only through national (Polish) funding and/or from private investors.

Even though the feasibility of geothermal energy has now been demonstrated in Poland, barriers still remains for private capital to flow in. The main financial barrier identified is the one related to financing the first drilling, which can be a highly risky business. Today no insurance system exists for such drilling risks in Poland.

7.3.2.1 Geothermal Areas and Projects

Three main geothermal provinces built of sedimentary basins with numerous geothermal aquifer can be identified within the country.

Carpathian Province
The Carpathian Province consist of five sub-basins, whereof the most important is the Podhale sub-basin with an area of app. 475 km^2. The water temperature in the Podhale sub-basin range from 36 to 86 °C and the mineralisation is very low (0.1-100 g/l). The main artesian aquifer occurs in a depth of 2-3.5 km.

The geothermal water occurs in the Eocene Epoch and Mesozoic Era - geologic formations, which are characterised by layers of carbonate wherein the water is contained. Fractures in the carbonates increases water circulation, which conditions a high well production.

The Banska-Bialy Dunajec Plant (the Podhale Region) was built in 1987-1990. After a 3-year trial exploitation period it was used in a geothermal heating network for Banska Nizna and Bialy Dunajec. The Banska-Bialy Dunajec Plant has now been linked to the central peak heating plant in Zakopane (transmission pipeline – 14 km.) Heat supply will then be based on geothermal energy and gas boilers in peak periods.

Fore-Carpathian Province
The Slomniki Plant is a relatively new project and is situated 30 km. north of Cracow. Four wells has been bored and documented the existence of 2 water bearing layers at a depth of 150-240 m. (Cenomanian horizon) and 600 m. (Dogger horizon). In both layers low temperature geothermal water (20 °C) occurs. The TDS is variable up to approx. 100 g/l. and water resources are estimated at around 100 km^3 with a thermal energy equal to 1.555 Mtoe. Experiments with cascade use of GE will also be carried out.

Lowland Province
The Lowland Province (Central Europe) consists of seven regions and has two on-line geothermal plants, the Pyrzcyce plant and the Mszczonów plant. The Pyrzcyce plant is situated in the Szczecin-Lodz region in Pyrzcyce town and the Mszcznów plant is situated in the Gruziadz-Warsaw region.

The Pyrzcyce plant operates as an integrated system with both heat exchangers-absorbtion and heat pump gas-boilers. The plant supplies approx. 12 000 domestic customers, and replaces 68 traditional heating plants (20 000 tonnes of coal/yr.).

The Mszczonów geothermal plant lies at the central area of Grudziadz-Warsaw region. The plant is based on reconstruction of a single, out closed well. The well is extracting water from the lower Cretaceous layer. Due to the relatively small size of the geothermal plant and since it has not been necessary to construct new wells for this project, the investment needs have been relatively limited compared to other geothermal projects.

In Stargard (75 000 inhabitants), a geothermal project is currently under implementation. Through the project, a geothermal base-load heating plant with a capacity of about 10 MW will be established in order to supply 310 TJ per year (or around 36 per cent of total annual heat demand in Stargard). The total budget for the project is USD 8.5 million, including a DEPA grant of USD 450 000. Other financial contributors will be the World Bank, GEF, NEFCO and, from Poland, National Fund and EcoFund.

A geothermal project in Kolo (20,000 inhabitants) is currently under consideration by DEPA for co-financing. The total project budget is USD 6.3 million and the remaining project funds are expected to be provided by national Polish funding and PCF/GEF grant.

Other project proposals for geothermal water utilization for heating purposes have been elaborated in Skierniewice and Zyrardow. In the Praga-Poludnie district, a preliminary project has been evaluated.

7.3.2.2 Organisations Responsible for Geothermal Energy Development in Poland

Governmental Institutions
In Poland, the energy sector falls administratively under the supervision of the Ministry of Economy, while environmental responsibility is an issue of the Ministry of Environment. The task of creating and monitoring rules governing the energy sector, such as price and tariff control and the development programmes, is turned over to the Energy Regulatory Authority (it covers the electricity, the gas and the heat sub-sectors).

In May 1997 a new constitution in Poland was approved by a national referendum and brought about the creation of 16 Voivodeships – regional policy bodies – reorganised from 49 former Voivodeships. The Voivodeship authorities are responsible for the civic, social and economic development of their respective region. Implementation of environmental policy is entrusted to the regions (Voivodeships), counties and municipalities. The Voivodeships are therefore responsible for activities, which are particularly harmful to the environment.

The Voivodeships could be a crucial institutional factor for future geothermal energy development in Poland. Currently, the Voivodeships are elaborating Regional Development Strategies with strong focus on how to integrate economic and environmental concerns in regional policies. The strategy of the Voivodeship Malopolskie (Southern Poland), which was the first of these regional strategies to be concluded and approved, pays particular attention to the geothermal potentials of that region and how GE could support regional energy supply and environmental priorities.

Private Sector
From the private sector, an outstanding case is the company Geotermia Podhalaska S.A., which has been capacitated through DEPA project support, and is now responsible for the Podhale geothermal project.

Geothermal Podhalanska S.A. has turned into a well-managed and structured geothermal company with a competent staff where management is focussed on further improving the efficiency of the company.

Universities and Other Research Institutions
Poland has a long scientific tradition related to geological science, including geothermal science, and maps and data collection have been carried out for the whole country.

A central institution for geothermal science is the Mineral and Energy Economy Research Institute within the Polish Academy of Science in Krakow (PAS MEERI). Within PAS MEERI, a geothermal laboratory has been established in Banska Nizna in the Southern Poland. The Laboratory has played an important role in relation to the Podhale geothermal project, in demonstrating the functioning of geothermal water for heating purposes. Moreover, the scientists working with the Laboratory have supported the development of and proposals for other geothermal projects in the country.

7.3.2.3 Institutional Factors Governing Geothermal Energy in Poland

Laws and Regulations Concerning Geothermal
There is a concession law in Poland, by which rights and conditions for concession to geothermal resources are defined. The duration of concessions is variable and could be a few years up to 20 years. It depends on what the subject of concession is and other circumstances, such as the agreement of local/regional self-governments, etc.

National Funding Sources for GE in Poland
The main sources of Polish government funding for environmental investments are the National Fund for Environmental Protection and Water Management (NFEP), the EcoFund and local and provincial environmental protection funds.

The NFEP (see below) and local and provincial environmental protection funds collect environmental taxes, fees and fines levied against polluters. It is estimated the combined revenue of these funds will amount to USD 500 million annually until 2010. EcoFUND (see below) is expected to raise USD 571 million in the period 1992-2010.

National Fund for Environmental Protection and Water Management
The main objective of the Fund is to provide subsidies and/or preferential loans for projects, which serve the protection of the environment. Special attention is given to ecological activities adapting Poland to the European Union standards. The National Fund for Environmental Protection and Water Management is the largest institution financing environmental protection projects in Poland.

The most important sources of income for the Fund are fees and penalties for the use of the environment. Fees are collected on the basis of the "Protection and Shaping of the Environment Act" for legal activities, while penalties are applicable for activities exceeding legal limits. Fees and penalties are imposed for the following: Draining sewage, air pollution, storage of waste, mining of minerals, cutting down trees and shrubbery, use of farm and forest areas for non-designated purposes. Fees for use of environmental services are collected by Voivodeship Marshal Offices and penalties are collected by the Voivodeship Environmental Protection Inspection Office.

EcoFund
The Polish EcoFund is a foundation established in 1992 by the Minister of Finance. The purposes of the fund are to effectively manage funds obtained through the conversion of a part of Polish foreign debt with the aim of supporting environmental protection-related endeavours (so-called debt-for-environment swaps).

The ECOFund provides financial support in the form of preferential loans and/or non-refundable grants. Such grants may be provided exclusively to investments related directly to environmental protection (in the implementation phase), as well as to non-investment projects in the area of nature conservation. The following five sectors are listed as priorities in the

ECOFund Statutes: Reducing the emission of gases causing global climate changes; limiting cross-border sulphur dioxide and nitrogen oxides transportation, and eliminating all low emission sources of the above gases; limiting the contamination flow into the Baltic Sea, and protecting drinking water resources; protecting biological diversity; waste management and contaminated soil reclamation.

7.3.3 Summing Up - Poland

Opposite most other CEECs, Poland experienced a period characterized by a positive economic development process and restructuring of the national political and economic system throughout the 1990's. The fast "pick-up" and the introduction of a market based and liberalized economy in Poland has gone hand in hand with substantial financial support from the EU as well as from international financial institutions and bilateral donors. However, within the energy and environmental sector, Poland still needs to complete and operationalise a list of reforms and initiatives.

Poland possesses important geothermal resources, which could be used as heating sources to replace some of the highly polluting, coal-based heating systems currently used in many Polish cities and towns. Through the implementation of geothermal projects in Poland from the early 1990's, important project experience is now available. This draws a general picture of a country highly suitable for these kinds of project implementations. In this overall positive picture, the existence of important national project funding mechanisms should also be noted, since it is seen as important factors in the attraction of substantial external project funding.

Following the successful implementation of individual projects, it is now the impression that Poland could shortly be in a position to simultaneously develop several potential geothermal project sites with own sources of finance and project planning. In that respect, it is interesting to notice the interest and involvement of the Voivodeships (regions) in supporting and formulating plans for regional renewable energy development, including geothermal.

This opens up for a rethinking of how acceleration of geothermal development programmes in Poland could most efficiently be supported through regional programmes. In order to promote such simultaneous project implementations, two main obstacles can be identified: 1) The risks related to the first drilling (financial obstacle) and 2) Lack of institutional experience/capacity by regional/local authorities to manage and operate geothermal programmes (institutional problem).

Of particular importance for future geothermal project implementation in Poland, will therefore be the creation of a risk insurance system to cover financial risks concerning the first drilling. This is currently the main technical/financial barrier for further project implementation in the country.

Furthermore, emphasize should be put on how to support existing institutional capacity at regional and local levels in order to coordinate and support implementation of regional geothermal development policies. This may include elaboration of financial plans and institutional support mechanisms as well as further analysis of different ways to encourage the use of environmental friendly energy sources such as geothermal.

Therefore, in addition to considering the promising project proposals, which have already been prepared for implementation in Poland, it is recommended that initiatives will be taken to support the two issues raised above, namely risk insurance and institutional strengthening.

7.4 Country Profile Summary - Romania

7.4.1 Energy Policy and Strategy

A medio-term "National Strategy for Energy Development in Romania, 2001-2004" was approved by the Romanian government in July 2001. According to the strategy, within the area of efficient energy use and utilization of renewable energy, the projects to be launched during the period will include the following:

- Establishment of a National Energy Observatory having as their main task the synthesis of energy consumption data, evaluation of energy indices, based on a unified, trustworthy and efficient database as well as correlation of national and international data concerning energy consumption.

- Improvement of energy management targeting the establishment of necessary conditions for imposition of authority to qualified persons in energy management of industrial consumers.

- Completion, in co-operation with EU, of the national programme for regulation and metering of thermal energy consumption for urban district heating system connected users.

- Establishment, in co-operation with GEF and WB, of the Romanian Fund for Energy Efficiency with the scope to support investments and promote reduction of domestic users' thermal energy cost through programmes in mountain areas targeting replacement of liquid fuel with biomass.

- Extension of investment programmes started in co-operation with EBRD targeting rehabilitation of centralised district heating systems.

7.4.1.1 State-Owned Energy Enterprises

To date, Romania's energy sector reform process has been relatively slow and incomplete, and the lack of execution in restructuring and privatisation has meant that Romania has experienced only limited progress.

