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 2: Country Profiles and Case Studies

DANCEE
Danish Cooperation for Environment in Eastern Europe
Ministry of the Environment

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Abstract
„This report supplements the thematic main report on strategic assessment of future potentials for geothermal energy systems in Central and Eastern European Countries (CEECs). The report includes country profiles and geothermal case studies from CEECs".

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

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Contents

Introduction

The Geothermal Energy Systems Assessment (GESA) project is reported in two volumes.

Volume I is the main report: Geothermal Energy Systems Assessment (GESA): A Strategic Assessment of Technical, Environmental, Institutional and Economic Potentials in CEECs.

Volume II is a collection of Country Profiles and case studies. Volume II includes country profiles on Poland (II: A), Romania (II: B), Russia (II: C) Slovakia (II: D) and Ukraine (II: E). Further, Volume II includes Non-Focus Country Profiles on: Bulgaria, Czech Republic, Hungary, Latvia and Lithuania (II: F). Finally, the GESA project produced a Strategic Action Plan (unpublished).

The GESA study distinguishes between focus countries and non-focus countries. Kvistgaard Consult wish to emphasize that this terminology is bound by time and context, meaning that it applies only to the current DANCEE programme perspective as of late 2001 and January 2002.

While 12 Central and Eastern European countries were considered for this study, main attention was given to analyze conditions in the five countries defined by DANCEE as focus countries: Poland, Slovakia, Russia, Ukraine and Romania. The remaining countries, the non-focus countries are 1) already phased out of the DANCEE program (Hungary), 2) currently in the process of being phased out (Czech Republic) or 3) subject to DANCEE (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.

Changes in DEPA's policies introduced in the course of 2002 may change the situation with regard to inclusion of countries in the DANCEE programme, as well as in the areas of collaboration covered by the programme.

1 Volume II.A: Country Profile - Poland

1.1 General Background Information

Through the 1990's, Poland experienced strong economic growth (table 1). In the period 1993-98 the average annual GDP growth rate was as high as 5.9 per cent. The growth remained strong, although it decrease to 4.1 per cent in 1999 and remained unchanged in 2000. The most direct impact came from the crisis in Russia and other Commonwealth of Independent States countries, which account for about 15 per cent of official Polish exports and a large share of unrecorded trade. Also, the relatively slow growth of the European Union (EU) economies, which account for almost three quarters of Polish exports, has recently limited the options for export growth.

Table 1: GDP Growth Rate (annual per cent) 1995-1999

1995	1996	1997	1998	1999
7	6	6.8	4.8	4.1

Source: www.worldbank.org

Poland joined OECD in 1996 and is a member of the Central European Free Trade Agreement (CEFTA). Poland is planning to enter the EU in the union's next expansion, and the country is in the midst of reforms necessary to meet membership criteria. Poland's Association Agreement with the EU came into effect in 1994 and the first round of EU Membership negotiations started in 1998.

Table 2: Energy Economic Key Figures for Poland

Country size in square kilometres	322 577 km^2
Population size	38.654 millions (30.6.1999)
GDP per capita USD95	4 061 (1999)
Annual energy use per capita (TPES toe)	2.42 toe/cap.(1999)
Average annual growth rate per cent of energy use (1990-1998)	-0.6 per cent (1990/1998)
Annual growth rate per cent of energy use per capita	-3.82 (98/99)
TPES/GDP	0.59 (1999)
TFC/GDP	0.39 (1999)
CO_2 per tonne oil equivalent – (CO2/TPES toe)	0.879 (1999)
Annual emission of CO_2 (million tonnes)	84.54 (1999)
TPES/TFC	1.51 (1999)
Net Import (Mtoe)	9.27 (1999)
Electricity Consumption (TWh)	122.62(1999)

Source: A combination of statistics from various sources[1]

Full membership of EU is a main foreign economic policy goal in Poland and progress on economic and social reforms, together with improvements in environmental quality and management, will be key to paving the way for Poland's accession to the EU. In recent years, Poland has become a leader among the CEEC in terms of the volume of foreign direct investment. Strong

[1] Energy Statistics of OECD Countries 1998-1999, IEA International Energy Agency, http://www.stat.gov.pl, OECD 2000, www.worldbank.org, www.eia.doe.gov (Energy Information Administration)

perspectives for the Polish economy, relatively low labour costs and a large labour pool, the size of domestic market, the prospect for EU accession and a general good business climate are all factors that have made Poland attractive to foreign investors.

1.1.1 Map of Poland

Source: www.countrywatch.com

1.2 The Energy Sector

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 intended 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; diversification of sources; increased competitiveness for Polish energy sources on 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 around 4 per cent today.

1.2.1 Energy Supply and Consumption

Energy use per capita is fluctuating through the 1990's with a peak 'period' in the years 1995-1997, which corresponds to a high level of GDP income during the same years. Despite impressive growth in GDP, Poland still has a relatively small energy use per capita compared to other CEECs.

Table 3: Annual Energy Use (toe per capita)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES/population	2.62	2.58	2.54	2.64	2.51	2.59	2.79	2.68	2.51	2.42

Source: IEA, International Energy Agency

Based on figures from table 4 it looks like Poland is moving toward a lower level of energy use per capita despite positive GDP growth.

Table 4: Annual Growth Rate of Energy Use per Capita

1990/1991	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
-1.69	-1.50	3.88	-4.68	3.15	7.50	-3.74	-6.32	-3.82

Source: IEA, International Energy Agency
*Example: ((1991-1990)/1990) * 100 = per cent change*
Average • (1990-1999) / 9 = -0.61 per cent

Poland is a net importer of energy (table 5). Imports increased during the 1990's by approx. 440 per cent, and by 1999 accounted for about 10 per cent of TPES (table 5). Poland's export and import of energy was more or less equal in 1994 and 1995, but since the import of energy has increased significantly more than the export.

Table 5: Net Imports (Mtoe), TPES (Mtoe) and Electricity Consumption (TWh)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Net Import (Mtoe)	2.10	3.70	4.05	2.76	0.04	-0.03	5.80	7.62	9.24	9.27
TPES (Mtoe)	99.85	98.49.	97.32	101.34	96.82	99.98	107.56	103.63	97.12	93.38
Electricity consumption (TWh)	124.71	118.11	113.11	114.53	115.37	118.14	122.02	123.92	123.99	122.62

Source: IEA, International Energy Agency

1.2.1.1 Energy Supply and Consumption in Relation to GDP

From 1990 to 1999, Poland experienced a 33 per cent decrease in energy dependency in relation to generation of GDP (table 6), indicating some success in decoupling generation of GDP and use of energy (TPES).

Table 6: TPES/GDP (toe per thousand 95 USD)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0.88	0.93	0.89	0.90	0.82	0.79	0.80	0.72	0.64	0.59

Source: IEA, International Energy Agency

Table 7 (TFC/GDP) shows that energy consumption (TFC) in relation to GDP has been reduced, but not to the same degree as TPES. This means that Poland is improving its energy efficiency using less energy on extraction, production, generation and distribution of energy. See section 1.2.2 for further details on this matter.

Table 7: TFC/GDP (toe per thousand 95 USD)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0.55	0.58	0.56	0.58	0.53	0.51	0.51	0.47	0.42	0.39

Source: IEA, International Energy Agency

1.2.1.2 Energy Supply and Consumption Based on Energy Source

Poland is the leading energy consumer among the CEECs when it comes to consumption of fossil energy. The energy structure is similar to that of other Eastern European Countries, relying heavily on fossil fuels to meet its energy needs. Coal represents around 2/3 of the total energy supply in Poland, oil another 1/5 and natural gas nearby 10 per cent (table 8).

Poland has only minor reserves of oil and natural gas and most of the oil and gas consumed in the country is imported from Russia. Currently the Polish Oil and Gas Company (POGC) is state owned, but it is planned to privatise the company. The 1997 Polish Energy Law contains a rule on third party access, which obliges POGC to make its pipelines available to transport of gas for other companies.

Coal is Poland's most important domestic energy source. Poland possesses significant resources of high quality coal and remains one of the most coal dependent countries in the world. Poland is an important exporter of coal, mainly to countries in Europe and ex-Soviet Republics.

Table 8: TPES[2] / Energy Source

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Coal	75.41	75.28	73.91	74.36	68.88	70.34	75.74	71.30	64.68	60.90
Oil, including petroleum	13.24	13.30	13.72	14.37	15.24	16.13	18.29	18.80	19.22	19.83
Gas	8.94	7.94	7.76	8.16	8.22	8.99	9.44	9.36	9.21	8.94
Nuclear*	--	--	--	--	--	--	--	--	--	--
Hydro*	--	--	--	--	--	--	--	--	--	--
Geothermal, solar, wind*	--	--	--	--	--	--	--	--	--	--
Renewable and waste[3]	2.23	2.07	2.14	4.53	4.57	4.60	4.21	4.19	4.07	3.96

Source: IEA, International Energy Agency
**Energy source is not significant or not present*

1.2.1.3 Energy Consumption Based on Sectors

The industry sector decreased energy consumption by approx. 25 per cent during the decade (table 9), while transport increased by approx. 10 per cent. Increase in energy used for transport began in the early 90's and continued throughout the decade. Other sectors remained, by large, at the same level.

Table 9: Annual Energy Use (TFC) / Sector

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industry	26.32	23.57	21.55	22.68	22.19	24.18	25.70	25.23	22.64	19.73
Transport	7.59	7.80	7.89	7.82	8.14	8.44	9.46	9.85	9.72	10.80
Others*	27.09	29.67	30.31	34.30	32.15	31.47	32.53	31.31	29.50	29.80

Source: IEA, International Energy Agency
** Agriculture and residential sectors are main 'consumers'.*

1.2.2 Energy Efficiency

Poland improved the efficiency ratio (TPES/TFC) from 1990-1999 by about 5.5 per cent (see table 10). Compared to the other CEECs, this place Poland

[2] Energy sources other than that of coal, oil and gas are based on 'production' numbers and not 'primary supply'.
[3] These data are not 100 per cent reliable since stock changes and import/export of energy are not included.

in the middle of the European energy efficiency continuum. This indicates that Poland still has a significant potential for improving the energy infrastructure, but the energy sector (extraction, production, generation of electricity etc.) can also be improved in order to reduce losses from supplier to consumer.

Table 10: TPES/TFC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES (Mtoe)	99.85	98.49	97.32	101.34	96.82	99.98	107.56	103.63	97.12	93.38
TFC (Mtoe)	62.19	61.98	60.66.	65.70.	63.37	65.00	68.88	67.63	63.13	61.65
TPES/TFC	1.60	1.59	1.60	1.54	1.53	1.54	1.56	1.63	1.54	1.515

Source: IEA, International Energy Agency

1.2.3 Energy Sector Structure

Despite concerns over Polish energy dependency on Russia, it is planned to increase import of Russian natural gas through a transit gas pipeline from Russia to Western Europe currently under construction. It is expected that this project will be completed by 2010.

Recently, POGC has signed a contract with the Danish Oil and Natural Gas Company (DONG) to build a gas pipeline across the Baltic Sea. Poland has also integrated its natural gas system with Siberia[4] and Germany and integration with more countries are planned for the future[5].

1.2.4 State-Owned Energy Enterprises

Although ongoing, the process of restructuring, and/or privatisation of the Polish energy sector, has been slow due to political obstruction 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 government 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

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[4] The Yamal pipeline connecting Poland to Siberian gas sources began operations in September 1999. The USD 35-billion pipeline was intended to carry natural gas supplies from the Yamal (West Siberia) field in Russia to Germany and other Western European countries through Belarus and Poland. Under a 25-year contract signed in October 1996, annual throughput of the pipeline is slated to increase to 14 billion cubic metres (about 494 Bcf).

[5] In July 2000, the prime ministers of Poland and Norway signed a declaration to begin Norwegian gas exports to Poland. A new pipeline will be built connecting Scandinavia to Poland under the Baltic Sea, and construction should be complete within the next four years. Until the pipeline comes on-stream, the Norwegian gas will be transported through German pipelines into Poland. There had been some controversy regarding the higher price of Norwegian gas as compared to Russian gas, but the president of the Polish Oil and Gas Company declared that the price of Norwegian gas was sufficiently competitive with Russian gas. Norwegian gas also helps the Poles in their goal to diversify energy sources.

2002. By March 2001, two power plants and six power and heating plants were 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.

1.2.5 Prices and Regulation

One of the objectives of the Energy Law was to free energy prices and make markets 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 thereby function as a subsidy for some (polluting) energy forms, such as coal.

1.2.6 Environmental Issues

Environmental impacts from energy production are of major concern in Poland. In particular, Poland faces serious problems from coal burning in power and heating plants and from coal mining. Coal use accounts for around 90 per cent of SO_2-emissions, 79 per cent of NOx-emissions and over 98 per cent of particulate emissions. Around 78 per cent of the CO_2-emission from fossil fuels comes from coal, 7 per cent from gas and around 15 per cent from oil.

Through the 1990's Poland has spent an increasing amount on environmental protection and the Polish government has passed legislation and introduced economic incentives to improve the country's environmental situation. Moreover, Poland has adopted the EU's "Integrated Pollution Prevention Directive" and implemented incentives for energy plants to be EU-compliant, as part of the policy aimed at encouraging early adoption of EU requirements.

Poland has developed one of the most sophisticated approaches to environmental management in the Central and Eastern European region. However, Poland still faces severe environmental problems, with major challenges in the fields of wastewater treatment and air pollution. The reasons for this include (a) the role heavy industry has historically played in the Polish economy, and (b) the country's energy culture and reliance on coal for power generation. Although pollution from power generation and industry has benefited from a large investment programme in environmental protection technology over the past decade, sectors such as coal mining and other heavy extract industries continue to produce considerable amounts of industrial waste, as well as polluting the atmosphere.

TABLE 11: CARBON DIOXIDE EMISSIONS FROM THE CONSUMPTION AND FLARING OF FOSSIL FUELS

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Million metric tonnes of Carbon equivalent	89.27	88.76	88.93	92.12	87.20	82.99	78.06	91.29	85.37	84.54

Source: EIA, Energy Information Administration

From 1990 to 1999, Poland managed to reduce CO_2 emissions by approx. 5 per cent (see table 11). The main factor behind this relatively low figure is

Poland's continued large dependence of fossil fuels, especially coal. Poland's CO_2 emission per capita shows a similar performance (see table 12).

TABLE 12: CO_2 (KG. OF CARBON EQUIVALENT) PER CAPITA

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2 340	2 320	2 320	2 400	2 260	2 150	2 020	2 360	2 010	2 190

Source: EIA, Energy Information Administration, IEA, International Energy Agency

The small improvement in CO_2 emissions that Poland experienced is also illustrated by table 13. The table indicates that Poland reduced CO_2 emission per TPES unit by about 3.8 per cent from 1992 to 1998, which is a small reduction compared to the other CEEC.

TABLE 13: CO_2 (KG. OF CARBON EQUIVALENT) / TPES (MTOE)

1990	1991	1992	1993	1994	1995	1996	1997	1998
--	--	0.914	0.909	0.901	0.83	0.726	0.881	0.879

Source: EIA, Energy Information Administration, IEA, International Energy Agency

1.2.7 Renewable Energy

Poland increased its share of renewable energy by 2 per cent point from 1990 to 1999 (table 14). Hydro energy and energy produced from solid biomass accounts for the majority of this share. Other renewable energy sources are present in Poland, but they are not significant enough to be included in statistics.