According to the Romanian Medium Term Energy Strategy for 2001-04, privatisation shall provide sufficient income for the chosen energy companies, consolidation of energy safety and fulfilment of post-privatisation objectives (competition, infrastructure modernization, strengthening of financial viability and market competitiveness capability of the energy companies) as well as social protection. Distribution may be entirely privatised, however production in thermal power plants may be only 25-40 per cent privatised.

Based on accurate financial analysis of cost, centres in electricity and heat production services that produce losses and do not show any recovery prospects, will be released. The Romanian and foreign investors will be attracted to create joint venture companies with the existing energy companies each participating with shares accordingly. Some co-generation and thermal power plants will be transferred to the local administrations and will be converted into commercial companies. There is a plan to privatise two such companies each year.

7.4.1.2 Prices and Regulation

Since 1997, energy prices in Romania have increased considerably and the prices are now getting closer to market prices. This is mainly a consequence of the implementation of IMF and World Bank loan agreements, where transparency and price deregulation have been main objectives for the energy sector.

However, alignment of legislation to the European legislation requires further amendment of tariffs according to external costs (that mainly reflect the impact on the natural and economic environment) and introduction of simulative options for energy efficiency projects or utilization of renewable energy.

The electricity tariff for domestic users will be uniform throughout the country mainly because of social cohesion reasons. The completion of the reforms regarding market mechanisms beyond 2004 will require revision of this principle and introduction of differentiated tariffs for end users. Local tariffs for heat will be generalised, differentiated by the utilization duration of the maximum power for corporate users, in such way that if there are changes in the technological process, significant deviation from the average price shall not occur. Cross-subsidies between industrial and domestic households have been completely removed by now.

The real cost of energy in Romania is high partly as a consequence of a highly inefficient energy supply system in the country, where obsolete and damaged generation and distribution systems are operating at high costs and with significant energy losses, and partly because of financial problems related to non-payments of energy bills by consumers. The energy supply today is therefore often a costly affair for the supplier (in the case of heating it is often the municipalities) and much attention is therefore currently given to alternative energy supply mechanisms in order to get rid of a weighty item of expenditure on the budget.

7.4.2 Geothermal Energy in Romania

In Romania, exploration of geothermal resources started back in the 1960's. Romania, like other CEECs, possesses considerable low-enthalpy geothermal resources (40-120° C). Today, more than 200 drillings (800-3 500 metres) have been carried out. From 1995-99, 14 new geothermal wells were drilled in Romania. The drillings (1 500-3 500 metres) were financed through national funding and were rather successful; only two drillings showed to be non-producers.

Although significant geothermal resources have been identified in Romania, direct utilization of the heat is rather underdeveloped. Total capacity of the existing wells in Romania is about 480 MW. However, currently only 152 MW is used, from 96 wells, producing hot water in temperatures ranging from 45° C to 115° C. More than 80 per cent of the wells are artesian producers and only six wells are reinjection wells. Main direct use of geothermal energy is for district heating (37 per cent), bathing (30 per cent) and greenhouse heating (23 per cent).

In comparison to other renewable energy sources existing in the country, geothermal energy may in the short run have the advantage of previous experience and applications. In Romania, the industry can manufacture most components used for geothermal projects and national companies are highly experienced in drilling, exploration and equipment of wells (see below).

A 1996 Phare-study, promoting a "Strategy on Renewable Energy Sources in Romania", concluded that "..geothermal energy is already competitive in most of the cases with natural gas and always with fuel oil" and that regarding economic potentials, top priority should be given to the use of geothermal sources for thermal applications in the existing DH supply system (in the cities near the geothermal fields and in new DH schemes for smaller towns and large villages) and for industrial or agricultural use.

7.4.2.1 Geothermal Areas and Projects

Proven geothermal resources in Romania have been identified mainly in the Western Plain (including Oradea and Bors), in the Southern Plains (near Bucharest) and in the Olt Valley. Further description of the geothermal potentials in the named regions can be found in the Romania Country Profile (Volume II).

The Western Plain
The main geothermal reservoir in Romania is located in the Western Plain along the Hungarian-Romanian border, 2 500 km^2 from Satu Mare in the north to Timisoara in the south. Out of a total potential geothermal energy production of about
5 300 TJ/year in Romania, more than 80 per cent of the potential is located in the Western Plain and a total of 88 wells have been drilled in the area.

Southern Plains
In the southern plain, north of Bucharest, 11 wells have been drilled at a depth of
1 900 –2 600 metres and 5 of the wells are currently active. The reservoir is located in fissured limestone and dolomits. Wellhead temperatures range from 58-90° C, highest in the northern part of the reservoir. TDS is around 2.2 g/l. The total installed power is 32 MW and main heating uses are for space heating and sanitary hot water.

Olt Valley
The Cozia-Calimanesti reservoir produces artesian geothermal water and is located in fissured siltstones at depth of 1 900-2 200 metres. Wellhead temperature is 90-95° C and the TDS of the water is 14 g/l.

7.4.2.2 Organisations Responsible for Geothermal Energy Development in Romania

Government
Within the government the overall responsibility for energy development lies within the Ministry of Industry. The Ministry has a special department for geological and mining issues.

The National Agency for Mineral Resources (NAMR) was established in 1993 as an independent advising agency to the government. The President of the Agency is appointed by the Prime Minister. NAMR is the central institutional body in relation to development of geothermal energy projects, since the agency is controlling and administrating the use of underground resources in Romania. In order to obtain a concession for geothermal energy development, an application should be passed to NAMR who will submit their recommendations to the Ministry of Industry for approval.

Private Sector

Two companies, TRANSGEX and FORADEX, have historically and presently been responsible for geothermal drillings and exploitation in Romania.

TRANSGEX, the smaller of the two companies, was privatised last year. The company has around 180 employees, including around 60 persons working on geothermal energy. The company is mainly represented in the western part of the country in the regions of Satu Mare, Bihoor, Salaj and Cluj.

FORADEX is still a state-owned company and has around 900 employees. 50 persons are working on geothermal energy, the remaining staff is engaged in the company's activities in oil, gas, water and diamonds. It is planned that FORADEX should be privatised sometime in the near future in order to allow a restructuring and modernization of the company. FORADEX is mainly operating in the area around Bucharest, the southern part and the south-western part of the country.

Universities And Other Research Institutions

The University in Oradea is the centre for geothermal research in Romania with its own geothermal department and geothermal plant. In the department computer models have been set up to simulate effects from geothermal energy projects.

In Bucharest, the Geological Survey Institute is carrying out research and mapping of existing geothermal resources in the country. Currently, the Geological Survey is working on an update of the national geothermal map.

7.4.2.3 Institutional Factors Governing Geothermal Energy in Romania

Laws and Regulations

The National Energy Regulatory Authority (NERA), an autonomous institution in the process of issuing the secondary legislation in the field, carries out the regulation, authorization and control in the field of electric and heating energy. The main responsibilities of NERA include issuing of regulation and licenses for operators within the energy sector, price and tariff establishing and approval of framework and contracts.

NERA establishes power prices and tariffs using a methodology approved beforehand by the Competition Office and based on principles of consumer protection, economic and financial feasibility of the operators, economic efficiency and attraction of investors.

Rules Directly Affecting GE

The approval and implementation of the new "Mineral Law" in 1997 has been of particular relevance and importance to the development of geothermal energy projects in Romania. With this new law, a company (private/public, national/international) can now obtain concession for geothermal exploitation for a period of 20 years from the state (earlier it was only one year). The Mineral Law has therefore opened effectively up for private and foreign investments in geothermal energy projects.

Moreover, implementation of the electricity and heating law, adopted in 1998, has started. The law opens up for more flexible consumer-supplier relations within the energy sector and makes it possible for consumers to buy energy from private suppliers.

7.4.2.4 National Funding Sources for GE development

The Romanian state budget has since the 1960s financed the drillings of more than 200 wells for geothermal exploitation. However, governmental funding for geothermal investments have been decreasing from 32 Million USD in the period 1985-89 to 24 million USD in the period 1995-99.

It is mainly the public research and development (R&D) activities that have been cut down (from 21 million USD in the period 1985-89 to 8 million USD in the period 1995-99). Field development activities have increased from 5 million USD (1985-89) to 10 million USD (1995-99).

Currently, the state budget is financing 1-2 new drillings per year and this activity level cannot be expected to increase in the near future. First of all because the state budget is currently under pressure and, secondly, because the Romania government is now awaiting that more of the already identified geothermal sites will be exploited further. Since wells are now already existing on several geothermal potential project sites in Romania, project costs, and risks, will be lower compared to projects where no drillings are made.

Finally it should be mentioned that a framework establishing an environmental fund was adopted in May 2000. The fund is intended to act as an economic instrument to support the development of major public investments within the environmental sector. However, the law remains very general and will probably require a secondary legislation in order to become operational.

7.4.3 Summing Up - Romania

Romania has during the last few years entered a more dynamic process of structural changes and economic reforms and after years of economic recession the growth rate have again turned positive. This recent development process has gone hand in hand with increasing economic support from the main international financial institutions (IMF, World Bank and EBRD) and opening up of the EU accession negotiations.

The energy sector in Romania has traditionally been run 100 per cent by the state, and reforming this sector is of high priority for the international community. Even though some initiatives have recently been taken by the Romanian government, reforms are processing slowly and the Romanian government maintains high influence in the national energy sector.

What concerns geothermal energy development in Romania, the country possesses large proven geothermal resources and economic feasibility studies of geothermal projects show that use of geothermal energy for heating purposes is economically profitable compared to existing heating systems using liquid fuel oil.

Within the last few years, the implementation of new laws in Romania on energy and concession rights has improved the conditions for geothermal project investors considerably. The new laws have lowered the investment risks and opened up for more market-based competition between private and public energy suppliers.

On the other hand, does the Romanian government not have in operation any effective programmes or economic support mechanisms (funds, eco tax-systems etc) for geothermal energy development. This may however change soon, since Romania is in urgent need of harmonizing with EU rules and regulations within the sectors of energy and environment.

Credited is due to the Romanian government for having financed more than 200 geothermal drillings in the country since the 1960s. In that sense, it can be argued that the government has paved the way for further development of the geothermal potentials in the country for other actors, private and public.

Until now, the Romanian municipalities have been reluctant to commit themselves financially to geothermal project investments. One reason for this is that these kinds of energy projects traditionally have been considered as long-term investments, which do not fit into the short-term planning practiced by many municipalities.

Another factor in explaining why Romanian municipalities, as well as other potential investors, have not brought more money into geothermal projects is that the financial markets for this kind of energy investments still do not function adequately in Romania. Banks and lending institutions in Romania often consider their risks and costs related to geothermal project investments too high, mainly because the banks do not know or recognize the real economic potential for these projects.

In order to bring about a "take off" situation for geothermal energy project development in the country it will be of great importance to be able to present a geothermal "success-story" in Romania. Concerning co-financing options for projects, the timing is good right now since external financial support to Romania is increasing dramatically in these years and most IFIs and donors give high priority to energy and environmental projects. Moreover, Romanian municipalities are struggling economically in these years with the existing old district heating systems, and the same municipalities do have clear economic, if not environmental, incentives to change heating systems.

7.5 Country Profile Summary - Slovakia

7.5.1 Energy Policy and Strategy

The 1999 *Slovak Energy Policy* focuses on preparations to enter the open EU energy market, and further defines safety of supply and sustainability as basic principles to follow. This means that the energy chapter of *National Programme for Implementation of the Acquis Communautaire* is a central instrument. This in turns focus on market liberalization, including a schedule for energy price adjustment and tariff modifications as well as regulation of monopolies and establishment of an independent regulatory body.