TABLE 14: CONTRIBUTION FROM RENEWABLE ENERGIES AND ENERGY FROM WASTE[6]

	1990	1992	1994	1995	1996	1997	1998	1999
TPES (Mtoe)	99.85	97.32	96.82	99.98	107.56	103.63	97.12	93.38
Per cent Contribution from renew. and waste	2.4	2.3	4.9	4.8	4.1	4.2	4.4	4.4
Hydro	122	130	149	162	166	169	199	185
Geothermal (transformation)	--	--	--	--	--	--	--	--
Geothermal (direct use)	--	--	--	--	--	--	--	--
Solid biomass	1 448	1 361	3 692	3 748	3 685	3 680	3 696	3 541
Wastes per cent contribution	0.8	0.8	0.9	0.8	0.5	0.5	0.4	0.4
Other*	--	--	--	--	--	--	--	--

Source: IEA, International Energy Agency

**Includes solar, wind, biogas and tidal energy etc.*

1.2.8 Energy Situation

According to the European Commission's Progress Report 2000 for Poland, only little progress has recently been registered within the energy sector. When energy efficiency and promotion of renewable energy sources is concerned, it is stated that this area remains somewhat neglected. The importance of implementation and promotion of renewable energy projects is stated in several governmental development and action plans, but real progress still needs to be seen and this will require more direct financial involvement and targeting from the Polish government and should be foreseen in the national budget

[6] Data other than per cent contribution and TPES is worked out in ktoe (kilo tonnes oil equivalent)

On the administrative side, the Commission recognise that an administrative structure seems to be established. However, due to the complexity of energy sector issues, it is doubtful if the relatively small staff in the Ministry of Economy will be able to manage future development of the energy sector efficiently. Poland is by far the most fossil fuel consuming country in Europe and it needs to deal with this situation.

1.3 Geothermal Energy in Poland

Poland's geothermal potential has been well recognised at the national and regional levels, as well as in many particular parties, by Polish scientific and research institutions and geothermal companies in the past decades. The state of knowledge in this field creates a proven and solid base for project preparation and run for new geothermal plants.

According to the state, energy policy with respect to geothermal energy, is regarded as a local energy source along with other renewable energy sources. Their share of the energy market is projected to reach 6-8 per cent by 2020. Geothermal energy can become to play an important role in local energy markets, specially in the space heating sector.

Taking into account the present geothermal status, activities of national, international and foreign bodies should preferably concentrate on preparation and running of new projects. In order to go forward and make proper progress, availability of sufficient funds remains one of the key factors and main problems to be addressed.

Three geothermal space heating plants went into operation during the 1990s; in the Podhale region (South-Poland), in Pyrzyce town (North West-Poland) and in Mszczonów town (Central Poland). Several other projects await being started pending legal requirements to be fulfilled and/or financial sources made available.

1.3.1 Provinces with Geothermal Energy and Projects

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

Geothermal Utilisation Project	Geothermal Province	Area km^2	Temp. °C	Drilling Depth (m)
The Banska-Bialy Dunajec Plant	Carpathian Province	12 000	35-100	2 000-3 500
(The Slomniki Plant)	Fore-Carpathian Province	17 000	25-50	150-600
The Pyrzyce Plant The Mszczonów Plant	Lowland Province	222 000	30-130	1 000-3 000

1.3.1.1 Carpathian Province

The Carpathian Province consists 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. Geothermal water resources have been estimated at approx. 100 km^3 with at thermal energy equal to 714 Mtoe.

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 and 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 be based on geothermal energy and gas boilers in peak periods. About 30 per cent of the population of Zakopane is linked to this system.

Regions	**Surface 10^3 km^2**	**Water Resources km^3 and Productivity m^3/h**	**Thermal Energy in Waters 10^6toe***	**Geological Formations (dominant)**
Podhale region	12	100 and n.a.	714	Tertiary Period (Eocene) and Mesozoic Era, both characterised by carbonates (with fractured permeability)

**It is assumed that heat will be extracted at a depth of 3 km and a low-end temperature of 20°C and the waters will not be re-injected.*

1.3.1.2 Fore-Carpathian Province

The Slomniki Plant is a relatively new project and situated 30 North of Cracow. Four wells has been drilled and they 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 first layer has a thickness of 5m. and a productivity of around 100 m^3/h. The other layer has an estimated temperature of 23 °C, which does not balance the extra drilling cost for reaching this layer, even though the layer is 14-60 m. thick. A newly made well is expected to give access to an aquifer with an estimated productivity of approx. 50-100 m^3/h.

Regions	**Surface 10^3 km^2**	**Water Resources km^3 and Productivity m^3/h**	**Thermal Energy in Waters 10^6toe***	**Geological Formations (dominant)**
N.a.	17	361 and 10-60 (100)	1 555	Palaeozoic and Mesozoic Era and the Tertiary period

**It is assumed that heat will be extracted at a depth of 3 km and a low-end temperature of 20°C and the waters will not be re-injected.*

1.3.1.3 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 replace 68 traditional heating plants (20 000 tonnes of coal/yr.). The geologic formations are primarily lower Jurassic sandstones and two wells are drilled at a depth of 1.5-1.6 km, which produces around 360 m^3/h. The temperature is 61°C and the TDS is 120 g/l.

The Mszczonów geothermal plant lies at the central area of the Grudziadz-Warsaw region. The plant is based on a single well construction with two purposes; extracting geothermal water for heating (40°C) and to produce drinking water. This is possible because the TDS is below 1 g/l. The well is extracting water from the lower Cretaceous layer.

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

Regions	Surface 10^3 km^2	Water resources km^3 and Productivity m^3/h	Thermal Energy in Waters 10^6toe*	Geological Formations (dominant)
Gruziadz-Warsaw	70	2 766 and n.a.	9 835	Lower Cretaceous
Szczecin-Lodz	67	2 854 and 360	18 812	Mesozoic –Jurassic, characterised by sandstone
Fore Sudetic-North Holy Cross	39	155 and n.a.	995	Crystallinic rock
Pomorze	12	21 and n.a.	162	N.a.
Lublin	12	30 and n.a.	193	N.a.
Peribaltic	15	38 and n.a.	241	N.a.
Podlasie	7	17 and n.a.	113	N.a.

**It is assumed that heat will be extracted at a depth of 3 km and a low-end temperature of 20°C and the waters will not be re-injected.*

1.3.2 National Institutional Factors Related to Geothermal Energy Development

1.3.2.1 Institutional Responsibility for Energy and Environmental Issues

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

In May 1997, a new constitution was approved by a national referendum and it brought about the creation of 16 Voivodeships – regional policy bodies – reorganized 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 Voivodeships, counties and municipalities. The Voivodeships are responsible for activities, which are particularly harmful to the environment.

1.3.2.2 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 on polluters. It is estimated the revenues of these funds combined will amount to USD 500 million annually until 2010. The EcoFund (see below) is expected to raise USD 571 million in the period 1992-2010.

1.3.2.2.1 The National Fund for Environmental Protection and Water Management

The National Fund for Environmental Protection and Water Management (NFEP) was established on the basis of an amended act concerning the shaping and protection of nature created in 1989. The Fund's objectives and scope of activities are defined by "The Protection and Shaping of the Environment Act", "The Water Act" and "The Geological and Mining Act". 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 Polish to European Union standards. The National Fund for Environmental Protection and Water Management is the largest institution financing environmental protection projects in Poland.

The Fund's Implementation is supervised by the Minister of Environmental Protection, Natural Resources and Forestry and controlled by a Supervisory Board, who decides on the direction of the Fund's development; approves the terms of granting financial assistance; receives reports on current activities; ratifies the budget and financial support for projects exceeding 300 000 EURO. The day-to-day operations are coordinated by a management board, which represents the Fund, decides on project financing priorities and manages co-operation with Voivodeship funds.

The most important sources of income for the Fund are fees and penalties for 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 these environmental services are collected by Voivodeship Marshal Offices and penalties are collected by the Voivodeship Environmental Protection Inspection Office.

In the period 1995-1999 the National Fund granted loans and subsidies for an amount of approximately 1 000 million Zl per year (equivalent to around

USD 250 million). Hereof, around 75 per cent were given as soft loans and 25 per cent as subsidies.

1.3.2.2.2 EcoFund

The Polish EcoFund is a foundation established in 1992 by the Minister of Finance for the purposes of effective management of funds obtained through the conversion of a part of Polish foreign debt with the aim of supporting environmental protection-related initiatives (so-called debt-for-environment swaps). To date, the Polish debt-for-environment swap model has been implemented by the United States, France, Switzerland, Italy, Norway and Sweden; hence the EcoFund is managing funds provided by all the aforementioned countries (a total of USD 571 million to be spent in the years 1992- 2010).

The task of the foundation consists of providing of co-funding for environmental protection-related projects. These are not only of crucial importance on a regional or national scale, but also of major influence on the process of achieving environmental objectives, recognised as priorities by the international community on a global as well as European level. EcoFund specifics distinguishing the foundation from other funds providing support to environmental protection-related investment in Poland, in that they exclude the possibility of providing co-funding to target local problems only. Another task of the foundation is transferring best technologies from donor countries to the Polish market, as well as stimulation of development of the Polish environmental protection industry.

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.

To reduce the emission of gases causing global climate changes, such as carbon dioxide, methane or freons (CFCs), EcoFund promotes broader use of renewable sources of energy and supports implementation of projects related to energy saving and to improvements in energy use. In particular, these projects cover the following topics: Energy saving in urban district heating systems; use of waste energy from industrial processes and manufacturing (assembly) hall heating; conversion from coal to gas, gas being a fuel with a considerably lower rate of CO_2 air emission; use of renewable sources of energy, such as biomass, geothermal energy, wind and solar energy; elimination of methane emission from hard coal mines, municipal land-fills, and sewage treatment plants; elimination of halones and freons consumption in manufacturing processes and in finished goods. In the air protection area, EcoFund supports projects dealing with the reduction of sulphur dioxides and nitrogen oxides from power plants and district heating plants (including reduction of cross-border transportation of any such contamination).

1.4 International Collaboration on GE Development in Poland

The main financial international players in Poland are the World Bank, EBRD and the European Union. Also NEFCO and NIB are involved in Poland, with support to the Staargard Geothermal Project.

1.4.1 The European Union

Since January 2000 there are three instruments financed by the European Community to assist Poland in their pre-accession preparations:

- The Phare programme;
- SAPARD (agricultural and rural development);
- ISPA (finance infrastructure projects in the fields of environment and transport)

In the period 2000-2002, total financial assistance to Poland will annually amount to 398 million EURO from Phare, 168.6 million EURO from SAPARD and between 312 and 385 million EURO from ISPA.

Within the environmental sector, the Phare programme focuses on institutional strengthening (for environmental impact assessment and pollution prevention and control at regional level) and air quality monitoring system.

Concerning the ISPA programme, the environmental main priorities in Poland is linked to drinking water, waste water and solid waste treatment for the major cities.

1.4.2 EBRD

The EBRD operational strategy for Poland is focused on key challenges for the transition to a market economy, and emphasises the requirement for a rapid response to new challenges as Poland's transition process moves forward.

According to the EBRD "Investment Profile 2001" for Poland, the Bank has maintained its responsiveness to progress in transition and also its "additionality" through a wide range of initiatives. This has been achieved by moving across market segments and by developing new approaches as the economic transition in Poland advances. The EBRD has been adjusting to the transforming Polish market by switching from debt to equity, from Warsaw to the provinces, from foreign-backed joint ventures to Polish companies without foreign shareholders, and from classical bank lending to capital market transactions. The EBRD is actively working in the fields of infrastructure, industrial restructuring, and support for small and medium-sized enterprises (SMEs).

In the power sector the EBRD focuses on providing lending to power and heat companies undergoing privatisation processes. Environmental investments are concentrated in water supply, waste-water collection and treatment, and solid waste management. The EBRD also supports projects involving public-private partnerships for provision of municipal services, and is developing wholesale financial structures, which will enable it to finance groups of projects. The EBRD cooperates closely with the European Union with regard to environmental investments.

The EBRD will continue to promote the implementation of energy-saving investments in the private and public sectors by investing in, and providing loans to, energy service companies. In addition, support will be given to upgrade of district heating networks by promoting privatisation and restructuring in the sector. The EBRD also seeks to provide finance to industrial companies with the implementation of comprehensive investment programmes aimed at reducing excessive energy consumption.

1.4.3 World Bank/GEF/IFC

With respect to IFC's work in Poland, IFC is expected to become increasingly selective in identifying projects that will support Poland's EU accession approaches. IFC is expected to continue to look for projects where its additionality is significant, including support for privatisation of heavy industry and projects, which are developed by locally owned and managed companies and which are commercially sound, but lack major sponsors. Three specific areas for future development can be highlighted: i) Further support for private health care development; ii) financing of basic infrastructure, especially in the power sector, energy efficiency and municipal infrastructure; and iii) continued support for financial markets development through investment financing and technical assistance support for specialised financial services, such as security, housing finance, and leasing.

1.4.4 Bilateral Donors

The USAID office in Warsaw closed in September 2000, after having provided nearly one billion dollars in support to Poland since 1989. In the latter half of the 1990s, USAID's activities concentrated on three strategic areas: Stimulating the private sector at the firm level, building a competitive, market-oriented financial sector and encouraging effective, responsive, and accountable local government.

1.5 Summing Up

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.

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1.7 The Case of Zakopane, Podhale

Project title: Podhale Geothermal District Heating and Environmental Project
Country/locality: Podhale/Poland
Date of start: 1995
Date of closure: 31/12/04 (World Bank, Closing Date)

People met during mission to Podhale (Zakopane), 5-6 June, 2001:

Geotermia Podhalanska S.A.:
Piotr Dlugosh, Managing Director
Wojciech Stankiewicz, Manager, Planning, Monitoring and Marketing Department
Technical staff

Geotermal Laboratory PAS MEERI:
Wieslaw Bujakowski, Head of Laboratory
Beata Kepinska, Geologist

Malopolskie Voivodeship (Govenor's Administration), Krakow:
Marcin Pawlak, Governor a.i.

I. Project Background

In the early 1980s, the Polish Academy of Science (PAS) in Krakow initiated efforts to find geothermal resources in the Podhale Valley. The work was based on data collected by oil exploration.

In 1992 the first project grant was approved from the DEPA for preparation of a feasibility study for geothermal heat supply to the Valley. The study had active participation in all phases from the five local municipalities involved, and concluded that geothermal energy is economic and technical feasible in major parts of the Podhale Valley.

It was therefore decided to establish a geothermal shareholder company, Geothermia Podhalanska S.A., with participation of the five local municipalities, the National Fund for Environmental Protection (Polish) and other minor shareholders. Geothermia Podhalanska S.A. should be responsible for the overall realisation and management of the geothermal project in the Podhale Valley, including funds allocation and budget. During this phase, another DEPA grant was approved for support for technical and organisational development of the project.

In 1995 a small geothermal demonstration plant and related distribution network for 170 houses in the village of Banska Nizna was finished and the first geothermal heat could be supplied to the consumers. Based on the positive experiences and prospects, the EU Phare and the Polish EcoFund decided to support the geothermal project for the Valley by providing equipment.

In July 1995, a third grant was approved from the DEPA to support progress in the project and to prepare implementation of a new project phase, which should include World Bank/GEF financing. In May 2000, the World Bank and GEF finally approved a loan and grant for the Podhale geothermal project that within the end of 2004 should connect a total of 80 000 to100 000 inhabitants in the valley to the geothermal plant, including the town of Zakopane (35 000 inhabitants).

II. Project Description

Main Project Objectives
- To reduce air pollution from local coal-fired space-heating boilers in the Podhale Valley through increased utilisation of geothermal energy resources and natural gas (peak).

- To reduce CO_2-emissions in order to help Poland meet its international obligations.

Project Financing
Total project budget: 99.3 mill USD

- World Bank, IBRD (38.2 mill USD)
- European Union (18.2 mill USD)
- GEF (5.4 mill USD)
- National Fund for Environmental Protection/Water Management (Poland) (12.7 mill USD)
- EcoFund (Poland) (1.3 mill USD)
- Other Local Contribution (20.4 mill USD)
- USAID (2.5 mill USD)
- DEPA (0.6 mill USD)

Further to the direct project financing DEPA has financed a major part of the initial study and feasibility work for the project. Totally, DEPA has contributed with around 23 mill DKK to the project process since 1993. The Danish TAC has been provided by Houe & Olsen.

Feasibility (Economic/Financial)
Prior to project implementation, financial analysis on geothermal heat supply in Podhale were carried out in order to estimate the economic fundament for Geothermal Podhalanska S.A. The analysis showed adequate rates of return for the company and, consequently, the project was recommended from an economic/financial perspective.

As part of the financial analysis, a market survey was done in Zakopane. The heat consumer "market" can be divided into three main groups: Cooperatives, hotels/restaurants and private clients, each one composing around 1/3 of the market. Since the district heating company in Zakopane only provided heat to around 20 per cent of the consumers in the town, (mainly from the cooperatives), the remaining 80 per cent of the consumers were consulted in order to determine their willingness to connect to the geothermal heat plant. The consumers, who would decide to use geothermal energy, were offered "soft loans" for installation of heat exchangers in their houses.

Based on the market survey in Zakopane, it was estimated that around 45 per cent of the consumers would connect to geothermal heat from September 2001. Furthermore, it was anticipated that around 70-80 per cent of the market would be covered by geothermal heat by the en of 2004 (100 per cent of the cooperatives, 80 per cent of hotels/restaurants and 60 per cent of private clients).

Environmental Benefits
The heating system in the Podhale Valley has traditionally been based on individual, coal-fired heat. The environmental benefits from the project are therefore expected to be significant, when coal is substituted by a combination of geothermal energy and gas (peak-load).

Annual Estimated Reductions in Emissions when Coal is Substituted with Geothermal Energy/Gas, in Podhale

	CO_2	SO_2	NOx	Particles
Annual Reduction (tonnes)	210 000	1 200	800	400

Source: DEPA

Technology and Transfer of "Know How"
The project, in its complete form, will provide district heat to the majority of the consumers in the Podhale valley (80 000-100 000 inhabitants). The service area will extend from about 14 km from the production wells to the city of Zakopane and about 7 km in the opposite direction to the town of Nowy Targ.

When in operation, the geothermal plant will cover the entire heat demand during 8 months a year, while a peak-load plant (gas-fired) will assist in covering heat demand during the coldest months of the year. Seven geothermal wells have been drilled (three wells for production and four for re-injection). The production wells will extract low-enthalpy geothermal water (85-85°C).

The capacity of the geothermal base load plant will be approximately 45 MW and the plant will deliver 1 000 TJ/y of geothermal heat. Additional capacity will be provided by a 33 MW absorption heat pump plant together with a central peak-load, natural gas plant (capacity: 48 MW) in Zakopane. A peak-load plant will also be constructed in Novy Targ (capacity: 14 MW).

III. Project Effectiveness

Financially Geothermia Podhalanska S.A. has succeeded in attracting the funding required for the project, approximately 100 million USD, from different donors and institutions, national as well as international. This is definitely an important outcome and has now prepared the ground for large-scale implementation of geothermal heat to the Podhale Valley.

However, the way to finally obtaining funding has been long and at times quite difficult and complicated. Inflexibility of the World Bank and EU-funds is considered by the recipients as an obstacle to smooth project implementation. For instance, if small adjustments had to be made to equipment specifications, it proved difficult to obtain acceptance of these minor changes from the financing institutions. In this process, the DEPA support, although being relatively small compared to the total budget, has been of crucial importance to the geothermal company due to its generally more flexible and complementary character.

Due to delays in the process of financial assignment (World Bank/GEF) the connection of the inhabitants in Zakopane to the geothermal plant was postponed until September 2001. The delay resulted in complains from the new consumers and some of them have even decided to change back to their private, coal-fired heat. The number of clients changing back is not a significant portion though, and will not affect the economic foundation of the project. However, it is deemed very important to have the Zakopane-connection ready and implemented prior to the coming heating season in order not to create a general negative attitude regarding geothermal heat supply in the valley.

The data collected through the Zakopane-market survey has, further to estimate the economic foundation for the project, 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.

Environmental
Since consumers until recently were still not connected to the geothermal plant, the environmental effects so far come from conversion from coal to natural gas in the old district heating system (from 1998).

Technology and Transfer of "Know How"
Although connection from the geothermal plant to Zakopane is still pending construction of the last part of the pipe system, important technical and institutional results from the project can be observed already.

Technical equipment for the geothermal plant has been installed and tested, and no major problems have been detected so far. The small geothermal demonstration plant in Banska Nizna, operational since 1995, has been well-functioning and demonstrating the technical feasibility of geothermal heat supply in the Podhale Valley.

The demonstration plant has also successfully demonstrated the technical feasibilities of cascade systems (fish breeding and vegetables), which extract more heat from the geothermal water. The DEPA's project support has focused mainly on institutional strengthening of Geotermia Podhalaska S.A. for the project management role and training of personnel in order to build up local organisational/institutional capacity to manage the geothermal project. In mid-1998 Geotermia Podhalanska S.A. merged with the local district heating company in Zakopane and the company staff has since gradually been cut down from 130 to 56 employees and further rationalisation is expected.

It is the consultants' impression from the visit that Geothermal Podhalanska S.A. has turned into a well-managed and structured company with a competent staff where management is further focussed on improving the efficiency of the company. Staff visits to the Danish geothermal plant in Thisted have been arranged in order to study practical, technical working processes. By both management and staff, these visits was characterised by being very beneficial for the participants. This way the participants also experienced how the Danish working methods are carried out.

IV. Project Impact

Economic/Financial
Due to considerable income from tourism in Southern Poland, there is no significant unemployment in the region and the negative employment effects

from the geothermal project have therefore not been considered as a major social problem. Moreover, the improvement of the local environment through conversion to geothermal heat is expected to attract more tourism to the region and thereby create positive economic and employment potentials for the region.

The geothermal project in Podhale is widely expected to be a catalyst for further investment in geothermal energy projects in Poland. Through the experience from the municipality/private geothermal company, involving provision of financing for large infrastructure projects, the company can be expected to use the experience also for smaller geothermal projects.

The small geothermal demonstration plant in Banska Nizna has successfully demonstrated potentials to increase the economic impacts of the geothermal projects if a cascade system is implemented and more heat is extracted from the return heating water. The experiences from Podhale could easily be duplicated to other geothermal projects.

Finally, the Podhale geothermal project is a positive lesson on co-operation between different bilateral and multinational financial sources in order to finance large-scale investment projects. The experience gained from this exercise can be very useful for future similar projects in the CEEC.

Environmental
The potential environmental impact of the Podhale project is very large due to the rich potential for geothermal energy in Poland and the current energy structure in Poland, based on coal-fired, private heating systems.

Technology and Transfer of "Know How"
The impact of the projects technical, but in particular institutional/organisational, experience has already been very encouraging since Polish experts from Geothermia Podhalanska S.A. has shown capacity to also support geothermal project development in Slovakia. First, in Ziar Nad Hronum, as sub-advisors on technical and organisational issues, and currently in the town of Tvardosin, near the Slovakian-Polish border, where Polish experts provided their support to the development of a new geothermal project.

In Poland, the experience from the Podhale project is also used broadly in relation to planning of new geothermal projects.

V. Project Sustainability

Financial/Economic
According to the project plan, Geothermal Podhalanska S.A. should be in a position to operate on a commercial basis after connection of the geothermal plant.

However, solidifying the consumer base will be essential for economic sustainability. Considering that by September 2001, 45 per cent of the consumers in Zakopane will be connected to the geothermal heat plant, it is anticipated that the project will have significant market penetration effect in the coming years (70-80 per cent market coverage is predicted for 2004). Therefore, consumers once converted to geothermal energy is highly expected to continue to use this source of heat (the consumers that have received heat exchangers, through "soft-loans" from the project are required to continue geothermal heat for 10 years or pay the full remaining balance of the heat exchanger, if they exit the system).

Furthermore, the economic sustainability of the geothermal energy will largely dependent on the development in relative energy prices in Poland. Currently, coal-prices are highly subsidized in Poland. In spite of the current liberalisation process in Poland and the country's up-coming accession to the European Union it is, however, widely anticipated that the remaining coal subsidies will be gradually eliminated and thereby make geothermal energy relatively more competitive.

Environmental
See under Project Impact IV.

Organisational/Institutional
Right from the initiation of project activities, the institutional/organisational component has been paid much attention in the Podhale project.

It is the impression of Kvistgaard Consult (KC), that the Podhale project is very efficiently anchored institutionally through Geothermal Podhalanska S.A. The company must be characterised as a modern, competitive company, focused on further development and efficiency. Through training and practical experience, the company seems highly capacitated and well prepared for future challenges.

During the visit to Southern-Poland, the KC consultant also met with the Marschal of the Malopolskie Voivodeship (the Governor of the Southern Poland region) and was here presented the recently approved Development Strategy for the region, 2000-2006. The strategy is highly focussed on environmental concerns, and development of the geothermal energy potential is defined as a priority. The Voivodeship is already directly involved in one small geothermal project (in the town of Smolinsk) 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.

In conclusion, it is the consultants conviction that geothermal heat, through the experience so far, has gained institutional and political acceptance in the region and is considered an important sustainable energy source for the coming decades.

Technology
The technical analysis and tests of the project are all very promising to date. However, there is still the risk that technical inconveniences can occur when the geothermal plant start its full operation.

Dissemination
The Podhale project has been widely presented in medias in Poland and in international conferences and journals (including in Denmark).

VI. Lessons Learned (Consultants findings based on visit to the Podhale Geothermal Project, including the Demonstration Plant in Banska Nizna):

1) The *local conditions* in the Podhale Valley represent opportunities that make the area highly suitable for geothermal energy projects, compared to other countries/regions:

   – The income-level in the Podahle Valley is relatively higher than in other CEEC regions, mainly due to a significant income from tourism.

   – The location (valley), combined with the potential income from increased tourism as a result of a cleaner environment, have been important (and visible) arguments for implementation of cleaner energy in the area.

   – The local presence of the very active Geothermal Laboratory

2) The careful and *step-by-step* development of the geothermal project has been central for obtaining funding and local support. The project has from the beginning been carefully developed, involving international institutions/donors as well as local stakeholders - also financially; It must also be highlighted that the construction and functioning of the small demonstration plant in Banska Nizna has been important in order to demonstrate the feasibility of geothermal heat.

3) *Local involvement* has been strong from early project planning phases and is definitely crucial in order to ensure sustainability of the project.

4) Substantial *national and local financial contribution (commitment)* is seen as an important factor in order to attract external project financing.

5) The geothermal '*Cascade system*' (fish and vegetable breeding) run by the Geothermal Laboratory in Podhale, shows that improved economic efficiency of the geothermal plants can be obtained through installation of such systems. The experience with the cascade system in Podhale could be used not only in Poland, but also in other CEECs.

6) Even though the Podhale project has succeeded in attracting significant financing from main financial sources, the financing process has been "heavy going" and would probably not have been possible without considerable local capacity and external (DEPA) institutional support.

7) In Poland, a lot of data collection and analysis has already been done and geothermal project proposals have been prepared. Remaining barriers to implementation of the projects are mainly of an institutional and financial character. Potential donors (including DEPA) should therefore focus more directly on concrete *project implementation* on selected sites in the country, including *financing arrangements* as opposed to more general issues.

8) Geothermal energy is considered an important future energy source in Polish regional development planning. Donors (DEPA) may want to consider supporting geothermal project implementation at regional levels, in areas where technical conditions and regional development plans invite geothermal exploitation. In that way, several local, small-

scale projects could be implemented simultaneously. The donor support could consist of institutional support to make the regional plan for geothermal energy operational and to create regional, institutional capacity to advice and support local towns in project preparation and implementation.

1.8 The Case of Mszczonów

Project title: Mszczonów, Geothermal Project	
Country/locality: Mszczonów/Poland	
Date of start: 1996	
Date of closure: 1999	

People met during mission to Mszczonów, 7-8 June 2001:

Geothermia Mazowiecka S.A.:
Marek Balser, Managing Director
Technical Staff

Geotermal Laboratory PAS MEERI:
Wieslaw Bujakowski, Head of Laboratory
Beata Kepinska, Geologist

Mszczonów Municipality
Józef Grzegorz Kurek, Mayor

I. Project Background

Mszczonów is a small town, located around 40 km Southwest of Warsaw, and has a population of around 6 000 people. Traditionally, the town has been heated by three coal-fired district heating plants. However, recently initiatives have been taken to promote a green, environmental profile in the town.

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 of an existing old closed well. The investigation further build on data and research made by the Geothermal Laboratory under the Polish Academy of Science, Mineral and Energy Economy Research Institute (MEERI) and was carried out according to an agreement between the State Committee of Scientific Research and Mzsczonów Urban District.

In Poland, thousands of existing wells have been closed down or excluded from oil or gas exploitation by now. However, the closed wells have become the possible subjects of water or geothermal heat exploitation. Research results from Mszczonów confirmed the value of such existing well and served as a base for further elaboration of a geothermal project plant in the town, which became the first such well reconstruction in Poland.

II. Project Description

Project Financing
Total budget: 11 mill Zl (around 3 mill USD)

- Geothermia Mazowiecka S.A. (shareholder company consisting of Mszczonów Municipality, National Fund for Environmental Protection/Water Management (Polish) and some smaller Funds (7 mill. Zl.)

- EcoFund (Poland) (2 mill. Zl.)

- Loan from Polish Banks (2 mill. Zl.)

Economic/Financial Feasibility
The energy market in Mszczonów is composed of a mix of flats, public buildings and industry, including a significant tax-free industrial zone. Prior to project implementation, consultations were held with consumer groups and support was given to the project idea.

The district heating network in Mszczonów covered around 60 per cent of the area of potential consumers in the town, including approximately 1 200 flats and public buildings (schools, medical centre etc). Based on calculations and consultations with consumer groups, it was decided to dimension the geothermal/gas plant for the whole area, including also consumers who are currently using other heating sources (coal).

Technical Data
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, including 2.3 MW from the geothermal plant, the rest would be absorbed from the heat pump and gas. The geothermal plant use 40°C water discharged by a single well both for heating purposes and drinking water production.

III. Project Assessment (Results, Impacts and Sustainability)

Economic/Financial
Currently, Geothermia Mazowiecka S.A. does face some economic difficulties. This is due to limited funding potential and unfavourable development in relative energy prices, which has prevented an extension of the consumer base to more than the 60 per cent originally covered. Moreover, new pipes in the town have been financed and installed by Geothermia Mazowiecka S.A. and this has put additional pressure on the company's financial resources.

The economically important local industrial zone (tax-free production area) where some big energy consuming industries are located, has still not converted to geothermal heat. And for the time being, there is not much economic incentive for these industries to do so, since recent price development has made coal favourable compared to gas/geothermal. Currently, energy prices in Mszczonów are 42 Zl/GJ for coal and 53 Zl/GJ for geothermal/gas. Furthermore, the relative increase in geothermal/gas prices has resulted in complaints from private consumers and some has changed back to coal-based heat.

Nevertheless, Geothermia Mazowiecka S.A. has positive outlook, since it is widely expected that future price development will be in favour of heat from geothermal/gas. Moreover, in order to improve efficiency and income potential from geothermal heat, it has been planned to build a recreation centre in Mszczonów.

The geothermal company considers the income from drinking water production as being relatively insignificant. However, increased prices on water consumption could make it a good business in the future.

The implementation of a geothermal heat plant has had drastic consequences for employment at the local level since 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 the local level.