Further, Slovakian energy policy addresses *energy conservation* and announces a programme for energy efficiency, wider use of Renewable (and domestic) Energy and R&D, and even a law on rational energy use. Finally, a programme of "regulated energy price adjustment" is part of the policy. In general, renewable energy (RE) has been included in the "State Energetic Conception of the Slovak Republic", according to which RE has a potential at 4 per cent of the primary energy resources available for the 2005-2010 period – equivalent to 40,000 TJ/year.

GE ranges as the second most important source of renewable energy to be relied upon to fulfil this strategy of partly substituting fossil fuels. Still, the considerable potential of alternative fuels may not be realized, in the absence of direct or indirect support through energy legislation. It is planned, however, to establish an "Energy Saving Fund" and make some amendments to the tax regulation, increasing the "excise tax" on fuels and energy and exempting "non-traditional" energy sources and CPH from costumes regulation.

7.5.1.1 State-Owned Energy Enterprises

Privatisation of the Slovak Gas Company (SSP), which make it a joint-stock company where 51 per cent of shares remain with the state, has been approved. The national electricity company (SE) and oil company (Transpetrol) are being privatised as well, together with the distribution sector.

7.5.1.2 Prices and Regulation

By 2000 the Slovak Government approved price increases for electricity averaging 40 per cent for households and 5 per cent for businesses, and increases of natural gas prices and heating price ceilings as well. Tariffs display a progressive rate, price decreasing with increasing consumption. Preparations are made for further opening up of the domestic energy market. Steps towards an independent regulatory authority have been taken.

7.5.2 Geothermal Energy in Slovakia

The Slovak Republic has a long historical and cultural tradition for the use of GE and it is one of the few CEEC countries where *installed capacity* is over 100 MW.

The *use* of GE in Slovakia today is for *multiple purposes*, including 13 agricultural farms (about 27 ha of greenhouses and some soil heating), fish farming, space heating and recreation purposes. The effectiveness and technological level is fairly low, due to seasonal use and low efficiency of the technical installations.

7.5.2.1 Geothermal Areas and Projects

Today, 26 prospective areas and structures with exploitable geothermal energy *potential* have been identified. The potential resources represent 5 538 MW and are located at depths between 200 and 5 000 metres, with water temperatures ranging from 20° C to 240° C.

In 14 of the prospective areas, further explorative work has been made. While the remaining 12 areas still await verification by drilling, 6 of these have been geologically assessed. (See also Slovak Country Profile, Volume II, and Strategic Action Plan, Volume III). At the *regional level* the most intense use of geothermal energy is in the town of Galanta, where geothermal energy is the primary energy source for district heating.

The geothermal energy potential does in many areas fulfil the technical criteria for geothermal water exploitation. High temperatures and high heat flow are typical characteristics of both the so-called *Neogene* basins and the volcanic mountain ranges of the inner *Carpathians*. The total amount of geothermal energy utilized in 36 localities represents thermal power of 130 MW and 846.4 l/s of geothermal water.

7.5.2.2 Organisations Responsible for Geothermal Energy Development in Slovakia

Government
At the level of government, the Slovak *Ministry of Economy* is the government regulatory and policy agency with overall responsibility for development and implementation of the energy policy in Slovakia. The ministry issues licenses for operation in the energy sector, approves construction, renewals and decommissioning of energy plants, or the change of their fuel basis, etc.

Capacity-wise the ministry is challenged, at least in the area of electricity, where it's role as regulator is changing. It is the Ministry of Finance, however, who regulates the energy prices. In contrast to the Czech Republic, Hungary and Poland, do Slovak household electricity prices not even (as of early 2000) cover production costs yet. However, an independent regulatory body is scheduled to take over energy price regulation by 2003. The Slovak *Energy Agency* assists the Ministry of Economy in developing and implementing the energy policy in the country.

The *Ministry of Environment* is not only a regulatory agency for geological resources, but also a *focal point* for implementation of geothermal projects in Slovakia. Through one of its offices for international collaboration and EU accession, a local (DANCEE) project coordinator has had, and will continue to have, a pivotal role in coordinating geothermal initiatives (involving Danish funds) in the future.

Private Sector
The two most important *private sector* players in the geothermal energy field in Slovakia is *Slovgeoterm* and *Galantaterm*. (See also case studies of Kosice and Galanta).

The *Energy Centre Bratislava* is a semi-official NGO operating in the field of energy and has already implemented and managed several energy projects and studies.
The *Geological Survey* is carrying out studies, investigations and research on geological resources of the country, including geothermal resources. The Atlas of Geothermal Energy of Slovakia, from 1995, is available from the Survey.

Based on analysis of this organisational "landscape" of organisations with capacity and experience in the field of geothermal energy planning, there are good reasons to assume that in the case of geothermal energy, the prospects for efficient collaboration in Slovakia, between the central and local governments and the private and non-governmental sector, are relatively good.

7.5.2.3 Institutional Factors Governing Geothermal Energy in Slovakia

Laws and Regulations

In Slovakia, there are some effective legislative, economic and fiscal instruments in place (see below) to influence energy consumption and to reduce the energy intensity of the national economy (ECB 2001). Moreover, the "Air Protection Law" will indirectly give GE a relative comparative advantage over other – more polluting – technologies. The law is founded on the principle of "best available technology" and determines emission quotas. These principles not only apply to newly built sources of air pollution, but existing sources have also assigned terms to fulfil stricter criteria and regulatory standards. According to a new law from 1998, heat suppliers and electricity distribution companies are obliged to buy heat and electricity from environmentally justifiable sources (Law # 70 from 1998, § 33).

Policy Instruments In Place Directly or Indirectly Promoting GE

In Slovakia, the following instruments are in place to promote renewable, including geothermal, energy:

- The 1999 Ministry of Economy programme for the Support of Energy Efficiency and the Use of Alternative Energy Sources.
- The Ministry of Agriculture programme for supporting RE sources use.
- Programme for insulation of domestic housing
- State fund for environmental protection, which is based on green taxes and from which municipalities can apply for funds.

Further, the concept of Energy Performance Contracting (EPC) has been introduced as an innovative financing mechanism. Finally, joint implementation or allowance trading is included in the instrumentation. The funds allocated in the state budget for support of improved energy efficiency are relatively smaller, however, than in Europe at large. Energy efficiency in Slovakia remained, by large, unchanged from 1990 to 1999. The mix of instruments above may be too moderate to induce energy efficiency as a feasible alternative to adjusting fuel and energy prices to market levels. However, numerous acts and directives does illustrate the increasing understanding of the necessity to be energy efficient.

National Funding Sources for GE Development

As for GE in particular, the Ministry of Environment and the Ministry of Economy jointly prepared a "Conceptual proposal of geothermal energy utilization in the Slovak Republic" in 1996. In response to this proposal the Government accepted a "Resolution" obliging the Minister of Environment to evaluate GE use in Galanta, the Poprad Basin, the Liptov Basin and the Skorusina Depression as well as undertaking a hydro geothermal evaluation of the Ziar Basin and study the feasibility of the so-called "hot dry rock" approach in Slovakia.

Between 1985 and 1999 Slovakia invested significantly in geothermal energy, with a highly significant shift from public to private funding after 1995. The majority of the funds were used for R & D including surface exploration and explorative drilling (see Slovakia Country Profile). Today, the following sources for funding of renewable energy exist in Slovakia:

- Programme for support of energy savings and exploitation of alternative energy sources by regional offices of Slovak Energy Agency
- Support from the State Environmental Fond
- Support from National Agency for Development of SMEs, including a Supporting loan programme and a micro loan programme

7.5.3 Summing Up - Slovakia

This analysis confirms that in Slovakia, actions are well underway that are already restructuring the formerly state-owned, now partly privatised energy sector and implementing long-term policies as well as providing more oversight and coordination of the sector. As a result, one may expect that within the next few years and certainly by the end of 2005 energy prices in the Slovak republic will have reached levels very close to the average European (EU) level along with harmonisation of the Slovak energy legislation with the EU energy strategy will have been completed.

Slovakia has an energy supply, which for heating and electricity production is mainly based on fossil fuel and nuclear energy. While total primary energy supply has decreased, GDP has increased, which signals that the Slovak Republic is in the process of decoupling energy use and GDP and thus moving toward a post industrialised society with generation of GDP from the tertiary sector and other less consuming businesses.

Thanks to current overcapacity and close integration with the European grid as well as a high density of gas network coverage, Slovakia will be in a position to meet the future demands for heat. Slovakia, however, does have an ambition that future demand should be met, increasingly, with less environmental costs and featuring an increasing share of renewable and environmentally sustainable energy sources.

An official policy goal in Slovakia is to have 6 per cent of PE production covered by renewables (4 per cent by 2005). If that goal is to be reached, then geothermal energy is bound to play a critical role. Because of the administrative and other difficulties in providing state support for renewables, foreign technical and financial assistance seems an essential prerequisite for development and dissemination of RE in general and GE in particular.

Slovakia has a very significant and well documented technical potential for exploitation of geothermal energy. Slovakia also has a very high capacity for implementation of geothermal projects. The capacity to work successfully with international investors and donors is noteworthy as proved in the case of the Galanta project and the efforts by Slovgeotherm to secure funding from the EU ISPA programme and international finance institutions.

Further to possessing a high volume and quality of proven geothermal resources, economic feasibility studies of the Galanta geothermal project show that while use of geothermal energy for heating purposes may not yet be very profitable per se, they may do well compared to existing heating systems using liquid fuel oil.

Within the last few years, the implementations of new Slovakian energy laws have indirectly improved the conditions for geothermal project investors. The new laws have opened up for more market-based competition between the different energy sources, removing some of the indirect subsidies that were beneficial towards fossil fuels relative to renewable energy.

With the earlier (historical) investment in geothermal drillings in the country, Slovakia is well posed in terms of geothermal potentials in the country being developed by new actors, private and public. Traditionally, the Slovakian *municipalities* have committed themselves financially to geothermal project investments. The municipalities are however struggling economically in these years with the existing, old district heating systems, and the same municipalities do have clear economic, if not environmental, incentives to change heating systems. In order to bring about a "take off" situation, external financial support and investments are needed. Since the existing government programmes and economic policy instruments (green taxes) are insufficient to trigger geothermal energy development, without such investments from outside Slovakia.

7.6 Country Profile Summary - Russia

7.6.1 Energy Policy and Strategy

Russia's long-term strategic energy objectives may be described briefly as:

- Increased efficiency in the use of fuels and energy resources.
- Improving the conditions for transition to energy efficient development.
- Reduction of the environmental impacts of the energy complex
- Increased volume and potential for energy export.
- Ensured Russia's independence and security in energy supply

In the process of fulfilling and making these goals more concrete it is noticed that Russia is planning a long-term use of nuclear power in order to replace the conventional energy sources gradually. At the same time it is noticed that the country's nine existing plants all are old, and in a matter of few years they will exceed their "life expectancy". The nuclear plant in St Petersburg is though – like the other plants - expected to have its "life expectancy" prolonged using additional investments in safety equipment.

A number of the goals mentioned above have already been met. The decrease in production of oil and gas during the recent years has now been stabilized, helped by the prices on oil, which have been high since 1999. Institutional reforms have been carried out, including privatisations, however in such a way that the Russian state still has great influence on the development and has a number of regulatory instruments at it's disposal. The coal industry is among the industries in which a restructuring has been initiated. The goal is to obtain a higher cost efficiency. Still it is expected that coal (together with slate oil, peat and wood) will continue to be a cheap source of energy in Russia for a long time. Concerning development and extension of the market conditions on the home energy market, there has been taken a number of important legal and regulational steps, including in the area of taxes, investments and price policies.