Environmental
The thermal energy provided by the district heating company in Mszczonów is 37,000 GJ a year, including 40 per cent geothermal and 60 per cent 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 NO_x by 82.9 per cent.

The urban environment of Mszczonów has also been improved by the geothermal project. Green areas have been created in the town with water posts and with drinkable geothermal water in the centre. The environmental impact of the Mszczonów project is very large since the potential for reconstruction of wells in Poland for geothermal energy use is considerable.

Organisational/Institutional
Compared to the geothermal project in Podhale where five municipalities have to co-operate, the institutional set-up is simpler in the case of the Mszczonów project, as only one municipality is involved.

From the early stages of project development, the Mszczonów Municipality has played an active role, also financially. The Mayor is personally very involved in the project and is linking other municipal activities to the geothermal energy use.

Moreover, it is the KC consultant's impression from the visit and meetings at the municipality that strong efforts, which also involves the Voivodeship, are concentrated on local environmental development. In conclusion, the institutional anchoring of the geothermal project seems to be strong and sustainable.

Technology and Transfer of "Know How"
The geothermal/gas heating plant in Mszczonów is fully completed and has been operational from 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 Poland has thousands of these abandoned wells and that some of them could represent interesting potentials for geothermal energy.

Since new well constructions are costly, and generally represent a significant financial barrier for geothermal project implementation, use of old wells will make geothermal projects possible also without heavy investment needs. Therefore, Poland definitely has a prospect for moderate-scale geothermal plants based on abandoned wells adapted for exploitation, working as cascaded and/or integrated systems.

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

IV. Lessons Learned (Consultants findings, based on visit to Mszczonów)

1) Through the Mszczonów project is has been successfully demonstrated how existing, but closed wells can be converted into geothermal production wells within a relatively short time frame. Taking into consideration the numerous existing wells in Poland, this experience is important and should be considered for possible replication in other Polish towns.

2) 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.

3) The project proved it 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.

4) In small-scale geothermal projects, as the one in Mszczonów, the economy of the geothermal companies is sensible to changes in the consumer base.

5) The economic foundation of the project is currently affected by recent development in energy prices (coal, gas) that has not been in favour of geothermal energy. However, the prospects (EU integration, market liberalising) give positive perspectives for future price development.

6) Given that socio-economic conditions in Mszczonów are different from those in Southern Poland, local project impacts (including employment effects and changes in energy prices) are felt relatively stronger here.

7) The institutional set-up of the geothermal company (with only one municipality involved, but as major shareholder) gives the project a strong local anchoring and the Mszczonów Municipality the possibility to plan independently in relation to the geothermal plant and how to make use of the heating water.

2 Volume II.B: Country Profile - Romania

2.1 General Background Information

With its 22 million inhabitants and 237,500 square kilometres Romania is a country rich in both human and natural resources, including gas, timber, petroleum and coal.

The Romanian government has committed itself to reform programmes[7] and made EU accession its highest priority. Romania's medium-term economic strategy (endorsed by all major political and civic constituencies in spring 2000) is in accordance with EU requirements.

Table 1: GDP Growth Rate (annual per cent) 1995-1999

1995	1996	1997	1998	1999
7.12	3.91	-6.6	-4.9	-3.2

Source: www.worldbank.org

Throughout the 1990s, Romania lagged behind most of its Eastern European neighbours in the pace of economic restructuring. While some reforms has taken root, the overall pace of development is slow. From 1997-99 the economy declined 14 per cent (table 1). This left Romania with one of the lowest living standards in Europe and it also hampered the country's efforts to join the European Union. However, evidence of the Romanian governments commitment to an economic reform led the European Union to invite Romania to begin negotiations for EU accession in December 1999.

By 2000, after years of high inflation, economic decline, and large trade and fiscal deficits, Romania's economy finally showed signs of recovery. Booming exports are improving the country's precarious balance-of-payments position and encouraging growth. According to national estimates, economic growth was 1.6 per cent in year 2000. Moreover, forecasts for the medium term (2001-2004) predict average annual growth of approximately 5.6 per cent, thereby finally putting national economic development on the right track.

[7] For 2002, the target is to reach a five per cent economic growth and reduce inflation to 22 per cent. In order to reach the targets, the IMF has conditioned a speed up of the reform process.

TABLE 2: KEY FIGURES FOR ROMANIA

Country size in square kilometres	238 400 km^2
Population size	22.5 millions (1999)
GDP per capita US$90	1373.33 (1998)
Annual energy use per capita (tonnes oil equivalent – toe)	1.76 (1998)
Average annual growth rate per cent of energy use per capita (1990-1998)	-4.54 (1990-1998)
Annual growth rate per cent of energy use per capita	-9.28 (1998)
TPES/GDP (toe per thousand 95 US$)	1.28 (1998)
TFC/GDP (toe per thousand 95 US$)	0.77 (1998)
CO_2 per tonnes oil equivalent (millions tonnes/TPES – toe)	0.688 (1998)
Annual emission of CO_2 (millions of tonnes)	27.5 (1998), 25.7 (1999)
TPES/TFC	1.66 (1998)
Net Import (Mtoe)	11.15 (1998)
Electricity Consumption (TWh)	47.43 (1998)

Source: A combination of statistics from various sources[8]

2.1.1 Map of Romania

[8] Energy Statistics of OECD Countries 1998-1999, IEA International Energy Agency OECD 2000, www.worldbank.org, www.eia.doe.gov (Energy Information Administration)

2.2 The Energy Sector

After the 1989 revolution, Romanian authorities planned to restructure the country's energy sector as part of a transition to a market-driven economy. This included introduction of competition within the energy sector and adjustment of energy prices to international prices - two of the major objectives of Romania's EU integration for the energy sector.

2.2.1 Energy Supply and Consumption

Total primary energy supply in Romania dropped by 35 per cent during the period 1990-1998 (table 5). Energy use per capita (table 3) dropped by 33 per cent during the same period. Import of energy also dropped by approx. 48 per cent (table 5).

Table 3: Annual energy use (toe per capita)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES/population	2.63	2.17	2.03	1.97	1.86	2.01	2.17	1.94	1.76	--

Source: IEA, International Energy Agency

In the period 1994-1996, Romania experienced a positive growth rate in energy use pr capita (table 4). These years were also characterised by positive growth in GDP (table 1). According to preliminary national estimates for year 2000, energy consumption in Romania recorded an increase of 2.7 per cent, thereby following the trend of national economic development. With an improved economy for 2001 – 2004, Romania could experience an increase in energy use which, with reliance upon present energy sources, will cause a serious environmental impact.

Table 4: Annual Growth Rate of Energy Use per capita

1990/1991	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
-17.49	-6.45	-2.96	-5.58	8.06	7.96	-10.60	-9.28	-

Source: IEA, International Energy Agency
*Example: ((1991-1990)/1990) * 100 = per cent change*
Average (1990-1999) = -1.89

Table 5: Total Net Imports of Energy (Mtoe), TPES (Mtoe) and Electricity consumption (TWh)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Net Import (Mtoe)	21.63	14.30	13.48	11.95	10.62	13.94	14.38	14.10	11.15	-
TPES (Mtoe)	61.10	50.34	46.35	44.89	42.28	45.51	48.97	43.77	39.61	-
Electricity Consumption (TWh)	67.86	57.99	52.87	51.72	50.8	52.83	54.97	50.77	47.43	-

Source: IEA, International Energy Agency

2.2.1.1 Energy Supply and Consumption in Relation to GDP

Romania decreased the TPES/GDP ratio by 20 per cent during the period 1990-1998, mainly as result of serious structural problems within the energy sector and the economic recession in the country.

Table 6: TPES/GDP (toe per thousand ´90 USD)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.60	1.51	1.52	1.45	1.32	1.32	1.37	1.31	1.28	-

Source: IEA, International Energy Agency

As in other countries with old energy distribution networks, Romania suffered from loss of energy during transportation (see table 11). Compared with table 6 above, table 7 illustrates that the decrease in energy use based on 'end user' figures (TFC/GDP) is 30 per cent, which is actually 10 per cent more than in table 6 (TPES/GDP). This means that due to an inefficient or old energy distribution network much energy is being wasted.

Table 7: TFC/GDP (toe per thousand ´90 USD)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.11	1.04	0.97	0.82	0.78	0.74	0.78	0.78	0.77	--

Source: IEA, International Energy Agency

2.2.1.2 Energy Supply and Consumption Based on Energy Source

Natural Gas

Romania's natural gas consumption plummeted by 48 per cent from 1990 to 1998 (see table 8). As consumption dwindled, production followed suit, nearly mirroring the decline and continuing to leave Romania in need of imports to meet its natural gas needs (around 30 per cent is imported). Proven natural gas reserves in Romania dwindled as the country's economic decline worsened, discouraging new exploration.

Table 8: TPES (Mtoe) / Energy Source

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Coal	11.66	9.35	10.79	9.37	9.75	9.89	9.71	8.74	7.08
Oil, including petroleum	18.25	14.66	11.94	12.74	11.61	13.21	13.15	12.79	11.56
Gas	28.83	23.79	21.19	20.37	18.55	19.23	19.41	15.93	14.92
Nuclear	--	--	--	--	--	--	--	1.407	1.383
Hydro	--	--	--	--	--	--	--	1.506	1.624
Geothermal, solar, wind	--	--	--	--	--	--	--	--	--
Combustible renewable and waste[9]	0.60	0.71	1.05	1.15	1.18	1.72	4.91	3.37	3.01
Electricity	--	--	--	--	--	--	--	0.019	0.033

Source: IEA, International Energy Agency
** Energy source is not significant or not present*

Russia is Romania's main foreign supplier of natural gas and in December 1999 Romania gained access to the Soyuz pipeline supplying Russian gas to Western Europe, after linking its pipeline system to the pipelines of Ukraine. The 12-mile pipeline link between the Ukrainian city of Khust and Satu Mare in north-western Romania will allow Ukraine to transport up to 4 billion cubic metres (13 billion cubic feet) a year of additional Russian natural gas to Romania. In the future, the Khust-Satu Mare pipeline will transport gas to Romania from Turkmenistan, Kazakhstan, and Uzbekistan as well.

In order for these potential imports to reach Romanian households, the country has begun to modernise its aging gas distribution system. Romania has initiated the process of replacing corroded steel pipelines with polyethylene pipelines, and underground storage capacity is being increased. Romgaz[10] is seeking to upgrade the country's 9 000-mile pipeline network, attempting to cut down on natural gas leakage and modernising measuring stations to make gas consumption more efficient.

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[9] These data are not 100 per cent reliable since stock changes and import/export of energy are not included.
[10] The national gas company.

Oil
Romanian domestic crude oil production has steadily declined over the past two decades, from about 294 000 barrels a day in 1976 to only 127 000 barrels a day in year 2000. Although Romania was once a fairly important oil producer and exporter, today Romania is forced to import around half the oil it needs for domestic consumption and consumption has been increasing since 1994. Primary supply of oil has gone down by 37 per cent during the period 1990-1998 (see table 8).

With proven petroleum reserves of 1.4 billion barrels – the largest in Eastern Europe – Romania is poised to reclaim it's standing as the region's most important oil producer. The Romanian government has committed itself to increase domestic production of oil in order to reduce the country's reliance on import. The removal of state price ceilings, plus relatively high world oil prices, have induced the national oil company (SNP Petrom) to restart some of its idled oil wells.

Romania has now opened up its oil sector to outside investors. This, together with the introduction of western technology and production methods, is expected to boost Romania's reserves and production in the next few years.

Coal
While Romania still has sizeable coal reserves, the country's coal *production* has fallen dramatically, 57 per cent from 1989 to 1998. Similarly, coal *consumption* plummeted 60 per cent in the same period. The sharp decline in coal production and consumption is mainly seen as the result of the efforts of the Romanian government to restructure the coal sector, including a reduction of state subsidies and closing of inefficient mines. Primary supply of coal has also dropped significantly during the period 1990-1998 (see table 8). In addition, Romania's economic contraction in the 1990's caused coal production to fall substantially.

As has been the case in other CEECs, the social impact of mine closures has been significant, as tens of thousands of coal miners have lost their jobs. Moreover, rising coal prices are affecting individual households, mainly in the countryside, who depend on coal for their coal fire.

2.2.1.3 Consumption of Electricity

Final consumption of electricity was reduced by about 32.5 per cent from 1990 to 1998 (table 9), again with 1995 and 1996 as peak years[11]. Since the late 1990's Romania has been able to generate a large share of electricity production from hydro power (see also table 19).

Table 9: Final Consumption of Electricity (Mtoe) and Main Energy Source for Production*

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
4.66	3.92	3.56	3.14	2.94	3.13	3.42	3.30	3.15	--

Source: IEA, International Energy Agency
** Up to 1992, electricity generation was primarily based on gas; from 1993-1996, gas was replaced by coal; and since 1997, hydro energy has increasingly been primary base for electricity generation (30.64 per cent of total in 1997 and 35.29 per cent of total in 1998).*

[11] Years with positive GDP growth figures – see table 1.

2.2.1.4 Energy Consumption Based on Sectors

The industrial sector accounted for a full 69.5 per cent of total energy used in Romania in 1998, with residential consumption making up only 17.8 per cent of the total and transportation just 12.7 per cent. Of this consumption, natural gas accounted for 37 per cent of the total, with oil (33.5 per cent) and coal (16 per cent) as other main fuel sources. Based on TFC figures, energy use in the industry sector declined by 58 per cent during the period 1990-1998, transport sector by 10 per cent and other sectors by 33 per cent (see table 10).

Table 10: Annual Energy Use (TFC, Mtoe) / Sector

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Industry	24.16	19.97	15.32	13.62	13.61	14.14	14.26	12.58	10.23
Transport	4.45	3.81	3.72	3.22	3.32	3.13	4.15	4.24	4.01
Others*	13.10	9.82	9.81	8.09	7.35	7.60	8.46	8.66	8.83

Source: IEA, International Energy Agency
* *Agriculture and especially residential sectors are main 'consumers'.*

2.2.2 Energy Efficiency

The TPES/TFC ratio increased by 16 per cent during the period 1990-1998 (table 11) meaning that Romania's energy distribution network efficiency has been worsened during the years. However, since 1996 Romania started to improve this trend and the energy efficiency is, based on statistical data, now turning towards a positive outlook. The country has started to modernise its aging gas distribution system, including the replacing of corroded steel pipelines with polyethylene pipelines.

Table 11: TPES/TFC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES (Mtoe)	61.10	50.34	46.35	44.89	42.28	45.51	48.97	43.77	39.61	--
TFC (Mtoe)	42.61	34.77	29.45	25.43	24.88	25.56	27.7	26.19	23.84	--
TPES/TFC	1.43	1.45	1.57	1.77	1.70	1.78	1.77	1.67	1.66	--

Source: IEA, International Energy Agency

2.2.3 Physical Energy Infrastructure

Thermal Energy Sector

Thermal energy supply is provided in 45 localities through centralised district heating systems. The transportation grids and moreover the secondary grids are in an advanced stage of wear, which leads to a big loss of energy, having serious consequences for consumers. It is therefore necessary to reconsider thermal energy supply at the national and local level; the necessity of grid modernisation; small-scale co-generation; efficient equipment promotion within a modern legal and institutional framework; together with new standards in building insulation.

Petroleum Pipelines

Romania has 4 475 km petroleum pipeline all owned and operated by Conpet, a joint stock company partly (70 per cent) owned by the Romanian State Ownership Fund.