Among the strategic goals which, despite the signs of economic recovery, have not been fulfilled yet, it is especially noteworthy that the output of the energy sector has not gone up as expected; that the discoveries of oil and gas have not increased; and that the investments in the sector have decreased on account of the economic and political changes (including the crisis of 1998). Most importantly, and most surprisingly, is maybe that the energy *intensity* of the country has not decreased as desired. In fact, it has increased by 20 per cent compared to the period before the reform.

7.6.1.1 Prices and Regulation

Traditionally, Russian heat consumers have been used to perceive heat as a free good and this legacy, - along with incomplete enforcement of dept collection - , make domestic energy very cheap. The Russian government, however, has decided that during the next 3-4 years, electricity prices must reach a level covering at least production cost. Current subsidies to for heat and hot water given by local governments, is thus scheduled to disappear by 2003. In a 10 year perspective, it is expected that electricity prices will approach those of the European union. CHP covers 65 per cent of the heat demand in most areas of Russia, and heat and electricity prices are therefore closely interdependent.

7.6.2 Geothermal Energy in Russia

In Russia, geothermal energy is part of a cultural and historical legacy dating back further than antiquity. Significant GE resources are available and identified, and Russia does have a record for GE use. Compared to the conventional energy sources, however, the contribution by GE to Russia's total energy supply is small. At 300 MW installed geothermal (direct heat) power, GE in Russia is dominated by direct use, - primarily in six towns and a number of settlements in Northern Caucasus, where GE space and district heating supplies a total of 220 000 people. In addition, GE heat up 465 000 m^2 of greenhouse space.

The case of Russia illustrates well the multiple direct uses of GE: Greenhouses, soil heating, fish and animal farming, cattle-breeding, manufacturing (such as wool washing, paper production, wood drying and oil extraction), various recreational uses, and finally space heating of course.

Combining a technical and contextual point of view, the following areas to be the most promising for geothermal energy utilization in Russia[10]:

- The European part of Russia, including Northern Caucasus and Dagestan
- Kaliningrad

[10] From a technical point of view several regions are promising for direct use of geothermal resources. Some of these, however – like Western Siberia – are also very rich in natural gas and oil and this hampers development of GE in such a region. Others – like Kamchatka and the Kuril Islands – are very remote, seen from a Danish perspective. In Kamchatka, two existing geothermal power stations adding up to 23 MWe generate electricity for the region of Mutnovka. Two more are under construction in the same geothermal field (totaling 50 MWe and with a final potential of 300 MWe). Finally, in the Kuril Archipelago, a 30MWe Island GE power is projected. GE is well developed in Siberia and International Finance Institutions such as the EBRD support GE projects in some of these "remote" areas of Russia. In Russia's central region – the Moscow Artesian Basin – the Moscow "syneclise" is a depressed structure of the East-European platform located between the Baltic Shield, Voronezh and the Volga – Ural anticlines. The potential of this area is not clear, but may appear sufficiently promising for further studies to be made.

- Lake Bajkal

A map of all geothermal regions are found in Country Profile - Russia (Volume II). In the following, only the prospects for GE in the European part of Russia and Kaliningrad is described and analysed.

7.6.2.1 Areas and Projects

Northern Caucasus is the largest region for development of geothermal energy in Russia (Povarov 2000). The geothermal potential of the region (Krasnodar and Stavropol in particular) is stressed by various sources, including Martinot 1998 and 1999. Most of the interesting areas are located in the Dagestan Republic, including two potential sites with a Russian share of the population of 90 per cent (Stavropol and Krasnodar) and 50 per cent (other areas in the North of the region) respectively. In total, the Dagestan republic has 180 existing wells, with geothermal potential at depths from 200 to 5 500 metres. The total amount of resources has been estimated at 4 million m^3/day. In contrast, the annual volume used today is 7.5 million m^3, only. One project, the Pilot *Kayasulinskaya* GEOPP, seems to be moving ahead[11].

There are several factors favouring geothermal investments in the European parts of South Russia. For instance, compared to the 300 000 living in the Kamchatka region, South Russia has a population of 20 million people. In South Russia, no additional drilling is necessary, since a lot of now abandoned oil and gas wells have already been drilled during the era of exploration after fossil resources, which are now largely exhausted. Since drilling often amount to 50 per cent of project costs, this investment may be considered having been made, already.

Nevertheless, existing geothermal firms in Russia face a difficult situation with *GasProm* concentrating on gas production only, and the government ministries no longer able to take an active economic role. An additional – technical - problem is that despite the long regional experience in using geothermal energy to heat buildings and greenhouses, the current – old – technology, with mineralised thermal water, results in rapid corrosion of heat pipes and heating devices.

Because the oil reservoirs in Northern Caucasus generally are exhausted, a high number of wells can be used for geothermal purposes. In the *Krasnodar* region, the geothermal reservoir is of a confided type with artesian conditions, and these conditions may lower exploitation costs significantly. In this area, geothermal heat is used in *Mostovskoi* town, where water of about 80° C is already used for heating greenhouses and cattle farms. A second main geothermal reservoir is confined in the Alpine fore deeps of the Northern Caucasus, in the *Khankala*, *Makhach-kala*, *Kyasula* and *Tarumovka* areas.

7.6.2.2 Organisations Responsible for Geothermal Energy Development in Russia

At the central level, the Ministry of Fuel and Energy of the Russian Federation – the Department of Strategic Development and R&D has a broad

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[11] Letter of intent send to the world bank, from the Russian joint stock company of energy and electrification "EES Rossii" and the so-called "branch open joint stock company"; *Stavropolenergy*".

expertise on energy planning in Russia, - including the role of renewables such as GE.

The Ministry of Natural Resources may also play a role in geothermal projects, as mineral water and other relevant natural resources are under the control of this ministry.

In Central Moscow Region (Krzhizhanovsky), the Russian Power Engineering Institute (ENIN) has a long and eminent history as the leading power engineering institute in Russia. Today, ENIN is also known for its extensive expertise on renewable energy technologies. In Moscow, international and joint venture projects may be coordinated in collaboration with the Centre for Preparation and Implementation of International Projects (CPPI).

Local and regional authorities and state or municipality-owned utilities and companies generally lack financial strength. Weak cash flow generation and regulatory risk outside their control, limit creditworthiness.

In recent years a number of private stock companies have become involved in exploration and utilization of GE in Russia. In addition, semi-public enterprises also play a role in the development of GE. Non-Governmental Organisations (NGO) advocating for development of GE in particular, hardly exist in Russia. Several universities and other research institutions, however, does work to promote GE. Also in Russia, an "Energy Carbon Fund" (ECF) has been set up, under the auspices of the Unified Energy System of Russia (UESR), providing legal and methodological support to JI project developers in Russia, and several other functions meant to operationalise the Kyoto Protocol. (See Russia Country Profile in Volume II).

7.6.2.3 Institutional Factors Governing Geothermal Energy

The link between the Russian economy and the regulatory environment is highly complex. It is evident that the conventional "medicine" of privatisation and subsidy elimination, so often prescribed by international IFI´s, does not seem to work in the case of Russia. One reason is inadequate legal and market institutions and a need for broad institutional reforms. An institutional (economic) view of Russia and developments there is consequently required. For instance, the many institutional weaknesses means dependence on other means of transaction and regulation, such as third-party arbitration, emphasis of personal trust and long-term relations. Joint ventures is one important means for overcoming such institutional barriers.

Laws and Regulations
As most other investments, the feasibility and attractiveness of GE-investments do in addition to other things depend on how relevant legal and regulatory rules are being observed and enforced. In general, the Russian state administration still is said to be in the early stages of adjusting to the needs of a market economy and the legal situation can still best be characterised by an "enforcement gap". On the whole, however, the Putin government is seen as actively and rather successfully rebuilding the authority of the state and revitalising Russia's transition to a market economy.

Rules Directly and Indirectly Affecting GE
Directly affecting the economic feasibility of GE projects, the programme for economic and social reforms in Russia for 2002 includes reduction of

government subsidies for heating, and a reform of the state monopolies in the sectors of electricity, gas and transport. In addition, measures to remove inconsistencies between federal and regional regulations have been announced.

The Russian law "on energy efficiency" broadly addresses energy policies and regulation, including metreing and billing, energy audits, building codes and education. It also allows for independent energy production in Russia and should therefore make RE more feasible. The law, however, stops short of detailing the implementation mechanisms needed to allow the kinds of market transactions – such as public power utilities being obliged to buy from small (private) producers. Federal and regional government energy efficiency funds are financed via taxes on energy sales, and is responsible for allocating funds to investment projects. By 1995 a few such projects operated successfully.

7.6.2.4 National Funding Sources for GE Development

The budget for the Russian Federation includes a chapter on South Russia, where a 2002-2004 scheme – by Decree of the Government of the Russian Federation, dated August 8. 2001, # 581, is earmarked for development of renewable energy (Table 4.6.8 of the budget annex). The allocation is 6 million roubles (200 000 USD). In addition, funds from international organisations are envisioned, - including support from the GEF.

7.6.3 Summing Up - Russia

Following the 1998 economic crisis, Russia entered into a process of structural changes and economic reforms. While the Russian government still has significant influence, the formerly state-owned energy sector is progressing towards market conditions. The implementation of new energy laws in Russia have indirectly improved, if not the immediate conditions for geothermal project investors, then at least set in motion a long term process that will eventually do so. The new laws have opened up for more market-based competition between different energy sources and will remove some of the indirect subsidies that currently distorts the market and disfavours renewable resources.

The technical potential for GE in Russia is much greater than realized at present. Geothermal studies have been performed in a large number of Russian cities, involving a high number of scientific institutes and a handful of universities and project implementation agencies. Also the human resource base in Russia is well developed in terms of qualified thermal engineers and geologists. Clearly, a number of potential geothermal sites have been identified, with favourable characteristics in terms of high water temperatures at relatively shallow depths.

In *Kaliningrad* and *St. Petersburg*, the geo-technical is currently not as convincing as in other Russian regions with geothermal potential. Kaliningrad, however, is in a special situation with a large regional energy deficit and more in-depth studies on the hydro-geology of the region might be relevant, focusing on Kaliningrad City and the City of Sovetsk.

In the *Northern Caucasus* regions, a majority of the technical potential exists in areas, where no drilling is needed due to existing boreholes left over from oil and gas exploration. Further, such conditions exist in some of these areas that makes it possible to avoid reinjection costs. The same region features some cities with long term experience within geothermal energy heating applications, and the whole region – as most of Russia – has existing district heating systems. In general, the Northern Caucasus region is striving to develop and introduce more renewable energy, particularly in nature parks and reserves in the mountain region.

One potential barrier to GE in Northern Caucasus (as in Russia in general) is the bad shape of existing District Heating Networks. Another barrier to GE – and RE in general – is the historically low energy prices, which as still relatively (and perhaps artificially) low despite recent price hikes and exhaustion of the regions fossil resources.

In Russia, the work on joint implementation for GHG emission reductions is progressing fast towards signing of an intergovernmental MOU featuring agencies mandated for joint working group cooperation, an internationally recognized system for reporting to the UNFCCC and implementation of JI projects and programmes.

Russian municipalities are struggling hard in these years with the existing old district heating systems. It is unclear to what extent the municipalities of fx the Krasnodar and Stavropol (Northern Caucasus) regions are able to commit themselves financially to geothermal project investments.