Natural Gas Pipelines

There are approx. 12 000 km. of gas pipelines in Romania with a capacity of about 211 m^3 per day. In 1996, Romgaz was planning to replace 30 miles of its 1 770-mile pipeline system. The Russian gas supplier Gazprom has entered into a joint venture with Romgaz to build a new pipeline to carry Russian gas to consumers in Romania and neighboring countries. The first segment of this 120-mile pipeline was commissioned in 2000, and the rest is scheduled for completion in 2002. Most of the natural gas imported into Romania comes from Russia, with some of this gas arriving via a pipeline through Ukraine.

2.2.4 State-Owned Energy Enterprises

To date, Romania's energy sector reform process has been relatively slow and the limitation 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 pace and methods 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 will be part of this. Distribution may be entirely privatised, however production in thermal power plants can be only 25-40 per cent privatised

Services that produce losses and do not show recovery prospects will be closed or withdrawn. The Romanian and foreign investors will be encouraged to create joint venture companies, with the existing energy companies each participating with shares. Some co-generation and thermal power plants will be transferred to local administrations and will be converted to commercial companies in which "Termoelectrica SA" will be able to have shares. There is a plan to privatise two such companies each year.

In June 2000, the Romanian government approved the reorganisation of Romgaz, the natural gas utility owned by the state, in order to comply with European Union regulations and to continue the liberalisation of its energy sector. Romgaz is to be restructured into four business units: Transgaz, for transport; Depogaz, for underground storage of natural gas; Exprogaz, the production unit; and a distribution company. The state plans to sell 100 per cent of the distribution company and 30 per cent of the production unit while it wants to keep 100 per cent ownership of the transportation unit.

Privatisation of SNP Petrom, the state oil company, has proceeded slowly. The government has undertaken a gradual program to revitalise the company and prepare it for partial privatisation, including liberalising prices, closing its most inefficient operations (many in the refining sector), and selling some of the more profitable ones. While foreign funding is being sought to modernise more than 1 800 miles of pipelines, the government must retain at least a 51 per cent share of the company by law. The government has considered selling as much as 30 per cent to 40 per cent of the company, with employees likely to be awarded a 10 per cent stake.

A reconstruction of the Romanian state-owned power company Conel is planned, starting with the distribution part in 2002. Conel, which has annual revenues of about $3 billion, supplies 8.2 million customers, and accounts for 97.6 per cent of electricity produced in Romania. Conel owns 36 subsidiaries generating heat and electricity and 42 electric network subsidiaries, but the intended restructuring will create separate subsidiaries for thermal generation, hydropower generation, transmission, and distribution.

The separate Conel companies are scheduled to be transferred to the State Ownership Fund and included in the government's privatisation program. Conel will retain ownership of the national grid, and will become the parent company for the supply and generation subsidiaries. The country's transmission and distribution systems are scheduled to become regulated monopolies.

Romania's power restructuring program is intended to promote competition between the various companies, in line with European Union regulations. As a first step, in October 2000 Romania's government decided to enlarge to 15 per cent the opening of the country's electricity generation market and it is planned to open gradually the local energy market, reaching at least 30 per cent by 2004.

2.2.5 Prices and Regulation

According to Romanian authorities, the tariffs policy will consist in passing the state regulated administration of tariffs to independent authorities. The methodologies for setting the tariffs for both electricity and heat will in the future be based on marginal costs of production, transport, distribution and supply. Alignment of legislation to the European legislation requires further amendment of tariffs to external costs, reflecting the impact on the nature and the environment, and introduction of simulative options for energy efficiency projects or utilization of renewable energy.

Since 1997, energy prices in Romania have increased considerably and the price settings are now getting close to market prices. This is mainly a consequence of the implementation of the IMF and World Bank loan agreements, where transparency and price deregulation have been main objectives for the energy sector. The energy prices may get another lift when a newly agreed loan agreement package with the IMF will be implemented shortly.

However, since the sharp price increases on energy consumption during the last couple of years have affected the economy of both industry and households in Romania, the government has decided to maintain energy subsidy schemes for all consumer groups in the country. Cross-subsidies between industrial and domestic households, however, have been completely removed.

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 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, regularly the municipalities) and much attention is therefore currently given to alternative energy supply mechanisms and forms in order to get rid of a weighty expense on the budget.

2.2.6 Environmental Issues

Romania is suffering from some of the region's worst environmental degradation. The country contains an abundance of natural resources and Europe's greatest source of bio-diversity. However, years of neglect and misguided economic development policies under communism has destroyed or put at risk much of Romania's environment.

In December 1995, the Romanian parliament adopted the Environmental Protection Law, providing the basic framework for environmental protection in Romania. However, commitment to protecting the environment has continued to be weak. The Ministry for Environmental Protection has established inspection offices in each of the 42 regions but these offices are generally understaffed and do therefore not have the capacity to carry out the required inspections.

Romania has struggled in the transition to a market economy, and the country lacks sufficient resources to confront its problems and protect its environment adequately. As a result, Romania continues to be plagued by industrial air pollution, as well as water pollution by industrial and municipal wastewater discharges, agricultural runoff, and insufficient treatment of toxic pollutants discharged by industry into municipal sewers.

Although Romania's energy consumption has decreased significantly in the past 10 years, as factories have cut back on production or closed down altogether, the country's inability to restructure its energy sector has resulted in only limited stimuli for energy saving in the long-term.

Romania's energy sector has a strong impact on the country's environment in relation to oil, gas, and coal production. Thermal power plants, burning low-efficiency solid fuels and high-sulphur content heavy fuel, contribute to air pollution. The low-quality coal that Romanian households burn for heat adds to poor air quality in urban centres. Thus, while the country's carbon emissions have dropped since 1990, Romania's energy and carbon intensity remain high. The expected economic turnaround will therefore put into question the country's ability to maintain its reduction in carbon emissions and meet its Kyoto Protocol obligations. Under the Kyoto Protocol, which Romania signed in 1999 but has not yet ratified, the country is an "Annex I country" required to reduce its emissions of greenhouse gases to 8 per cent below 1990 levels by 2008-2012.

Much of Romania's decrease in CO_2 emissions is due to industrial production cutbacks, rather than energy efficiency measures. Although the implementation of modern pollution-control technology will help continue the downward trend of Romania's emission levels, Romania should be wary of the example set by other transition countries. Table 12 and 13 illustrate that Romania managed to cut down on CO_2 emissions from 1990 – 1998 by about 44 per cent.

Table 12: Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
Million metric tonnes of Carbon equivalent	49.5	-	-	-	-	-	-	-	27.5	25.7

Source: EIA, Energy Information Administration
**Preliminary*

In order to preserve the reductions in emissions achieved during the last 10 years, Romania will need to implement a number of measures. Reductions of pollutant load to the air, water, and land will be severely hampered, unless the local environmental protection agencies responsible for implementing environmental management programs are capable of modelling, monitoring, and regulating pollution sources. Romania has established a National Committee on the Ozone Layer in order to implement some of the international treaties the country has signed.

Table 13: CO_2 (kg of Carbon equivalent) per capita

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
2133.62	--	--	--	--	--	--	--	1222.22	1142.22

Source: EIA, Energy Information Administration
IEA, International Energy Agency
** Preliminary*

Romania reduced CO_2 emissions per TPES by about 8 per cent (see table 14) from 1992 to 1998, either due to down cuts down in energy intensive activities and inefficient energy production, or due to introduction and implementation of cleaner technology. Based on information from table 15 it is evident that Romania reduced CO_2 emissions during the period 1992-1999 by approx. 52 per cent while energy consumption (TPES) has went down by approx. 35 per cent from 1990-1998, thus there has been some degree of CO_2/TPES improvement.

Table 14: CO_2 (kg. of Carbon equivalent) / TPES (Mtoe)

1990	1991	1992	1993	1994	1995	1996	1997	1998
		0.747	0.756	0.752	0.735	0.697	0.745	0.688

Source: EIA, Energy Information Administration
IEA, International Energy Agency

In the short-term, Romania is faced with the challenge of continuing to clean up its environment, while halting ongoing pollution and environmental degradation. One of the current government's priorities is to contain the hot spots of industrial air and water pollution by enforcing the Environmental Protection Law more vigorously.

To increase public knowledge of the environment and participation in policymaking, Romania is setting up environment councils as forums for discussion, beginning with a pilot program in Constanta. Guidelines for public participation are being developed so that NGOs can complement governmental work in the area of environmental protection.

Table 15: Fossil Fuel-Related CO_2 Emissions in Romania, 1990-99 (in million tonnes of carbon)

Component	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 from coal	12.69	10.32	10.68	10.39	10.58	10.78	11.09	9.70	7.92	7.35
CO_2 from natural gas	19.43	15.11	13.60	13.08	12.25	12.97	12.87	11.95	9.36	8.95
CO_2 from petroleum	15.57	11.32	10.35	10.48	8.98	9.73	10.15	10.94	9.97	9.37
Total	47.69	36.74	34.63	33.95	31.81	33.47	34.11	32.59	27.24	25.67

Source: http://fossil.energy.gov/international/romnover.html

2.2.7 Renewable Energy

Romania increased energy production from renewable energy sources by approx. 700 per cent from 1990 to 1998, mainly because of a significant increase in hydro energy, introduced in 1997 (table 8).

Table 17: Contribution from Renewable Energies and Energy from Wastes.[12]

	1990	1991	1992	1993	1994	1995	1996	1997	1998
TPES (Mtoe)	61.10	50.34	46.35	44.89	42.28	45.51	48.97	43.77	39.61
Per cent contribution from renew. and wastes	0.98	1.41	2.27	2.56	2.79	3.78	10.03	7.70	7.60

Source: IEA, International Energy Agency

2.3 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. Currently only 1-2 new drillings are carried out per year. This is due to limited governmental funding but also to the fact that many promising geothermal sites have now already been identified within the country and is awaiting further exploitation.

Although significant geothermal resources have been identified in Romania, direct utilisation of the heat is 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 of temperatures ranging from 45 to115 °C. More than 80 per cent of the wells are artesian producers and only six wells are re-injection wells. Main direct use of geothermal energy is for district heating (37 per cent), bathing (30 per cent) and greenhouse heating (23 per cent). Other types of use are industrial process heating and fish farming.

In comparison to other renewable energy sources that exist in the country, geothermal energy may take advantage in the short run from 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.

In January 1996, the European Commission, financed through the Romanian Phare programme released a "Strategy on Renewable Energy Sources in Romania". The Phare-study proposed a short list of projects recommended for funding (based on project proposals submitted by FORADEX[13]). Among the proposed projects were *Otopeni* and *Calimanesti*, which afterwards received funding for further development of project activities. The Phare-study concluded that geothermal energy is already, in most cases, competitive with natural gas and always with fuel oil (This finding has - in the case of Romania - further been evidenced by Marcel Rosca in the case of the Oradea geothermal project, see Rosca, 2000). Finally, the Phare-study stated that regarding economic potentials, top priority should be given to the use of geothermal sources for thermal applications.

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[12] Data other than 'per cent' contribution and TPES is worked out in ktoe (kilo tonnes oil equivalent)

[13] A state owned company with proven geothermal experience.

2.3.1 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. They are located in porous, permeable formations; for example sandstone, siltstone or carbonate strata.

2.3.1.1 *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.

Totally, 88 wells have been drilled in the Western Plain (exclusive those from Oradea and Bors, see below) with wellhead temperatures ranging between 70-105 degrees C. The main geothermal areas are Satu Mare, Tasnad, Acas, Marghita, Sacuieni, Salonta, Curtici, Lovrin, Tomnatic, Sannicolau Mare, Jimbolia and Timisoara. The main uses of the geothermal water are heating of greenhouses (31 ha), space heating (2 460 flats) and sanitary hot water (2 200 flats).

2.3.1.2 *Oradea*

The Oradea reservoir is located in Triassic limestone and dolomite at depths of 2 200 to 3 200 metres. The reservoir is exploited by 12 wells with well-head temperature ranging between 70-105 °C. TDS is 0.9-1.2 g/l.

At present, 2.2 per cent of the total heat demand in Oradea is supplied by geothermal heat including the local university, which has its own geothermal plant. From Romania a proposal has been made to extend the geothermal heat supply in Oradea to cover 15-20 per cent of total heat demand.

2.3.1.3 *Bors*

The Bors reservoir is found only 6 km from Oradea and is located in fissured carbonate formations. The TDS is 13 g/l and the reservoir temperature is higher than 130 °C at the average depth of 2 500 metres. At present, three wells are used for production and two wells for re-injection. The installed power is 15 MW and the geothermal water is used for heating of 12 ha of greenhouses.

2.3.1.4 *Southern Plains*

In the southern plain, north of Bucharest, 11 wells have been drilled at depths of 1,900 to 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 degrees 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.

In Otopeni (12,000 inhabitants), near the international airport of Bucharest, a geothermal system, consisting of three production wells and one re-injection well, was finalized in 1988 for production of heat and hot water. The system was designed to meet the heat demand from nearly 2,000 apartments and 25 smaller villages (43 600 Gcal/year). However, due to poor conditions of the system, making it difficult to meet the heat demand, it was closed down in 1994.

In the EU funded "Strategy on Renewable Energy Sources in Romania", 1996 (see also above), the Otopeni geothermal project was one of the projects proposed for funding. In 1997, the Danish consulting company Houe & Olsen (H&O) carried out a feasibility study in Otepeni in collaboration with representatives from FORADEX.

In the feasibility study, one scenario was suggested for reintroduction of geothermal heat in Otopeni, total project costs were calculated to USD 4.8 million. It was anticipated that a 10 per cent grant would be available for the project and that the remaining costs would be covered by a new established geothermal enterprise, consisting of among others the Otopeni municipality (10 per cent). In the end, the Otopeni project was discontinued, mainly as a consequence of lack of (financial) support from the municipality.

During the consultant's meeting in Bucharest with representatives from FORADEX, it was confirmed that the Otopeni project had not advanced any further and it was not considered a priority to re-open the case. Instead FORADEX mentioned the possibility to develop further project opportunities North of Otopeni, since the water temperature there is also high (80 to 90 °C compared to 60 to 75 °C in Otopeni). However, potential in that area would be mainly for balneology and recreation facilities and only to a limited degree for heating.

2.3.1.5 Olt Valley

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

It would be possible to produce about 18 MW of thermal from the three existing wells. However only around 8 MW is currently used, mainly for space heating and balneology purposes. The Calimanesti project was proposed in the EU funded "Strategy on Renewable Energy Sources in Romania" from 1996, and the Austrian Government decided to support its development (1 million USD).

Further development of the Calimanesti project is one of the priorities defined by FORADEX. A concrete proposal is the connection of 11 blocks of flats in Calimanesti to geothermal heat supply. According to FORADEX, the funding needed for this project would not exceed USD 500 000.

2.3.2 Organizations Responsible for Geothermal Energy Development

2.3.2.1 Government

Within the government the overall responsibility for energy development lies within the Ministry for 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 concessions for geothermal energy development, applicants should pass their applications to NAMR, who will in turns submit their recommendations to the Ministry of Industry for approval.

2.3.2.2 Private Sector

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

TRANSGEX, the smaller of the two companies, was privatised last year. The company has around 180 employees, hereof around 60 persons working on geothermal energy. The company is mainly present 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 within oil, gas, water and diamonds. It is planned that FORADEX should be privatised sometime within a near future in order to allow restructuring and modernization of the company. FORADEX is mainly operating in the area around Bucharest, the southern part and the southwestern part of the country.

2.3.2.3 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 of 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.

2.3.3 Institutional Factors Governing Geothermal Energy in Romania

2.3.3.1 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, authorisation and control in the field of electric and heating energy. The financing of NERA is entirely ensured from extra-budgetary sources, obtained from granting licenses and authorisations and from the contributions from the operators in the system. Currently, NERA employs 51 people.

The main responsibilities of NERA are:

- Issuing the regulation for efficient and transparent functioning of the national energy system
- Issuing authorizations and licenses for economic operators in the sector
- Establishing the methodology for calculating prices and tariffs applicable to the natural monopoly activities in the sector
- Approving standard framework contract between the economic operators in the sector on sales, acquisition, transport, dispatching and distribution of the electric and thermal energy to end consumers
- Establishing prices and tariffs for the captive consumers
- Approving power transit contracts through the national energetic system

NERA establishes power prices and tariffs using a methodology approved by the *Competition Office* and based on the following principles:

- Consumer protection
- Ensuring the economic and financial feasibility of the operators
- Encouraging the operators to increase the economic efficiency
- Attracting investors
- Rules directly affecting GE

The approval and implementation of the new "Mineral Law" in 1997 has been of particular relevance and importance to 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 (before it was only one year). The Mineral Law has therefore opened 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.

2.3.3.2 Energy 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 utilisation of renewable energy, the projects to be launched during the period will include the following:

- Establishment of the National Energy Observatory. The main task of the Observatory is synthesis of energy consumption data and evaluation of energy indices. These will be 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 training and imposing the authority of qualified persons in energy management of industrial consumers

- More rational use of electricity and natural gas in industry

- Completion of energy efficiency demonstrative projects in Ploiesti and Craiova financed by the Government, EU and Global Environmental Fund

- Completion, in co-operation with EU, of the national programme for regulation and metering of thermal energy consumption in 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, 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

- Application of EU Directives concerning household appliances and small capacity boilers

2.3.3.3 National Funding Sources for GE Development

The Romanian state budget has since the 1960s financed the drillings of over 200 wells for geothermal exploitation. However, government 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 currently is under pressure and secondly, because the Romania government is now expecting that more of the already identified geothermal sites will be exploited further. Since wells already exist 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.

2.3.3.4 Status vis-a-vis EU Enlargement / Integration

By incorporating rigorous environmental standards into the *acquis communautaire* and stipulating that the environmental dimension will be taken into account throughout the entire spectrum of community policies, the EU has made it quite clear to countries aspiring to EU membership that they must clean up their environment.

While Romania's environmental legislation now complies over 90 per cent with the EU, Romania's environmental problems persist. In the years ahead, Romania's challenge will be to comply with EU environmental laws, overcome the legacy of environmental degradation from the communist period, and make an environmentally sound economic recovery.

By the end of year 2000, Romania had closed six of 31 negotiations chapters. During this year, Romania plans to complete the preparation of another 23 chapters. In mid-September 2001, the European Parliament approved the latest progress report on Romania's EU accession process, which will be released later this year. The report saluted Romania's latest progress in issues such as macroeconomic stabilisation and strengthening of the banking system. However, it was also emphasized that Romania is registering delays in implementing structural reforms, especially within agriculture, environmental protection and energy.

2.4 International Collaboration on Geothermal Energy Development in Romania

In conjunction with Romania's Ministry of Water, Forestry, and Environmental Protection (MOWFEP), which is the country's primary government agency charged with environmental matters, the World Bank has planned a Pollution Abatement Project loan package to help address industrial pollution problems significantly impacting human health and productivity. Under the loan agreement, the U.S. Agency for International Development (USAID) is to sponsor specific loan measures regarding the institutional development of MOWFEP, environmental management at the local level, the development of an environmental service industry, and public participation.

The World Bank recently initiated a project to create an Energy Efficiency Project Fund, which should foster a large increase in energy efficiency investments in Romania through development of self-sustaining market-based mechanisms. The initial capital fund will be provided by GEF, but contributions from other donors may also be identified.

USAID has begun work with seven Romanian EPAs to improve their capabilities for environmental inspecting and monitoring through demonstrations of new techniques, procedures, and systems to better characterize and regulate pollutant emissions. The agency is also developing an inventory of opportunities for reducing greenhouse gases, as well as identifying low-cost reduction measures and discussing emission-trading concepts. USAID is trying to help spur reforms in Romania to revitalise and restructure Romania's energy sector, by pushing with oil and gas liberalisation, power sector competition, and energy efficiency.

In the years 2000-2002 total EU financial assistance to Romania will amount annually to at least 242 million EURO from Phare, 150 million EURO from SAPARD and more than 200 million EURO from ISPA. ISPA is supporting the sectors of environment and transport with both sectors receiving around half of the annual allocation.

The German Ministry for Economic Co-operation and Development has recently opened a bureau at the Romanian Ministry of Development that will facilitate contacts between German investors and Romanian officials and seek business opportunities in Romania, mainly within the energy sector, environmental protection, IT and infrastructure. German is currently ranked second on the list of foreign investors in Romania.

2.5 Summing Up

Romania has, during the last few years, entered into a more dynamic process of structural changes and economic reforms. After years with economic recession, the growth rate has 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 with an opening up for EU accession negotiations.

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

Whit regard to geothermal energy development in Romania, the country possesses large proven geothermal resources. 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 implementations of new laws in Romania on energy and concession rights have 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, the Romanian government does not have any effective programmes or economic support mechanisms (funds, eco tax-systems etc) for geothermal energy development in operation. This may however change soon, since Romania is in urgent need to harmonize with EU rules and regulations within the sectors of energy and environment.

It should be credited to the Romanian government, that since the 1960s it has financed more than 200 geothermal drillings in the country. 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 can be 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 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 yet do not function adequately in Romania. Banks and lending institutions in Romania often consider the risks and costs related to geothermal project investments too high, mainly because the banks do not know or recognise 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 may be right, 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.

In conclusion, DEPA is recommended to consider support for implementation of a geothermal (demonstration) project in Romania.

Prospectives and conditions for future geothermal development in Romania look promising and indeed more attractive than just a few years ago.

The geothermal project proposed for possible DEPA co-financing would, in the first instance, be the Oradea project. The Oradea case is considered an excellent opportunity to demonstrate a good, sustainable geothermal project within Romania. The local technical, institutional, environmental and economic conditions in Oradea are positive for geothermal project implementation. Moreover, since Oradea is placed in the Western Plain, the region with the highest geothermal potential in the country, the demonstration effect would be strong, with regard to possible duplication into neighbouring communities.

2.6 References

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World Bank. 2001. *Romanian Country Assistance – Strategy Paper.*

2.7 List of Institutions Visited and Individuals met

Romanian Geothermal Association:
Mr. Ioan Cohut, President

National Academy for Mineral Resources (NAMR):
Ms. Maria Iuliana Stratulat, President
Ms. Magdalena Stoia, Director
Ms. Floriana Sora, Technical Officer

Ministry for Environmental Protection:
Mr. Augustin Dudas, Chief Inspector, Bihor County
Mr. Dorin Borota, Engineer

Geological Survey of Romania:
Dr. Gheorghe Udubasa, Director
Dr. Serban Velicio, Scientific Director

Prefectura, Bihor County:
Mr. Aurel Tarau, Prefect
Mr. Horia Jarca, Director
Ms. Lucia Surdu, European Integration and External Relations

Municipality of Oradea, City Hall:
Mr. Kapy Stefan, Vice Mayor
Mr. Constantin Jurca, Vice Mayor
Mr. Emilian G. Sala, Director, Financial/Economic Manager

University of Oradea:
Prof. Dr. Vasile Bara, Decan

Municipality of Beius:
Mr. Odobasianu Nicu Silviu, Mayor
Mr. Iuhas Viorel, Vice Mayor

FORADEX:
Mr. Mihail Smarandescu, President
Mr. Mihai Sarbulesco, Chief Engineer
Mr. Rodica Voiculescu, Overseas Activity Division

Dafora group (owner of TRANSGEX)
Mr. Gheorghe Calburean, Chairman

TRANSGEX S.A.:
Mr. Iacobescu Alin, Director General

Geofluid S.A.:
Mr. Miklos Antics, Technical Manager
Mr. Marcel Rosca, Consultant, Thermal Engineering

World Bank:
Mr. Dan Petrescu, Communication Officer

EBRD:
Mr. Mihail Sevortov, Principal Banker

3 Volume II.C: Country Profile - Russia

3.1 General Background Information

Russia is a giant in terms of geography and variation of geological conditions. With only 2.8 per cent of the world population against 42 per cent of the worlds known coal resources, Russia's declining population is however relatively small.

Since the 1998 crisis, the Russian economy has picked up, and the real GDP growth rate has been positive for the last three years (see table 1).

Table 1: GDP Growth Rate (Annual Per cent) 1995-1999

1995	1996	1997	1998	1999	2000*	2001*
-4.14	-3.40	0.9	-4.9	3.2	5.0	4.2

Source: www.worldbank.org
**: Estimated*

While the reasons behind the economic recovery are complex, the doubling of both Russian domestic and world market energy prices since early 1999 is one important factor and a major development trend affecting the energy sector.

Table 2: Key Figures for Russia's Energy-Economic Situation

Country size in square kilometres	17 075 400 km^2
Population size	144.8 million (2001)
GDP per capita USD95	2 663 (1998)
Annual energy use per capita (tonnes oil equivalent – toe)	3.96 (1998)
Average annual growth rate per cent of energy use per capita (1990-1999)	-4.78
Annual growth rate per cent of energy use per capita	-2.22 (1997/1998)
TPES/GDP (toe per thousand 95 USD)	1.49 (1998)
TFC/GDP (toe per thousand 95 USD)	1.01 (1998)
CO_2 per tonne oil equivalent (TPES - toe)	0.69 (1998)
Annual emission of CO_2 (million tonnes)	400.09 (1999)
TPES/TFC	1.47 (1998)
Net Import (Mtoe)	-345.12 (1998)
Electricity Consumption (TWh)	715 908 (1998)

Source: A combination of statistics from various sources[14]

[14] Energy Statistics of OECD Countries 1998-1999, IEA International Energy Agency OECD 2000, www.worldbank.org, www.eia.doe.gov (Energy Information Administration), http://www.statistics.sk. IEA statistical information on GDP for non-OECD countries is based on 1990 exchange rates, which is not directly comparable to GDP data for OECD countries, which is based on 1995 exchange rates. To convert 1990 rates into 1995 rates we have used a 'price-index-converter'. Source: http://minneapolisfed.org/economy/calc/cpihome.html#calc Based on calculations from the source above, the index difference from 1990 to 1995 is 1.17, therefore data from 1990 are multiplied by 1.17 to make comparisons between 1990 and 1995 possible.

3.1.1 Map of Russia

Source: www.countrywatch.com

3.2 The Energy Sector

The energy sector in Russia holds a key position both economically and politically. Having large quantities of natural gas, coal, oil, wood, uranium and hydroelectric power, the energy situation of Russia is characterized by full self-sufficiency in energy. The key position of the sector also applies to export earnings, as 40 per cent of Russia's foreign currency earnings stem from export of energy.

In the period 1995-1999 gas covered about half of the country's total energy consumption. It's noteworthy that Russian energy consumption has *dropped* 30 per cent from 8.5 tonnes oil equivalencies (toe) per capita in 1990 to 6.0 toe per capita in 1999. Supply-wise, is natural gas still the largest source.

The Russian industries and consumers owe the partly state-owned Gazprom, - who fully dominate the market - , more than DKK 20 billion and the lacking payments have motivated the company to aim at the export market. Russia has an insignificant production of renewable energy, with hydroelectric power and wood amounting to a few per cent of the total consumption.

District heating is of central importance to the heat supply of Russia – of which the main part is based on gas and in addition crude oil.

Since the Russian economy has high energy intensity, the energy efficiency is low. As a consequence – and considering the size of the country and the energy sector – a more efficient exploitation could result in a very large potential energy profit. This applies in relative terms as well as in absolute terms. Most estimates of Russian energy intensity are high; 20 to 100 per cent above countries with similar industries and climate. Such estimates have low reliability, because of the problems of measuring GDP and incomes in a tax avert Russia. Most analyst however seem to agree that many opportunities exist for energy savings in the region of 10 - 30 per cent, with payback times between one and five years.

Though improving recently, the 1999 level of Russian real wages had declined by 20 per cent in one year. With more than 10 per cent of the labour force unemployed, more than 30 per cent of the population lived below the poverty line of USD 35 a month. With a declining population and a life expectancy of males at about 61 years in the year of crisis in 1998, the picture of the socio-economic situation in Russia is (or was) bleak. It is no wonder therefore, that the tariffs and user charges has not been allowed to keep pace with inflation, and to some extent has continued to serve as an instrument of social policy.

From a narrow viewpoint of energy efficiency, of course, the cocktail of low wholesale gas and electricity tariffs (at around one-tenth of the Western European level for the past decade), and low rates of cash collection despite even lower tariff levels for households, has been a major problem.

From the viewpoint of environmental protection and sustainable development, these same problem have meant that incentives for improving energy efficiency and investing in renewable energy sources has been low or absent.

If the rate of recollection is used as an indicator for the future, this incentive pattern is about to change. While the rate stood at less than 20 per cent in 1999, it had improved "very substantially" by 2000, according to the EBRD (EBRD, 2001).

With one of the worst ratios in the world for conventional energy use, Russia is very much locked in a wasteful pattern, – in 1998 no more than 4.5 per cent of the country's energy equipment was less than 5 years old.

The energy demand in Russian Federation is mostly covered by fossil fuels (coal, oil and gas) and nuclear power stations (see table 8). The contribution of renewable energy in general and geothermal energy in particular is fairly small and due to the relatively low prices of traditional energy carriers, new developments are faced with significant barriers in this area. Conversely, have many "lack-of-knowledge" barriers already been overcome, as the Russian Federation has inherited and performed a large number of research-based assessments of its geothermal potential.

3.2.1 Energy Supply and Consumption

Annual energy use per capita has since 1992 and up until 1998 decreased by approx. 26 per cent (see table 3)

Table 3: Annual Energy Use (toe per capita)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES/population	--	--	5.35	4.99	4.28	4.21	4.14	4.05	3.96	--

Source: IEA, International Energy Agency

Negative growth rates have characterised especially the first part of the 1990's (see table 4). This period is also characterised by negative GDP generation. 1998 was a year with remarkably large negative GDP generation due to an economic crisis, and there was a negative energy growth rate of 2.2 per cent that year.

Table 4: Annual Growth Rate of Energy Use Per Capita

1990/1991	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
--	--	-6.73	-14.23	-1.64	-1.66	-2.17	-2.22	--

*Example: ((1991-1990)/1990) * 100 = per cent change*
Average: • (1990-1999) / 6 = -4,78
Source: IEA, International Energy Agency

From 1995 to 1998 Russia increased export of energy by approx. 10 per cent (see table 5) while inland consumption dropped, thus making export of energy an important industry for Russia alongside other industries.

Table 5: Primary Energy Supply, Net Import and Electricity Consumption

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Net Import (Mtoe)	--	--	-314.17	-294.70	- 315.14	- 314.25	- 331.51	- 338.50	- 345.12	--
TPES (Mtoe)	--	--	795.02	740.95	635.13	623.39	610.92	596.66	581.77	--
TPES – Net Import (diff.)	--	--	1109.19	1035.65	950.27	937.64	942.43	935.16	926.89	--
Electricity Consumption (TWh)	--	--	908.12	850.14	769.97	756.95	743.24	730.05	715.91	--

Source: IEA, International Energy Agency

3.2.1.1 Energy Supply and Consumption in Relation to GDP

Table 6 shows that Russia has not been able to decouple GDP generation and energy consumption / production significantly. From 1992 to 1998 Russia reduces the TPES/GDP ratio by approx. 3 per cent.

Table 6: TPES/GDP (toe per thousand 95 USD)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
--	--	1.45	1.48	1.45	1.48	1.50	1.45	1.49	--

Source: IEA, International Energy Agency

Table 7 indicate that for consumption, being energy available to end users (i.e. industry) the decline was about 9 per cent in the same period. The difference in TPES/GDP and TFC/GDP could mean that Russian industry's part of GDP generation has declined more than can be observed by the TPES/GDP ratio. This actually means that Russia is experiencing a decoupling within the industry sector, which is not shown in table 6. This is due to inefficient extraction, production and distribution of energy (see table 11).