In the process of supporting geothermal energy in Russia, it is important to acknowledge that the current privatisation of the residential sector does not lead to automatic energy savings, - as some international finance institutions sometimes seem to believe. Even where heat and hot water are metered and most residential apartments are privatised, residents may not be neither de-jure or de-facto responsible for maintenance of the buildings, let alone energy efficient investments. In the very long term, of course, it is possible that future home owners associations will form and assume such responsibilities. Meanwhile, incentives and responsibility for district heating distribution losses, remain institutionally mismatched, as payments are based on the heat leaving the plant rather than what reaches consumers buildings.

7.7 Country Profile Summary - Ukraine

7.7.1 Energy Policy and Strategy

The Government of Ukraine is increasingly concerned about the problems related to the energy sector and is aware that one possible way to meet the future challenges is through increased used of renewable and non-traditional energy sources. The government is currently financing three important national programmes all aiming at supporting the renewable and non-traditional energy sectors in the country:

1) Renewable Energy Development Programme
The National Academy of Science in Ukraine has recently, on request from the Ukrainian government, elaborated a long-term development plan for utilization of non-traditional and renewable energy resources in the Ukrainian territory. The plan considers the potentials for each of the 24 administrative regions in the country and can as such be used as a regional energy planning tool. Various regions show impressing potentials for geothermal energy

development, where more than half of the local energy demand could be covered by geothermal.

2) Wind Power Engineering Development Programme
This programme is financed through a kind of "ecological" tax on electricity consumption. 0.75 per cent of the revenue collected from electricity consumption in Ukraine (10-12 million USD per year) is dedicated to develop wind power in Ukraine, both in relation to production techniques and for scientific work. The programme is implemented within the Ministry of Industrial Policy.

Today, the wind power business in Ukraine is benefiting not only from large governmental support programmes, but also from the existence of several abandoned, old military factories which are now producing equipment for wind power. From a rational point of view it may be difficult to justify this strong support to wind energy. The real explication behind this strategy seems to be more of political character than based on real strategic decision making.

3) Ecologically Clean Geothermal Power Engineering in Ukraine
In 1996, a 5-year programme was approved by the Cabinet of Ministers in Ukraine to support scientific geothermal activities in the country. The Institute of Engineering Thermophysics (IET) at the National Academy of Science in Ukraine was appointed the leading institution of the programme, which has been implemented through the Ministry of Science. The programme will be concluded by the end of this year and due to great satisfaction with the results obtained so far, an extension of project activities for another 5-year term will most probably be approved. The annual IET programme budget is around 200 000 USD.

The real challenge for these three programmes will be to establish a close relation between policy recommendations and real political action. This will again be closely related to how, and to what degree, renewable and non-traditional energy forms will find their own market in Ukraine.

What is obviously needed in order to make these governmental programmes and initiatives truly operational in Ukraine, is the development of complementary implementation plans (business plans), which will integrate financial, political/institutional as well as technical issues into coherent and concrete operational activities. As identified in the governmental Renewable Energy Development Plan, various regions present very encouraging and interesting future energy scenarios, which should be developed further.

7.7.1.1 State-Owned Energy Enterprises

In 1994 the Ukrainian government initiated a reform of the power sector aimed at improving commercialisation and competition within the sector. Progress has been achieved, however, the government is still interfering excessively with the regulatory environment.

In early 1998, Naftogaz Ukrainy was created, - a company formed by uniting former state-owned oil and gas companies into one single state-owned oil and gas company. Naftogaz Ukrainy controls oil and gas production and marketing as well as the national oil and gas pipeline network, one of the country's largest sources of revenue. Among the future plans is to privatise Naftogaz Ukrainy, however, when and which model to be used has still not been decided.

Even though the outlook from an investors point of view for Ukraine may now look more positive than a couple of years ago due to recent successful implementation of political and economic reforms in the country, it will probably take some time to convince investors to put money into the energy sector. Concrete results need to be seen and this should be based on coherent, integrated and sustainable energy planning, addressing as well financial, political, institutional and technical issues.

7.7.1.2 Prices and Regulation

Although improvements have been made over the last couple of years, energy prices in Ukraine do still not reflect related costs. The electricity prices are set for the country as a whole, while heat price settings are based on municipality price calculations, approved by a national regulatory commission. Heat prices may therefore vary between regions and municipalities.

Heat prices have only increased modestly over the last couple of years. A reason for this is that Ukraine does not have an efficient subsidy system in function and sharp heat price increases may therefore create serious problems and conflicts among the already poor Ukrainian population.

Moreover, the heating sector is plagued by lack of payments, in particular from the industry. The heat tariffs for industry in Ukraine are around three times higher than for households. All this together has left the heating sector with big losses and deficits.

However, energy prices in Ukraine will soon have to edge up with production costs in order obtain a functioning, market based economy, as required by the international financial institutions. New economic attractive and sustainable solutions to the heating sector are therefore urgently required in the country.

7.7.2 Geothermal Energy in Ukraine

7.7.2.1 Geothermal Areas and Projects

Around 40 per cent of the Ukrainian territory represents promising geothermal sites with water temperatures between 60° C and 130° C. The most promising areas are found in the Western part of the country (Zakarpatsky) and on the independent peninsula of Crimea.

Currently 10 geothermal projects are implemented, however in practice only 5 smaller plants (1-5 MW) with a total installed capacity of around 12 MW are in operation, mainly in the Crimea Peninsula. The IET has assisted in the implementation of these projects, however it has until now proven to be difficult to maintain a continuous operation of the plants after the IET staff has left the project site.

More than 100 wells drilled in Ukrainian territory during the last decades could be used for geothermal energy development. However, currently less than 20 are in use. This is mainly due to lack of capital for project implementation but also related to the fact that many of the drillings are not placed in urban areas where they could benefit from existing distribution systems.

The assessment of geothermal potential for the whole territory of Ukraine has been going on for several years now, supported by the governmental scientific programmes (see also 7.7.1). Through this research work priority sites for commercial use and for construction of demonstration plants have been identified. Moreover, operational reserves to a depth of 3 500 metres have been explored and evaluated and it has been estimated that geothermal heat supply systems with a total capacity of up to 50 000 MW could be constructed in the country.

Geothermal fields with water temperatures up to 100° C are, at present, deemed to be most prepared for commercial utilization. Moreover, feasibility studies made by the IET, based on 12 scenarios of heat capacity and water temperature, have shown that geothermal heating systems are economically attractive and profitable for capacities higher than 6.0 MW and water temperatures exceeding 80° C.

The existence of high temperature geothermal water in the Ukrainian underground creates realistic possibilities and potentials for generation of electricity. This may be the case in the regions of Zakarpatsky, Kharkivsky and Crimea. Moreover, in Crimea, the geothermal water contains dissolved gas which make also make it feasible to produce electricity from lower temperature water. The potential for electricity production, and related cost-benefit estimations, have not yet been fully investigated.

7.7.2.2 Organisations Responsible for Geothermal Energy Development in Ukraine

Government

In Ukraine, there is not one particular ministry responsible for geothermal energy development. Instead, responsibilities and support to geothermal activities in the country are spread out between different ministries and governmental related programmes and committees.

The Ministry of Energy in Ukraine, although being responsible for overall energy development in the country, is in practice mainly concerned with the "big" energy issues, such as those related to the power sector, including politics on nuclear and electrical power and power generation plants.

The Ministry of Science is responsible for, and financing, the scientific 5-year programme, implemented through IET, on Geothermal Power Engineering (see 7.7.1).

The Ministry of Industrial Policy is responsible for the development of the governmental Wind Power Programme, financed through the eco-tax on electricity consumption, which in theory should also provide some funds for industrial and scientific activities related to other renewable energy forms such as geothermal. However, in practice the eco-tax is functioning as a direct state support to the wind power sector.

The Ministry of Environment, through their geological department, is involved in drilling and underground activities, also involving those of geothermal concern.

Moreover, geothermal energy development in Ukraine has until now been supported from various governmental programmes and committees established for specific purposes.

A clear future challenge in Ukraine will be to coordinate and integrate the geothermal support activities carried out between the different ministries and institutions. A clearer institutional set-up for renewable energy development, including geothermal, will probably be needed in order to make more efficient use of the funds designated for these purposes.

Private Sector
Within geothermal energy development, the private sector has not yet played a very visible role. This is mainly related to the fact that geothermal energy projects have not yet reached the "commercial acceptance" compared to other energy sources, as for instance wind power.

For the wind energy sector, a coherence has been established between scientific and commercial level through the Wind Power Programme. Equipment for wind energy projects is produced locally in the factories earlier used for military equipment production. These factories could, however, as well be used for production of equipment for geothermal energy products and is thereby representing an important capacity resource for the country when looking further into the future potential for geothermal energy implementation in the country.

Universities and Other Research Institutions
The centre for geothermal research and science in Ukraine is the Institute for Engineering Thermophysics (IET), placed in Kiev. Within the institute two departments are working on geothermal issues; the Department of Technology of Geothermal Energy Production and the Department of Thermal Energy Utilization. The technical capacity in the institute is very high and would provide a strong backup support in relation to future geothermal project implementation in Ukraine.

In year 2000 the Ministry of Education was merged with the Ministry of Science in order to create a stronger coherence between the scientific and educational environments. What regards geothermal energy, the merge has resulted in a stronger interaction between the IET and the Polytechnical Institute in Kiev, thereby improving conditions for creation of a future, well-capacitated geothermal resource base in the country.

7.7.2.3 Institutional Factors Governing Geothermal Energy in Ukraine

Laws and Regulations
An existing law on concession rights in Ukraine permits companies to obtain a 10-15 years license right to exploit geothermal underground resources.

On the other hand, the Ukrainian legislation does not permit penetration of potable water reservoirs. In practice, this will impede realization of some potential geothermal projects where the geothermal reservoir is placed under such water reservoir.

7.7.2.4 National Funding Sources for GE Development

At present, no national funding mechanism is used to support geothermal project implementation.

However, the Ukrainian government does have in operation a couple of funds which could apply in a higher degree also to geothermal projects. One example is the “ecological” tax on electricity consumption (0.75 per cent), mainly dedicated to the developing of wind power in Ukraine. Another example is a fee system, although not very operational, implemented by the Ministry of Environment, that levies taxes on air and water emissions and solid waste disposal. These revenues are channelled to environmental protection activities.

7.7.3 Summing Up - Ukraine

Ukraine has just recently started recovering after nearly a decade of recession and struggling through a difficult transition process to a more liberalized political and economic system. Although still in a premature phase, the ongoing process is directed towards the EU requirements. Recent development trends in Ukraine have been recognized by the international financial institutions, which have credited the country by increasing their loan portfolio significantly.

Ukraine has traditionally been very dependent on Russia on energy import, mainly on gas and oil. The wish to become more independent, together with recent increases in national energy consumption and energy intensity, has motivated the Ukrainian government to consider more intensive use of alternative energy sources.

Ukraine possesses significant high-temperature geothermal resources, which could cover a large part of the energy supply within several regions of the country. The geothermal resources have been scientifically investigated and feasibility studies and data material have been developed. However, so far geothermal project implementation in the country has been very limited, and only at small-scale, mainly due to financial constraints.

The Ukrainian government is currently supporting development of renewable energy sources, including geothermal, through three programmes. Wind power is, however, the renewable energy form receiving by far most political and economic support in Ukraine.