Table 7: TFC/GDP (toe per thousand 95 USD)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
--	--	1.11	1.11	1.07	1.10	1.01	1.00	1.01	--

Source: IEA, International Energy Agency

3.2.1.2 Energy Supply and Consumption Based on Energy Source

Russia is an exporter of energy (see table 5) and thus produces more energy than needed for inland consumption. Russia has, despite a decline in energy consumption, a large dependency upon fossil fuels (see table 8).

During the period 1992 - 1998, Russia experienced a decline in energy production for coal (25 per cent), oil (48 per cent) and gas (16 per cent)).

Table 8: Energy Supply and Consumption, Primary Supply[15] / Energy Source (Mtoe)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Coal	--	--	126.91	125.01	113.99	109.09	111.83	101.40	95.34	--
Oil, including petroleum	--	--	237.98	200.12	150.57	146.98	133.64	130.02	124.10	--
Gas	--	--	368.46	352.49	316.88	311.50	312.92	311.48	310.88	--
Nuclear	--	--	31.18	31.39	25.94	26.32	28.78	28.63	27.36	--
Hydro	--	--	14.84	17.94	15.13	15.16	13.27	13.54	13.63	--
Geothermal, solar, wind										--
Combustible renewable and waste[16]	--	--	17.28	18.54	14.11	15.96	12.07	13.50	12.15	--

Source: IEA, International Energy Agency
* *Energy source is not significant or not present*

3.2.1.3 *Consumption of Electricity*

Final consumption of electricity has also decreased (24 per cent) during the period 1992-1998 (see table 9).

Table 9: Final Consumption of Electricity (Mtoe)*

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
---	---	65.78	60.70	54.63	53.18	51.70	50.73	49.71	---

Source: IEA, International Energy Agency
**Gas delivers 42.71 per cent of the energy for electricity generation.*

3.2.1.4 *Energy Consumption Based on Sectors*

Russia experiences, during the period 1992-1998, drastic cut downs in the transport sector (-41 per cent) and in the residential and agricultural sectors (-45 per cent)

The industry sector's use of energy declines by about 11 per cent. Despite the drastic fall in energy use within the transport sector, use of energy starts to increase from 1994 and onwards until 1998 by 7 per cent (see table 10). Energy consumption in the transport sector is typically characterized by use of fossil fuels – mainly petroleum.

Table 10: Annual Energy Consumption - Mtoe (TFC) Per Sector

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industry	---	---	163.82	224.13	176.33	166.64	139.47	155.87	146.29	---
Transport	---	---	94.62	70.59	51.69	54.01	58.07	53.32	55.38	---
Others*	---	---	341.46	249.85	233.18	229.59	206.78	197.54	187.17	---

Source: IEA, International Energy Agency
* Residential *and* agricultural *sectors are main 'consumers'.*

3.2.2 Energy Efficiency

During the period 1992-1998 Russia actually experiences a decline in energy distribution efficiency of about 13 per cent, while most other countries are experiencing an increase (see table 11). As mentioned earlier, Russia has some of the worlds' oldest energy distribution networks, with only 4.5 per cent

[15] Energy sources other than that of coal, oil and gas are based on 'production' numbers and not 'primary supply'.
[16] These data are not 100 per cent reliable since stock changes and import/export of energy are not included.

being less than 5 years old. Large quantities of energy are wasted due to old distribution networks.

Table 11: TPES/TFC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES (Mtoe)	---	---	795.02	740.95	635.13	623.39	610.92	596.66	581.77	---
TFC (Mtoe)	---	---	612.94	556.69	469.95	462.69	411.49	412.28	395.22	---
TPES/TFC	---	---	1.30	1.33	1.35	1.35	1.48	1.45	1.47	---

Source: IEA, International Energy Agency

3.2.2.1 The Importance of District Heating

Heat consumption and production is much more important in Russia than in most other industrial countries, as heat represents 40-45 per cent of final energy consumption, across all sectors, and two thirds or more of energy consumption in the residential sector is used for heat and hot water. (See table 10).

Current privatisation of the residential sector does not lead to automatic energy savings, - as some international institutions sometimes seem to believe. Even where heat and hot water are metered and most residential apartments are privatised, residents may be neither de-jure nor de-facto responsible for maintenance of the buildings, let alone energy efficiency investments. In the very long term, of course, it is possible that future homeowners 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 homes and buildings.

3.2.3 Physical Energy Infrastructure

Transneft is the state-owned company responsible for Russia's extensive oil pipeline system. Many of these pipelines are in a state of *disrepair*; with Fuel and Energy Ministry figures indicating that almost 5 per cent of crude oil produced in Russia is lost through pipeline leaks. Transneft lacks the funding to repair or upgrade many of these malfunctioning pipes, and the company's focus has instead been on building new pipelines. In addition to those in the Caspian Sea Region, Russia has a number of new oil and gas pipelines planned or already under construction[17].

Natural gas is the predominant fuel in Russia, accounting for nearly half of the country's domestic consumption. With 1 700 trillion cubic feet (Tcf) in proven gas reserves, Russia has more than enough for itself, allowing it to export significant amounts of gas. In 1998, Russia produced 20.9 Tcf of gas and consumed only 13.8 Tcf, with the excess 7.1 Tcf exported, making Russia the world's largest gas exporter.

3.2.4 Prices and Regulation

Traditionally, Russian heat consumers have been used to perceive heat as a free good and this historic legacy, as well as incomplete enforcement of dept

[17] The proposed Ukraine bypass pipeline is just one of several new gas and oil pipelines that Russia has in the works to increase its export capacity. The Blue Stream pipeline, which is currently under construction, aims to supply 564 Bcf of natural gas to Turkey, when it is completed, and is the centrepiece of Russia's export diversification strategy.

collection makes domestic energy appear cheaper than its price implies. The Russian government has however decided that during the next 3-4 years, electricity prices must reach a level covering at least production cost. Current subsidies by local governments for heat and hot water are scheduled to disappear by 2003. In a ten-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.

3.2.5 Environmental Issues

While the 1998 crisis helped reduce air and water emissions, pollutions per unit of GDP has not improved significantly (5 per cent) from 1992 to 1998 (see table 14). Compared to major OECD nations and large developing countries, Russia's *carbon emissions* rank third, behind the United States and China. In contrast to both these countries however, Russia's emissions dropped from 573.50 million metric tonnes of carbon emitted in 1992 to 407.52 million metric tonnes in 1997 (see table 12). Russia now emits considerably less than its quota under the Kyoto Protocol, and thus have emission credits to trade with Western countries in exchange for much needed hard currency.

The reason behind this reduction was a drop in industrial production and economic crisis, not improvements in energy efficiency (see table 11). Energy and carbon intensities (2.7 metric tonnes of carbon per person) in Russia remain high (see table 13), and while per capita carbon emissions have fallen (approx. 30 per cent) since 1992, Russia will need to improve its "eco-efficiency" to maintain this trend.

Table 12: Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
Million metric tonnes of Carbon equivalent	---	---	573.50	535.63	477.28	444.31	444.19	407.52	397.85	400.09

Source: Energy Information Administration, International Energy Agency (EIA).
** Preliminary*

Table 13: CO_2 (kg. of Carbon Equivalent) Per Capita

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
---	---	3856.76	3606.94	3218.34	3000.06	3007.38	2766.60	2708.30	2734.72

Source: Energy Information Administration, International Energy Agency (EIA).
** Preliminary*

Table 14: CO_2 (kg. of Carbon Equivalent) / TPES (Mtoe)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
---	---	0,721	0,723	0,751	0,713	0,727	0,683	0,684	---

Source: Energy Information Administration, International Energy Agency (EIA).
** Preliminary. (http://fossil.energy.gov/international).*

3.2.6 Renewable Energy

Renewable energy in Russia faces a range of constraints on their dissemination. In the first half of the 1990´s *Martinot* (1998) identified a series of transaction barriers seriously limiting investments in RE and technology transfer. He identified six kinds of barriers that limit energy efficiency and renewable energy in Russia. These include lack of information and issues related to legal and market institutions; contracts and property rights prominently among these. Lack of historical heat consumption data is another problem, and the fact that the link between energy savings at a building, and actual fuel savings at a district heating plant is complex. However, the same author concluded that in Russia:

- Favourable conditions like market level energy prices and privatisation exist.
- Huge technical potentials and economically profitable opportunities exist.
- Russians are highly technically qualified to take advantage of opportunities.
- New institutions and market oriented skills, market intervention and joint ventures are important means of overcoming transaction barriers.

While some Russian technologies may have lower performance than Western European state of the art, a wide range of modern technologies is indeed available in Russia. This includes meters, valves, insulation, sensors, automatic controllers, pre-insulated piping, heat pumps and variable speed drives as well as solar photovoltaic. What many Russians lack, is the market oriented skills and institutions to take full advantage of their technological capabilities; the innovative, creative and experience based ability to turn an idea or design into a reliable, quality commercial product or service (Martinot 1998). Underdeveloped capabilities in this area include: Business management, finance, marketing, creative product development and innovation, quality assurance, economic analysis and legal contracting. In addition, based on detailed analysis of the six barriers, a demand (by concrete RE projects) for the following important functions follows:

- Securing approval and support of government officials
- Finding and matching investment and joint venture partners
- Arranging finance
- Evaluating and verifying information, about partners and projects
- Obtaining information about technologies and markets
- Project identification
- Cost-benefit and risk estimations
- Licensing arrangements
- Trust building
- Contract negotiation
- Preparation of technical specifications and bidding documents
- Bidding and selecting bids for equipment and installations
- Management, supervision and evaluation of projects

3.2.7 The Energy Situation

Russia experienced an economic crisis in 1998 that was accompanied by a decline in energy use, but in the last 3 years Russia has had a positive GDP. Energy use declined by a no less than 26 per cent in the period 1992-1998 and electricity consumption decreased by 24 per cent in the same period. Energy use within the residential and agricultural sectors have also declined, by approx. 40 per cent.Russia is more than self-sufficient regarding energy and thus exports large amounts of energy. Exports of energy accounts for about 40 per cent of Russia’s exports earnings.

From 1995 to 1998 Russia increases energy exports by approx. 10 per cent.

Due to a large dependency upon export of energy, Russia only manages to increase a decoupling between TPES and GDP by 3 per cent during 1992-1998, despite the fact that the industrial sector actually reduced the dependency on energy by 9 per cent.

Use of fossil fuels has in general decreased, especially oil and coal has been cut down, while natural gas has only gone down by approx. 16 per cent from 1992 to 1998.

When it comes to efficiency (here illustrated by the TPES/TFC ratio) the situation in Russia actually worsens by 13 per cent during the period 1992-1998, a fact that probably is due to the old, badly maintained energy infrastructure. This also affects the CO_2/TPES ratio that only improved by about 5 per cent from 1992 to 1998, which is not impressive compared to other countries.

Energy prices in Russia have traditionally been subsidized, but it has been decided that Russia's energy prices should be approximated to EU prices over a 10-year period.

3.3 Geothermal Energy

In Russia, geothermal energy is part of a cultural and historical legacy dating back further than antiquity. The hot waters of Ural gave rise to fairy tales and legends, and Russians associated geothermal waters with A.S. Pushkins poem "Bakhchisarai fountain", Karl Brullovs painting of the same, and Boris Asafiews ballets (Svalova 2000). In 1957 the first boreholes were drilled to explore the geothermal possibilities for electric power use. In the following years several considerable resources were discovered in the area of Kamchatka. Significant GE resources are available and identified, and Russia has a record of GE use. Compared to the conventional energy sources, however, the contribution by GE to Russia's energy supply is very low (0,06 per cent of total electric power), partially due to the economic situation of the country. At 300 MWh 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 and Kamchatka, where GE space and district heating supply a total of 220 000 people. In addition GE heat up an area of 465 000 m^2 of greenhouses.

The case of Russia illustrates the multiple uses that GE direct use can comprise well: greenhouses, soil heating, fish and animal husbandry, cattle-breeding, manufacturing (such as wool washing, paper production, wood drying and oil extraction), various health and recreational uses (hydropathical use, swimming pools) and then not least space heating.

From a technical point of view, Kvistgaard Consult considers the following areas to be the most promising for geothermal energy utilization in Russia:

- European part of Russia
- Northern Caucasus and Dagestan
- Central region (Moscow Artesian Basin)
- Siberia and West Siberian platform
- Lake Bajkal
- Kamchatka
- Sakhali and Kuril Islands

Map of Russian Geothermal Regions

Source: V. Kononov

All these regions are promising for direct use of geothermal resources from a technical point of view. Some are however, – like Western Siberia – , also very rich in natural gas and oil and that hampers development of GE in the said region. Others, – like Kamchatka and the Kuril Islands – , are very remote seen from a Danish perspective. In what follows, therefore, Kvistgaard Consult limits itself to describing and analysing the prospects for GE in the European part of Russia.

Kvistgaard Consult, however, does point the readers' attention to the fact that GE is well developed in Siberia and that IFI´s, such as the EBRD, are supporting GE projects in some of these more remote areas of Russia.

3.3.1 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, Stavropol and Krasnodar. In these areas the Russian share of the population is 90 per cent, in other areas in the North of the region it is about 50 per cent (Dr. Michel I. Saparov, personal conversation at ENIN, Moscow, 26.09.2001). In total, the Dagestan republic has 180 existing wells, with geothermal potential at depths from 200 to 5500 metres. The total amount of resources has been estimated at 4 million m^3/day. In contrast, the annual volume used today is only 7.5

million m^3. One project, the Pilot *Kayasulinskaya* GEOPP, seems to be making progress[18].

There are several factors favouring geothermal investments in the European part 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 for fossil resources, which are now largely exhausted. Since drilling often amount to 50 per cent of project costs, the existing wells reduce project costs very considerably.

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.

On the basis of the analysis presented in this country profile on Russia, the following project activities and tasks may be identified as relevant for promotion of GE in Russia, with particular relevance to Northern Caucasus[19]:

- Provision of institutional support and capacity building to strengthen development of efficient RE use in South Russia, and servings it's 20 million plus population.
- Assessment of technological barriers for wider dissemination of RE in south Russia
- Assessment of institutional barriers for wider dissemination of RE in south Russia
- Assessment of economical barriers for wider dissemination of RE in south Russia
- Elaborate mechanism to trade GHG emission quotas and JI projects, to enable local enterprises raised additional funds for local RE projects.
- Identification of the most viable wells for geothermal energy
- Design of a model geothermal heat supply system and plant
- Assessment of the GHG emission reduction capacity relating to development of RE in South Russia.
- Develop a regional training and data centre for RE in South Russia
- Organize a workshop on promotion of RE in South Russia
- Establish institutional and financial RE project implementation mechanisms
- Prepare a regional RE promotion programme, including one focusing on nature reserves, sanctuaries and national parks.

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[18] 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*". The proposed project is described in Vasil´ev and Ilénko . (Vasilév, V.A. and V.V.Ilénko . (Results of Research and Development of the Two-Circuit Stavropol Geothermal Power Station).

[19] The North Caucasus region provides a congruence of favorable conditions for RE in general. This does not only apply to GE, but also to wind farms, including good wind resources, flat terrain dominated by agriculture, high populations densities, and severe power deficits.

- Undertake public consultations in support of RE programmes.

Implementing agencies in South Russia could include the North Caucasus Higher School Research Centre (NCRC) and the local energy company Geotermneftegas, Stavropolenergy as well as the regional administrations of South Russia.