Geothermal energy in Ukraine will need to demonstrate its economic and commercial feasibility in practice in order to activate a dynamic political-private sector support in the country, as it has been the case, for instance, within the wind power sector. Production capacity for equipment is available in Ukraine as well as technical engineering geothermal expertise. Moreover, the government has demonstrated its competence and willingness to introduce eco-tax’es on energy production (for the Wind Energy Programme) in order to support development of renewable energy forms.

With a view to current conditions and situation in Ukraine, it is therefore recommended that support will be given to assist ongoing efforts to implement geothermal demonstration projects in the country. However, taking into consideration the government’s current fragmented support mechanism for geothermal energy, together with an actual process in the country characterized by political and economic reforms and sharply increasing inflow of foreign capital, it is also recommended that practical project implementation should be complemented by development of coherent (business) strategies and plans for regions where particular encouraging geothermal potentials have been identified.

The regions identified as being the most prospective concerning geothermal energy development are Crimea and Zakarpatsy. These regions have rather different characteristics and should therefore be analysed separately in order to assess their potential in relation to potentials, sustainability and demonstration effects of project implementation.

7.8 Geothermal Energy Potentials in the CEECs – a Comparative Analysis

In what follows, a comparative synthesis of the five focus countries is presented, based *inter alia* on the conclusions from the country profiles in volume II. Some of the countries share characteristics and conditions on some components, but important differences can also be registered.

The five focus countries may be conceptualised in two groups:

- Group I consists of Slovakia and Poland, which are already both highly integrated into the EU.

- Group II consists of Romania, Russia and Ukraine with economies and political systems which are not strongly integrated into the European Union.

7.8.1 Economic Potentials

The main barrier for geothermal project implementation in all five focus countries is the lack of funds. However, the point of departure differs between these countries. Poland and Slovakia are relatively more advanced in more or less all economic and political areas and these countries currently represent other opportunities and securities to potential investors than do Russia, Ukraine and Romania.

Poland and Slovakia now face EU accession soon and have through the last decade profited from strong economic support from EU countries and international financial institutions, which has in turn created optimal conditions for economic growth and restructuring of the country. While full and final integration with the EU energy and environmental chapter is still pending, major steps towards liberalization of energy prices have brought price levels and settings closer to EU levels.

Geothermal energy development has now proven to be economically feasible under present conditions in both Poland and Slovakia. This has attracted more interest from municipalities as well as from private investors to take part in geothermal projects in these countries. However, where new drillings are needed, the obtaining of funds to finance the first drilling remains a critical barrier since this drilling is always related to certain risks regarding the quantity and quality of the geothermal water.

In the view of this, it is deemed to be crucial for future geothermal development that some kind of insurance system will be defined and implemented in order to attract required private and/or national project capital. The fact that financial support from IFIs and bilateral donors to, in particular, Poland is now decreasing as a consequence of the country’s increasing ability to act financially independently, is further strengthening the importance of this issues.

The economies of both Russia, Romania and Ukraine experienced the similar kind of serious difficulties throughout the 1990's and the transition process in these countries has been and, to some extent, still is a difficult task. The challenges have first of all focused on economic recovery and then, afterwards, on concerns for the establishing of transparent rules and regulations, also within the environmental and energy sector. However, the countries have now passed important steps in their development and are now receiving increasing financial support from the EU and the international financial institutions.

Energy prices in the CEECs have increased substantially over the last few years, however, price subsidies, in-transparent price calculation mechanisms and neglecting of negative environmental effects are still, in some degree, characteristic for energy price settings in all countries in question. This, in turn, is highly favouring some (polluting) energy sources over renewable, environmentally friendly energy forms, such as geothermal. A particular sensitive issue in Ukraine and Romania, and to some extent also in Poland, is related to coal price subsidies. Coal has a particular socio-economic importance in these countries, which makes it highly difficult for the government to eliminate existing coal subsidies.

While Russia, Ukraine, Slovakia and Romania do not have any efficient national funding mechanism in operation to support geothermal project development, in Poland there are two funds (Eco Fund and National Fund for Environmental Protection), which have both contributed with significant funding for the geothermal projects implemented so far in Poland. Moreover, the contributions from these Polish national funds have become important instruments in order to attract international funding for the projects. It is therefore considered a strong positive factor for Poland to have these funds in operation.

In fact, Ukraine also has an "ecological tax" (on electricity consumption), however this tax revenue is dedicated to wind power development. In case geothermal will be able to demonstrate its profitability in Ukraine, this eco-tax modality may well be extended to include geothermal industry. Russia is well advanced in operationalising and – together with the Energy Carbon Fund - institutionalising the concepts of joint implementation and carbon credits. As to committing to renewable energy, allocations made in august 2001, in the federal budget, for renewable energy initiatives in South European Russia are noteworthy.

While in Poland loans for geothermal projects can be provided with subsidized interest rates, this is not the case in any of the other four focus countries. High interest rates and short repayment terms in these countries impede therefore to a large extend large scale project implementation. This, again, is directly related to the fact that in these countries geothermal investments are still considered a highly risky business, which requires a high "risk premium".

Another feature to be considered is the variety in socio-economic conditions between countries and regions. Even within the same country, socio-economic conditions may differ considerably and may present very distinctive contexts for implementation of geothermal projects. In Poland, for instance, it is obvious that the richer, southern part of the country represents a total different geothermal outlook than for instance other regions. This same picture was also found in Russia and Ukraine, countries which both contain various, dispersed regions with high geothermal potentials.

7.8.2 Institutional and Political Potentials

A general picture of all five focus countries is that responsibility for geothermal energy development is divided between different Ministries and public institutions, thereby making it difficult to identify a coherent, national approach. Although different support programmes exist, mostly related to scientific work, it is also characteristic that none of the five focus countries have a clear and operational policy on renewable energy, including geothermal.

Even though comprehensive reforms have been undertaking within the energy sectors during the transition period, geothermal energy has to a large extent been neglected in this process. Most countries have developed medium and long term so called “strategies” for renewable energy, indicating goals and potentials. These strategies, however, in general do not include much description on how to achieve these goals and, in particular, concrete information on how to finance related activities and projects.

In order to pave the road for future geothermal development in these countries, it will therefore be necessary to complement these very general strategies with concrete, realistic and operational action plans with particular focus on geothermal. The developing of such plans (“Business Plans”) should in particular address issues of institutional, financial and socio-economic character, all elements which are of utmost importance to project sustainability and impact, but is not generally included in sufficient degree in existing technical geothermal (feasibility) studies. Such comprehensive plans would be a major tool for future sustainable advance within the geothermal field and would naturally integrate the need for stronger coordination of donor funding and loans.

Another important and related feature identified within the institutional context is the division of responsibility between the national (governmental) level and the regional/local level. The current tendency in all countries is to delegate more autonomy to decentralized levels, including issues of energy and environmental concern. However, these political intentions are generally not followed by similar and sufficient increases in the transfer of resources (human and/or economic) from the state. Moreover, as it is particularly the case within the energy sector, the state wants to maintain “certain influence” and only delegate some limited responsibility and autonomy. All together, these circumstances add to paint a picture of a very complex institutional environment within these CEECs. Geothermal energy development is certainly affected by this situation and it must therefore be considered a high priority to clarify and map these issues, including ownership rights, as part of a general approach to improve the institutional environment for geothermal investments.

In Romania, Ukraine and, to some extent, in Russia, geothermal energy projects still need to prove their profitability before it can be expected that significant national (private/public) capital will be allocated to such projects.

This is mainly due to two factors: Firstly, due to scarce resources in the national budgets, in general not much funding is channelled to environmental/renewable energy purposes, unless there is a very clear indication of "good business". Secondly, even though much reforming has already taken place within the political environments in these countries, real transparency and rational political decision making is still lacking. This is the case for the energy sector where the oil and gas business (import/export) traditionally has been considered an attractive business for some politically influential groups in these countries. It is therefore difficult to change the existing energy structures over the night, even though it from the outside would seem obvious to do so. Again, what will be of crucial importance to geothermal energy development in these countries will be to show good demonstration projects, governed by realistic business plans.

Although no particular geothermal legislation exists, laws on concession rights for underground resources are now applicable for geothermal resources in all countries. In Romania, the Mineral Law from 1997 represents a major progress in this field, since it opened up the possibility to obtain license for up to 20 years (earlier it was only one year and thereby a serious problem in relation to attract private investment capital for geothermal projects). Also Ukraine has recently modified their law on concession rights, which makes it more attractive for private companies to invest in such projects.

However, from a Western perspective, institutional shortcomings in the countries in question, including legal enforcement gabs, lack of information sharing and market institutions (enforceable contracting and property rights) generally represent an important barrier for large scale foreign investment, - in particular with respect to Russia, Ukraine and Romania. In this context, joint ventures may be an attractive way for prospective investor to overcome such institutional insufficiencies.

7.8.3 Technical Potentials

Data material and significant research work on geothermal energy already exists in all focus countries. Moreover, relevant human resource capacity is available to support future geothermal development. Within all countries there are small scientific groups of geothermal specialists with several years of experience, but it is also characteristic that young geothermal scientists are currently being educated through special courses on the universities and practical working experience.

In Russia, Ukraine and Slovakia the scientific capacity and the centre for geothermal research are placed in the capitals (respectively, Moscow, Kiev and Bratislava), far from the most potential project sites. All three countries are characterized by having not only one, but several very promising geothermal regions. In Romania, the geothermal centre is placed in the city of Oradea, in the area which is by far the most promising from a geothermal point of view. In Poland, the geothermal centre is in the Southern region (Podhale), where also main geothermal project activities are ongoing. The presence of geothermal scientific expertise and activities close to project sites is deemed to be a positive factor in relation to project sustainability and local support.

In all five focus countries, several boreholes already exist, drilled in the past for gas and oil purposes. These wells could in principle be used for geothermal purposes also, and the first such project has successfully been implemented in Poland (Mszczonów, see case study, Volume II). In Poland more such projects build on existing drillings are foreseen and also in Romania, Slovakia, Ukraine and Russia this concept could be further developed. However, in some areas it seems to be more problematic to include existing wells for geothermal purposes, since many of them are not placed close to towns with heating networks. From a point of view of geothermal energy use, it is an important (economic) advantage if district heating networks already exist, however, the existing district heating infrastructure is often in very bad condition, requiring new investments in order to rehabilitate or change the existing network.

7.8.4 Environmental Potentials

Even though some improvements took place in environmental legislation and energy policy, as well as in CO_2 emission levels, all five focus countries continue to have serious environmental problems directly related to the use of polluting energy sources.

The district heating sector emit a significant part of the total CO_2 emissions, and the sector is stuck in a vicious circle: Prices are raised I order to create income to improve the existing networks, which often are in poor condition and the owners (often municipalities) do often not have economic opportunities to improve the systems. But there is a tendency for frustrated consumers to disconnect from the district heating systems, when the price go up without any notable short term improvement in the service. Such disconnections in turn leads to even higher prices for the remaining costumers, - thus the vicious circle. The increasing inefficiency of the heating systems is reflected in the increased national energy inefficiency in all five focus countries throughout the 1990's, - except from Poland and, to a lesser extent Slovakia.

Geothermal heating plants represent an opportunity to break this vicious circle. GE is an attractive vehicle for improvements in the energy system, because each project brings with it opportunities to take a holistic or systemic view of the district heating system, in which the project is to be integrated. In the process, new technologies, insulation materials and standards can be introduced, potentially leading to systemic change saving energy and increasing efficiency beyond the geothermal unit.

As a positive remark, it should be noted that all countries in question now by law require assessments of the environmental impact of geothermal projects prior to project approval, as well as for other project types.

7.8.5 Overall Assessment

To sum up the comparative analysis, table 7.8-1 gives an overview of the potentials for each of the five focus countries within different categories. It should be noted that each category contains a range of factors, for instance does *technical potential* include geothermal resources as well as human capacity, and is as such a weighted mix of all these factors.

Table 7.8-1 Geothermal Potentials in CEECs

	Economic potential	*Institutional/policy potential*	*Technical potential*	*Environmental potential*
Poland	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓✓
Russia	✓✓	✓✓✓	✓✓✓✓✓	✓✓✓✓
Romania	✓✓	✓✓✓	✓✓✓✓✓	✓✓✓✓
Slovakia	✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓
Ukraine	✓✓	✓✓	✓✓✓✓✓	✓✓✓✓✓

(✓✓✓✓✓ = maximum score; ✓ = minimum score)

As it can be seen from table 7.8-1, the *technical potential* is considered to be very high for all countries included. This is an important point of departure, since the technical potential will be the first thing to look for when considering geothermal project implementation within the CEECs.

It should also be noted that the environmental potential is considered to be high in all countries, with some variation in scale between the countries. Based on the current situation and future outlook, Ukraine is considered to present the case of most significant environmental benefits, while Slovakia already has a much more energy efficient structure in place and does therefore, at the aggregated level, present less environmental potential.

The *economic potential* varies more between the countries and does to a certain degree reflect the countries' current capacity to present an attractive climate for geothermal project investment, including through national funding mechanisms and programmes. The *institutional/policy potential* refers to the central issues described in 7.3.2 and on to what degree the countries are currently institutionally organised and structured to support geothermal development. As it is the case with the economic potential, the institutional/policy conditions also vary considerably, - mostly reflecting different stages of the transition process and EU approximation.

In conclusion, it shall be emphasized that all five countries represent interesting cases for geothermal project implementation. From a *technical* and *environmental* point of view it is evident that all countries have clear potentials. The generally lower scores on the *economic* and *institutional/policy* components should be interpreted in the way that the five countries, at this point of time, need additional support on these issues in order to make geothermal project development sustainable. Moreover, even though the four components have been treated separately here, they should in real cases always be integrated in order to obtain a holistic judgment of project effectiveness, impact and sustainability.

Finally, an important factor, which is not really integrated into the above assessment, is the *demonstration effect* of geothermal projects. In Poland and Slovakia, and to some extent in Russia, GE plants and their potentials are now well-known. However, in countries such as Ukraine and Romania this is not the case and the demonstration effect from GE projects is a crucial parameter, which should be taken into consideration when assessing potential project proposals.

8 Towards Strategic Development of Geothermal Energy Potentials in the CEECs

This report has so far identified barriers and risks, as well as opportunities and drivers, for promoting geothermal energy projects in CEECs. It has also identified the need to focus on characteristics, advantages and disadvantages of politics and funding sources, donors and investors, within the CEECs.

From the *Retrospective Analysis* (Chapter 6), and from the geothermal projects visited during this study, it has been clearly demonstrated that geothermal energy systems indeed represent an interesting and promising opportunity for future energy supply to Central and Eastern European countries and regions. A list of valuable lessons has been learned from the geothermal projects implemented so far. This experience has been mapped out through this study and represents an efficient guiding tool for future selection of geothermal projects for financing.

From the *Prospective Analysis* (Chapter 7) it was concluded, that all five DANCEE focus countries (Poland, Russia, Romania, Slovakia and Ukraine) have strong geothermal potentials. The *technical* and *environmental* potentials were deemed to be high in all countries in question. With respect to *socio-economic* and *institutional/policy* issues, however, the point of departure differed more between countries and regions. Since these latter issues are of crucial importance in order to attract investors and demonstrate project sustainability, it is considered essential that future geothermal project implementation in the CEECs will be based on not only technical and financial parameters, but also on thorough analysis of socio-economic and institutional conditions of relevance to the project.

Inputs from Danish sector experts have been an important factor in achieving successful geothermal project results so far. Moreover, DEPA (DANCEE), and the Danish experts contracted, is well regarded in the CEECs as well as among local stakeholders and other international geothermal players. It is of paramount importance to acknowledge that the reason why Denmark and the Danish Ministry of Environment has a high international comparative advantage in achieving sustainable (environmental) results in the renewable energy sector, is the *system character* of the Danish energy related products. It is systemic in the sense that the institutional underpinning and context, is often exported along with the products, thus contributing to create positive institutional change and more conducive environments for renewable energy in the recipient countries. An example of this, is when a geothermal project introduces not only components that improve the insulation of the district piping network, but the institutional components of the project also help to create institutional improvements at regional and national level.

From this assessment, questions may be raised on how international donors, bilateral agencies and international finance organisations may best help to promote Geothermal Energy in the CEECs, in cooperation with the national and regional partners and institutions. A range of different international players are today involved in geothermal project activities in the CEECs and others might have both interest in and potential to get involved. In the past DEPA, through the DANCEE programme, has worked with international financial institutions as well as with Nordic and national lending institutions. Most of the support from the international society has however so far been given on an individual and uncoordinated basis, thus leaving a clear need for more coordination and cooperation within the field of geothermal energy development.

8.1 International Players

In the following, some of the main international players, currently involved in geothermal project activities in the CEECs, are presented briefly.

8.1.1 The European Investment Bank (EIB)

With a subscribed capital of EUR 100 billion, the European Union's major financing institution, the European Investment Bank, was able to sign loan signatures at EURO 127 billion in the EU from 1996 to 2000. About 60 per cent of these were issued for infrastructure projects, but the energy sector has now been added as eligible for loans in the future. The EIB has lately been active in identifying the characteristics and requirements of geothermal energy, with a view to make geothermal energy "bankable"[12].

While in the past the EIB has funded as much as 10 geothermal projects totalling 253 430 000 EURO, almost all of these projects have been located in one particular region of Italy.

8.1.2 EBRD

The environmental priorities of the Bank's financing in the energy sector includes a goal of minimizing atmospheric emissions and effluents by switching to less polluting fuels. Elaborating on this strategy and the related instruments, the Bank announces that it will seek to blend financing with grants, such as those available form the GEF, for projects that reduce greenhouse gas emissions. Further, the bank stress that direct lending and mobilization of co-financing with Export Credit Agencies and commercial banks through senior loans will "continue" to be the main component of the Bank's financing strategy for the energy sector. EBRD also has an Energy Operations Policy committing the bank to a strategic assessment of the potential for renewable energy utilization in its countries of operation ("COO").

With a USD 100 million loan to the Russian company "Geotherm", the EBRD currently supports one geothermal project in the CEECs. The project is located in Russia's far eastern region of Kamchatka. The same project is preparing a phase II, for which the Global Environment Facility (GEF) has granted funds for preparation of a business plan.

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[12] This perspective was evident in a presentation on the International Workshop on the Future of Geothermal Energy, where keynote speaker, Mr. Günther Westermann related the "*Perspectives on future EIB participation in geothermal energy development in the CEECs, Russia and Ukraine*".

8.1.3 The World Bank Group

During the last two decades, the World Bank Group (IBRD, IDA, IFC, MIGA, ICSID) has supported 12 geothermal projects, totalling 1.4 billion EURO.

In the CEECs, the World Bank has so far provided co-financing (loans) for the geothermal projects in Zakopane (Podhale, Poland) and Klaipéda (Lithuania). Another Polish project (Stargard) is currently on the brink of receiving financial support from the World Bank.

The World Bank has expressed its satisfaction with the results obtained so far from the geothermal energy projects in the CEECs, implemented and co-funded with the DANCEE programme.

8.1.4 The Nordic Finance Group

The Nordic group of geothermal investors includes the Nordic Investment Bank (NIB), the Nordic Development Fund (NDF), the Nordic Environment Finance Corporation (NEFCO) and the Nordic Project Fund (NOPEF), all of which contributed to the development of geothermal projects in the past.

During the last decade the *Nordic Investment Bank (NIB)* has supported 4 geothermal projects, totalling 1.4 million EURO. The projects focused on direct use and had minor R&D components. One project was in China, another is in Slovakia (a loan in 1994 to the gas company SPP) and yet a new Slovakian project await a decision by NIB. In the same period, the *Nordic Development Fund (NDF)* has supported 2 geothermal projects, totalling 0.7 million EURO. These projects focused on "direct use", with minor R&D components. The *Nordic Environment Finance Corporation (NEFCO)* has supported 3 geothermal projects, focused on direct use, totalling 0.4 MEURO. Finally, the *Nordic Project Fund (NOPEF)* supported 6 geothermal projects, totalling 0.2 million EURO. These projects focused on "combined uses".

8.1.5 UNEP and GEF

GEF funding (grants) have so far been provided for the geothermal projects in Podhale and Klaipéda. Further geothermal projects in Poland are currently under consideration for GEF funding, including the Stargard and Kolo projects.

The UNEP-GEF Sustainable Alternatives Network (SAnet)[13] is based on GEF's knowledge and communication engine to cultivate growing momentum in emerging markets for cleaner technologies. The operational goal of SAnet is to facilitate consideration of cleaner "win-win" technology alternatives and related market opportunities by executives, who make critical business and policy decisions.

[13] Information on this initiative may be obtained from Frank Rittner at Frittner@worldbank.org or through SANet@unep.fr and at www.SustainableAlternatives.net

Within the geothermal energy field, SAnet intends to bring together interested public and private players to discuss the best ways to level the playing field in specific markets and countries. SAnet wants to facilitate join market visions that can form the basis for market development coalitions.

8.1.6 The IEA (GAI)

Under the auspices of the International Energy Agency, the Geothermal Implementing Agreement (GIA) was recently been prolonged intil 2006. Initiated in 1997 and bringing together national programmes, the GIA presents an important framework for international cooperation in geothermal research.

Fostering collaboration on R&D and technologies and improving understanding of the benefits of GE are the main mandate of the GIA. The GIA is expected to develop a set of future "guidelines for market acceleration" addressing issues such as legislation, risk management, green power production credits and development of geothermal energy. To this end, GAI recently administered a survey covering a broad range of countries (from Albania to Yugoslavia) and issues, including national acceptance, energy policies, licensing, promotional issues educational, media and marketing issues[14].

8.1.7 The European Union

Even though no EU directives today seems to aim explicitly at regulating or promoting geothermal energy development, the EU should be considered a main strategic player, as far as the future of geothermic energy in the CEECs is concerned. Several recent strategic documents from the EU focus on and stress the strategic importance of renewable energy sources (White Paper 1997 and Green Paper 1996). One strategic EU document deals explicitly with the potential of geothermal resources (Blue Book 1999).

The Commission of the European Communities has appointed the Italian Geothermal Association (and member of the European Geothermal Council EGEC), to issue a "European Geothermal Directory". The Directory will provide a comprehensive overview of companies, consultants and organisations supplying equipment or services for the geothermal sector, as well as plant operators. Research and cultural institutions and media involved in the field will also be included. Geographically, the directory will cover all European countries, both inside and outside the European Union, including part of the Russian Federation and Turkey. The directory will be a tool for disseminating names and scope of interested parties, with a view to facilitate contacts and favouring inter-relations between European entities.

8.2 DEPA as an International Player Promoting Geothermal Energy

Owing to the experiences from the DANCEE programme, The Danish Ministry of Environment is in a good position to continue and intensify its

[14] Further information on GIA may be obtained from Mr. L. Rybach, Chairman of the IEA Geothermal Implementing Agreement GIA implementing committee.

pivotal role as a promoter and disseminator of renewable energy sources like GE, in CEECs.

By commissioning a strategic study on geothermal energy, hosting an international workshop on the future of geothermal energy in the CEECs and finally preparing a strategic action plan, DEPA has contributed to achieving a high level of international coordination and collaboration in promoting geothermal energy in the CEECs.

The strategic study provides DEPA with an instrument by which to steer, govern and channel future investments and selection of geothermal projects. Consequently, future geothermal projects to be supported by DEPA through the DANCEE programme should be selected according to a set of economic, institutional, technical and environmental criteria (see box 6.7-1 – 6.7-4). These criteria will be based on prevailing political, institutional and regulatory conditions in the sense of policy initiatives and programmes to promote geothermal energy.

This study confirms that a new market is indeed developing, offering commercial opportunities for pioneer companies. This market, however, is by nature dependent on governments and international organizations cooperating to establish a stable and solid framework for private investments. The involvement of industrialised countries in the GE sector in CEECs is both necessary and desirable for this sector to develop its full potential.

Based on this experience, it is strongly recommended that future geothermal projects in the CEECs are not carried out in isolation, but integrated into "packages", where the geothermal components are complemented both on institutional, policy and financial issues, as well as at the technical level, with other renewable energy technologies including energy saving technologies.

8.3 Towards Concerted Action - Actions To Be Taken by DEPA

Through this study it has been documented that a range of issues will need to be addressed in order to create conditions for a real "take off" for future development of geothermal energy potentials in the CEECs. Core challenges include the following issues:

- Strengthening of mechanisms and fora for international collaboration on support to geothermal energy development in the CEECs.
- Ensuring that future GE demonstration projects in the CEECs will be based on not only technical but also thorough economic, institutional and policy analysis in order to ensure sustainability of these project activities.
- Creation of attractive economic conditions and climate for GE investments in the CEECs, - also for smaller projects - , for national as well as for potential international investors.
- Better linking and coordination of geothermal projects with other energy and environmentally related projects within the CEEC regions.
- Improvement of institutional and regulatory support mechanisms within the CEECs for GE project development.

- Stronger involvement and commitment from CEECs in GE project development, involving both national and regional levels.

- Improvement of promotion, advocacy and information systems for geothermal project development in, and between, the CEECs.

Based on the analysis and experience provided by this study, a list of concrete and strategic DEPA action proposals has been developed, taking into consideration comparative advantages and the complementary role of the DANCEE programme. The initiatives proposed should be considered with a view to common action involving international as well as national key players related to geothermal energy development in the CEECs.

It is recommended that DEPA, through the DANCEE programme, will:

- Take active part in, and collaborate more closely with, relevant international (European) fora promoting geothermal energy development. For instance, does the GIA represent a good opportunity for Denmark to be on the forefront with, and influence the future development within the field of geothermal energy.

- Consider taking a supportive role in the creation of an insurance system for GE in all CEECs. Whether on a commercial basis, - in the form of a revolving fund or a consortium model - , overcoming the barrier of "first step risk" remains a key to expansion of the geothermal sector. Creating an institution to cope with this risk is paramount in creating a take-off situation for GE.

- Contribute to the creation of European consortia and joint ventures, by giving priority to projects including co-financing from European industrial partners, e.g. through the use of (advance/reimbursable) project identification and pre-feasibility studies.

- Seek closer collaboration between bilateral donors and international finance institutions (including Nordic and Danish lending institutions) providing low interest loans for GE, based on thorough analysis of the comparative advantages and complementary roles of the different agencies involved in financing and supporting development of geothermal energy.

- Coordinate geothermal project activities more thoroughly with other relevant (Danish) energy/environmental projects/programmes in the CEEC in question. This should be done both in order to achieve maximal environmental/energy effects from the (Danish) funds, but also in order to involve other potential (Danish) investors and funds, which may have an interest within the geothermal field.

- In policy dialogues with partner countries, promote the idea of creating a favourable investment climate for GE through tax reductions for renewable energy products, tax incentives for GE investments, soft loans and financial incentives for end users of RE/GE sources.

- Concentrate future attention more on management, institutional, policy and financial issues in relation to geothermal project implementation. Neglect of these issues have in the past created unsustainable situations, even for projects with significant technical potentials.

- Consider how decentralizing and regional development could be better linked to geothermal projects, since geothermal potentials often are more of regional than of national concern in the CEECs. This could create the basis for large scale geothermal development at regional levels through development of comprehensive and coherent regional Business Plans, addressing relevant issues of technical, institutional/political, environmental as well as of financial character.

- Support development of mechanisms that could ensure transfer of "best practices" from geothermal development activities in one CEEC to other countries in the region. Best practice could be either project specific or related to national/regional policy issues. It could also be in the form of project visits and workshops, seminars etc.

- Intend to link implementation of geothermal projects closely to solving other energy related problems in the CEEC regions, such as energy efficiency, optimisation etc. Of particular importance is the fact that geothermal plants will not be dimensioned in accordance with current heat consumption, but based on realistic expectations of future heat demand.

- Continue technical and financial support for GE demonstration projects in countries where geothermal potentials are significant, but undeveloped. Project implementation, however, should be based on comprehensive analysis of not only technical but also economic, institutional and policy issues in order to minimize risks and ensure sustainability of project activities.

- Consider how to create efficient funding mechanisms to support implementation of smaller geothermal investments projects. This could be in the shape of institutional support to regional authorities in regions with significant geothermal potentials and where multiple geothermal project implementation are feasible.

- Support the CEECs in creating adequate institutional and regulatory infrastructure for geothermal project development (national level) and in implementing plans and projects (regional and local level).

- Support creation of a Central and Eastern European GEO-Heat information centre, located on a geothermal heated campus. Such a centre has been in operation for 25 years in the US, providing information, data, publications, tours, lectures, training and user guides and could indeed be a useful platform for further promotion of GE in the CEECs.

- Support advocacy and media presentations in the CEECs on GE in general and its potential for replacing coal and other hydrocarbons in particular.

- Support an annual update of "Best Practice" to be distributed and used worldwide to improve conditions and the platform for geothermal project implementation. (The best practice from this GESA study could serve as a point of departure for such updates.)

- In general, ensure that the enthusiasm and optimism for the future of geothermal energy development that this study has awaken in the CEECs as with international geothermal players, will be followed up by appropriate initiatives and action.

It should be emphasized that although the above mentioned action proposals focus on DEPAs complementary role and advantages within the international context, DEPA should not await actions to be taken by IFIs and/or other donors, but should be willing to act on their own and take action to support the future development of geothermal energy in the CEECs.

9 Concluding Remarks

Through this comprehensive assessment of geothermal energy potentials in the CEECs a number of issues and challenges of relevance to future development of geothermal energy in the CEECs have been identified and analysed.

It is obvious from the outcome of this study, that geothermal energy development currently is rather neglected or underestimated in relation to national energy policy reforms and planning in the CEECs. In order to promote geothermal energy development in the CEECs more focus will therefore be needed on the creation of incentives and frameworks for this particular energy source.

It has been confirmed that the *technical and environmental potentials* of geothermal energy systems are e*xtensive* in Central and Eastern Europe. Considerable reservoirs of high-quality hot water exist under ground in most of the CEECs examined by this study and calculations and studies of environmental accounts demonstrate strong positive effects from geothermal energy plants. The study also demonstrates the major geo-political forces and environmental policy developments that will only increase the tendency to internalise more and more environmental accounts directly into the economic system that govern both economic decision makers and the "invisible" hand of the markets.

From an *economic* point of view, and although departing from a low point, the ongoing process of changes in all focus countries was found to be creating improving future conditions for geothermal energy development. However, it was also found that the CEECs demonstrate rather different levels of preparation and needs in relation to make GE an attractive "economic business". In some countries donor funding will be required to demonstrate efficient geothermal project models, whereas in other CEECs, focus should be directed more towards how to attract private/national investors. The relative imperfections of insurance systems to cover geological risks is one important factor impeding inflow of private capital into geothermal projects.

From a *political and institutional* point of view this report has identified the major challenge to the future of GE in the CEECs. Both politically and institutionally there is a certain amount of inertia in most of the countries investigated. GE faces, and is confronted with, established interest groups and mindsets. It also faces existing infrastructures, legislation and other rules and patterns that are not always conducive to the development of the GE sector. These challenges have been listed throughout this report and they are addressed by the strategy outlined and proposed.

The geothermal projects evaluated have been launched on an individual basis as separate projects initiated from a bottom-up approach. The experiences so far from these projects have created a list of *lessons learned* which have been presented throughout this report. Eventually, these lessons were converted into a set of *best practice* criteria to be used as a base for future implementation of geothermal projects in the CEECs.

Know-how and technologies built into the Danish district heating systems, and the institutional environment surrounding it, serve to make the Danish low-temperature district heating systems highly relevant for export in relation to geothermal projects in the CEECs. The effort and experiences generated by Danish geothermal experts have proved very useful in several CEECs, where geothermal energy sources have been integrated into CEECs district heating systems.

One of the major outcomes of this study is that in order to achieve most value and environmental impact in the CEECs for the DANCEE funds, geothermal energy projects should in the future be considered as much more than just isolated projects. Indeed, a much more comprehensive approach is needed, both in relation to the CEECs, but also taking into consideration the various existing and potential actors and their comparative strength and weakness.

The timing of this geothermal study has been excellent. The fact that for most CEECs the period of transition is gradually completed and taken over by an advanced degree of "normalisation" and European integration offers new perspectives. In this context, promotion of geothermal energy at a wider scale presents new opportunities but indeed also a range of challenges which must be faced and handled by all actors involved.

Another, more unpredicted, result of this study and its timing, has been the great and active interest from international as well as Danish actors within the geothermal field, to follow the study "on the line" and contribute to the discussions and development of operational action proposals in favour of geothermal development in the CEECs.

The increasing international attention on the potentials of geothermal energy was documented at the International Workshop on "The Future of Geothermal Energy in the CEECs", carried out on 8-9 October in Copenhagen, as a part of this study. The workshop was attended by representatives from international financial institutions involved in geothermal project activities, such as the EBRD, EIB and NEFCO/NIB and by other international geothermal organisations and programmes, including the UNEP/GEF Network and the Geothermal Implementing Agreement (GIA). From Denmark the workshop was assisted by representatives from DEPA, DEA, Danish Investment Funds and private companies.

Further to contribute to this particular study, the workshop also paved the ground for further concerted action and contact between both international and national geothermal actors. The workshop indeed confirmed that DEPA, due to its flexibility and experience so far, could become a main player in the future in order to create a "take-off" for geothermal energy development in the CEECs.

This study has documented that sustainable development of geothermal energy projects in the CEECs will not only require an optimal mix of financial and technical assistance inputs. It will also require that the institutional and policy framework will be prepared to support such inputs. Moreover, with an adequate institutional framework in place, foreign investors will be encouraged and GE projects may be implemented easier and faster than earlier.

When compared to the IFIs, a major reason why DEPA has a pivotal role in promoting geothermal energy, is the "scaling problem". This problem is evident when, for instance, the European Investment Bank and the World Bank voice its preference for "large" projects. This situation creates a need for someone to fit project and promoters and help "tailor" projects, including packets of finance. Maximising the additionality of DEPA in comparison to IFIs and bilateral donor organisations is an important objective in this process.

With this report, DEPA moves towards a strategic process designed to optimise the environmental impact and benefits for DEPA funds. As outlined in this study, coherent and integrated support to geothermal energy development in the CEECs presents highly positive and promising potentials for environmental investments. Through a strengthening of its central position within the geothermal field, DEPA will therefore contribute significantly to achieve the objectives of the DANCEE programme, within an area where Danish experts and companies possess relevant competences and experiences.

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