The Northern Caucasus region embraces two “geothermal” provinces. The first includes the so-called Alpine tectonic unit and the second is called the epi-Hercinian Scythian plate. The Alpine tectonic unit include the administrative regions of Krasnodar and Stavropol (as well as the Adygeya Republic). Drilling that was previously used for oil and gas exploitation densely covers this part of the Alpine areas of Northern Caucasus. Very intensive oil exploration also provided knowledge of the subsurface structures. Because the oil reservoirs are generally exhausted, a high number of wells can be used for geothermal purposes.

In the *Krasnodar* region, the geothermal reservoir is of confided type with artesian conditions. Thermal waters are present in Mesozoic and Cenozoic multi layer aquifer systems, where water temperatures at 2000 metres are between 80-100°C. The reservoir is recharged by water with low salinity that precipitates in the mountains and would therefore probably not need to be re-injected into the reservoir. This may lower exploitation costs significantly. In this area, geothermal heat is used in *Mostovskoi* town, where water at about 80°C is used for heating greenhouses and cattle farms, and subsequently dumped into the river, after being cooled down to about 20°C.

From a technical viewpoint, another potential location of geothermal space heating project is located in *Stavropol* territory near the towns *Mineralnye Vody*, *Pyatigorsk*, *Georgievsk*, and *Kislovodsk*. One of the constraints on using geothermal heating at these locations, however, can be to obtain the permission for drilling from local authorities, which are obliged by the Russian low to protect *resources of mineral waters*. The second main geothermal reservoir is confined in the Alpine area of the Northern Caucasus, namely the *Khankala*, *Makhach-kala*, *Kyasula* and *Tarumovka* areas.

In the Dagestan Republic geothermal energy for district heating has been used for the last 50 years. Some towns like Makhach-kala or Kizlyar have district heating systems, which partly cover their heat demand. In total, geothermal heating is supplied to about 200 000 inhabitants of those towns. Additionally, geothermal heat is utilized in green houses of total surface of about 80 000 m^2. In Kayasula, located in south part of Stavropol territory close to Dagestan, a project has been planned to utilize high enthalpy geothermal brines for electricity generation. Nearby Neftekumsk is also an interesting area in this respect (See DANCEE Strategic Action Plan, Kayasula Field, Stavropol Region).

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. Within this area, in the town of Yaroslavl, some geothermal activity has taken place during the last ten years. One well was drilled to a depth of 2000 m and this well is still fully equipped for use. A full set of confirmative hydrodynamic tests was performed, but possible yields still have to be precisely calculated, as there was no suitable submersible pump. The potential in this area seems sufficiently promising for further studies to be made. As for further technical description of potentials, – water temperature, depth of drilling and geological structure, etc - , the reader is referred to the footnotes.

Table 13 shows the capacities of GE in Russia, distributed according to different forms of direct use. Table 14 displays the number of geothermal wells drilled, for different purposes and include information on wellhead temperatures.

Table 13: Geothermal Direct Uses In Russia (1.01.2000)

Use	Installed capacity (MW)	Annual energy use (TJ/yr=1012J/yr)	Capacity factor
Space heating	110	2 185	0.63
Greenhouse heating	160	3 279	0.65
Fish and animal farming	4	63	0.5
Agricultural drying	4	69	0.55
Industrial process heat	25	473	0.6
Bathing and swimming	4	63	0.5

Table 14: Wells Drilled For Electrical And Direct Use Of Geothermal Resources From January 1st, 1995 To December 31st, 1999

Purpose	Wellhead Temperature	Number of wells drilled (Electric power)	Number of wells drilled (Direct use)
Exploration	All	40	90
Production	> 150°C	20	
	150-100°C	6	16
	<100°C		184
Injection	All	12	16
Total		78	306

3.3.2 Organizations Responsible for Geothermal Energy Development

3.3.2.1 Government

At the central level, the Ministry of Fuel and Energy of the Russian Federation plus the Departments of Strategic Development have broad expertise in energy planning in Russia, including the role of renewables such as GE.

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

In Central Moscow Region, the Russian (Krzhizhanovsky) Power Engineering Institute (ENIN) has a grand 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.

3.3.2.2 Private Sector

In recent years a number of private companies have become involved in exploration and utilization of GE in Russia. Private companies in the GE sector include *Geotermneftegas*, *Neftegasgeoterm*, *Geoterm*, *KamES* and *Energiya-M*. In addition, semi-public enterprises also play a role in development of GE. In Northern Caucasus, the government enterprise *Podzemgidromeneral* Institute construct installations for extraction of chemicals from thermal brines.

Non-Governmental Organizations (NGO) advocating for development of GE in particular, hardly exist in Russia. Several universities and other research institutions, however, do work to promote GE. GE research in Russia is coordinated by the special Scientific Council on Geothermal Problems, under the Russian Academy of Sciences. Also, the Moscow State University has researchers working with geothermal energy. ENIN, the Power Engineering Institute turned research organization for utilization of renewable energy sources has significant expertise and experience with GE development, including the supervision of the Stavropol Geothermal Pilot Plant in Kayasula. Extensive information about ENIN is available at; www.mtu-net.ru/lge.

In Russia, an "Energy Carbon Fund" (ECF) has been set up, under the auspices of the Unified Energy System of Russia (UESR). With 660 000 employees, and partly state owned (53 per cent), UESR control about 90 per cent of heat production in Russia as well as 74 per cent of electricity generation. The ECF is designed as a revolving investment mechanism for implementation of energy efficiency projects in the energy sector and energy saving measures in industry and municipalities. A Council with representatives of the Russian Parliament, Ministries, regional administrations and public delegates governs the ECF.
The ECF is meant to perform the following functions:

- Coordination and implementation of GHG emission reductions
- Develop a pilot corporate emission-trading scheme
- Identify, design, finance and implement GHG reduction projects
- Provide the Russian co-financing part of JI projects
- Supervise JI projects and reinvest proceeds from JI
- Prepare a national system of monitoring, reporting, GHG registry and trading.
- Provide legal and methodological support to JI project developers in Russia.

These functions are meant to operationalise Article 6, Article 17 and other articles of the Kyoto Protocol. A GHG reduction project portfolio with an estimated value of more than USD 25 billions has been identified.

3.3.3 Institutional Factors Governing Geothermal Energy in Russia.

The link between the 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 IFIs, does not work in the case of Russia. One reason is inadequate legal and market institutions, and the ensuing need for broad institutional reforms. An institutional (economic) view of Russia there is consequently required. For instance, the many institutional weaknesses mean dependence on other means of transaction and regulation, such as third-party arbitration, emphasis of personal trust and long-term relations. Joint ventures are one important means of overcoming such institutional barriers.

3.3.3.1 Laws and Regulations

As most other investments, the feasibility and attractiveness of GE-investments depend on a certain amount of legal and regulatory rules being observed and enforced. In general, the Russian state bureaucracy is said still to be at an early stage of adjusting to the needs of a market economy and the legal situation still best characterized by an "enforcement gap". Civil society is too weak to control the public administration, and the objectives, functions and competences of governance structures are often poorly defined, leaving room for both "discretionary" manoeuvring of bureaucrats and rivalry between different agencies and branches of government. New laws and frequent revisions to existing laws, along with conflicts between local, regional and federal laws, and lack of enforcement mechanisms further add to this problem. On the whole, however, now the Putin government is seen as actively and rather successfully rebuilding the authority of the state and revitalizing Russia's transition to a market economy.

3.3.3.2 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, include 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 metering 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, at what terms the major power producers is obliged to buy power from other producers.

Federal and regional government energy efficiency funds are financed with taxes on energy sales, and allocated funds to investment projects. By 1995 a few such funds operated successfully.

3.3.3.3 Russia's New Energy Strategy

Russia's long term energy strategy objectives can be summarized 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
- Increased volume and potential for energy export.
- Ensure 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 gradually replace the conventional energy sources. At the same time it is noticed that the country's nine existing plants all are old, and in a matter of 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 through 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, 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, a number of important legal and regulationary steps have been taken, including in the area of taxes, investments and price policies.

Despite signs of economic recovery the output of the energy sector in terms of discoveries of oil and gas and investments have not gone up as much as the strategic plans have forecasted. These strategic goals, therefore, remain goals. Most important, and most surprising, is maybe that the energy intensity of the country hasn't decreased as desired. Actually it has increased by 20 per cent compared to the period before the reform. The aggressive and planned structural changes in Russia are described in a number of English-language documents[20].

3.3.3.4 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 organizations are envisioned, including support from the GEF. Thus, a proposal for a project: "Promotion of Renewable Energy Development in South Russia" has been given full and official support[21]. This allocation – as well as the similar allocation for an energy savings programme - may be seen in the context of a World Bank study on the promotion of Renewable Energy in Russia, and the so-called "Stavropol Renewable Energy Project". It reflects a stated ambition of the Russian policy to increase renewable energy use several times during the next ten years. This strategy attach much importance to heat supply issues in several regions, and is based on the fact that RE in Russia has a "region specific" nature, with RE resources unevenly distributed across the country. In this strategy, South Russia has been identified as one of the regions where the "economically justified capacity of renewable energy resources is rather large" (ENIN).

[20] These include: "Basic Provisions for the Structural Reform in the Sphere of Natural Monopolies" and "Action Programme for the Restructuring, Privatization and Stronger Control in the Sphere of Natural Monopolies"

[21] Letter to Julian Schweitzer of GEF from Head of Department of Environment Protection and Ecological Safety, Mr. A. Amirkhanov , Ministry of Natural Resources (MNR) of the Russian Federation.

The South Russian Renewable energy scheme has the following objectives (according to the plan of the Russian Federation and international investors):

- Implement measures to eliminate barriers to promotion of renewable energy
- Prepare investment projects to ensure utilization of geothermal, solar and wind energy units in South European Russia.
- Prioritise renewable energy supply for state nature reserves
- Review the regional resource base
- Prepare feasibility studies and project documents for RE projects
- Propose a regional training and data centre on RE established
- Develop a concept for establishing institutional and financial mechanisms to implement RE projects
- Arrange an international workshop on promotion of renewable energy development in South Russia.

Among the particular obstacles identified in the Russian development plans, the Russian Power Engineering Institute (ENIN) has emphasized inexperience in the establishment and operation of modern double-circuit geothermal heat supply systems and binary low-boiling geothermal power plants as major obstacles to a rapid and efficient development of large geothermal energy reserves in South Russia.

3.4 International Collaboration on Geothermal Energy Development in Russia.

3.4.1 Danish – Russian Collaboration on GE and Environment

So far, the Danish – Russian collaboration on GE has been explorative. In Kaliningrad, the Danish Energy Agency (DEA) did in September 1994 grant DKK 450 000 for the initial phase of a study titled: "Development of Geothermal Energy in the Kaliningrad Region". The final report is to be issued by Danish Oil and Natural Gas (DONG) in 2001 and will comprise calculations for a row of geothermal case studies. The appendix: "Preliminary assessment of Geothermal Aquifers in the Kaliningrad Region, DONG, 20th February 1996" was made with the assistance of Petroleum Geology Investigators (PGI).

The Baltic Region has priority in the Danish-Russian co-operation and the possibility of using geothermal energy for the supply of heat to district heating networks in the Kaliningrad Region has been preliminary investigated by DONG in co-operation with the Russian company Gas-Oil. The screening phase for geothermal aquifers was reported on in February 1996. Information about district heating network conditions has been gathered and options for the construction of a demonstration plant has been discussed since then. The project has received local support, but the central government has given it low priority due to the possible existence of more obviously suitable locations for geothermal plants in Russia, and the project has only progressed slowly. The present status for the project is, that some sites have been selected for a more detailed evaluation/demonstration project.

3.4.2 The World Bank Group

Acting on a request to undertake a study of potential geothermal energy development in Russia, the World Bank recently carried out a study, focusing on identification and removal of institutional and technological barriers for broader utilization of this form of energy (Aide Memoire, 2000). The bank sent a fact-finding mission to Russia in May 2000 to obtain basic information about certain proposals and potential project ideas. The mission met representatives from the Russian Academy of Sciences and Ministry of Fuel and Energy and discussed the available material on geothermal energy in Russia.

The development of non-traditional energy sources on the basis of geothermal fields of Russia is one of the priority purposes of long-term cooperation between the Russian Ministry of Energy and the World Bank on the problems of GHG emission reduction.

3.4.3 The EBRD

While stressing that the sustainability of the impressive recovery strongly depends on the continuation of systemic reforms, the EBRD view of Russia is sufficiently optimistic for the bank to have announced a step-up of its activities, including those in the infrastructure and environment sectors. As far as the latter is concerned, the EBRD foresee collaboration with grant donors, in projects with "environmental rationale". The bank sees such projects as requiring a pro-active approach, and as being contingent on availability of donor grant funds being offered to partially cover investments. While EBRD commitments and disbursements to Russia may appear moderate in recent years, the level of investment is picking up again now nearing the pre-crisis level. Thus, during the first half of 2000, the bank signed investments in Russia totalling EURO 263 million, expecting a full-year commitment of up to EURO 750 million. In addition to the investment projects, the Bank administered 441 technical cooperation projects with a total of EURO 216 million made available by other donors.

In Kamchatka, the bank is involved in exploration and use of geothermal resources, which exceed several times the regional needs and amount to an electrical capacity 2 000 MW and a thermal capacity up to 5 000 MW. One rationale behind GE in that regions is that tariffs for power are the highest in Russia and are considerably higher then those in the world, today up to 12 cent/KWh. In the Kamchatka GE projects, the resulting decrease of CO_2 discharges are being prepared for sale at international market as a part of Russian quota.

"Geotherm" PC, together with RAO "EES of Russia", EBRD, with the support of the Government of Russia and the administration of the Kamchatka region, realizes the large power project (Mutnovsky GeoPP 50 MW) according to international rules for the first time in Russia. A license (for 30 years) for Mutnovsky steam field (> 300 MWe) has been sold or issued to "Geotherm" PC.

3.4.4 The Position and Potential of Danish Companies in Russia

The potential for Danish involvement in development of GE in Russia is high. Staff of the Danish Company Houe & Olsen recently participated in a World Bank Geothermal project identification mission to Russia and DONG is also active in terms of collaboration with Russia. Among the activities carried out by DONG in Russia, is a technical study of the prospects for GE in the Kaliningrad region. Further, the Danish Consulate General in St. Petersburg is actively involved in advising initiatives in GE, as part of its general responsibility.

3.4.5 The Level Of Competence, Local Companies

Martinot (1998) stresses that Russia's technological infrastructure, scientific and technical knowledge, engineering and technical skills, factories and equipment are all well developed. Russia's capacity to develop and produce energy efficiency and renewable energy technologies are excellent.

3.4.6 The Role of DANCEE Local Project Coordinators

The DANCEE has appointed both a Programme Coordinator (PC) for the Federation of Russia (based in Copenhagen, DEPA) and a Local Project Coordinator (LPC) for the NW Region of Russia (based in Russia). In addition, activities in St. Petersburg and Kaliningrad are coordinated by another PC, also based in Copenhagen (DEPA).

3.4.7 Co-Financing Options and Record of IFI Collaboration

The options for co-financing between DANCEE and IFI´s are very clear in the case of Russia. Besides the EBRD involvement in Kamchatka, the World Bank is promoting renewable energy projects and geothermal energy pre-feasibility studies in the European part of Southern Russia. Meanwhile – in pace with the enlargement of the European union – NEFCO is expected to gear up its activities in Russia.

3.5 Summing Up

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 developing independently. 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 sources and will remove some of the indirect subsidies that currently distort the energy market and disfavour renewable resources.

The technical potential for GE in Russia is much greater than what is currently being utilised. 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. A number of potential geothermal sites have been clearly identified, with favourable characteristics in terms of high water temperatures at relatively shallow depths.

In *Kaliningrad* and *St. Petersburg*, the geo-technical potential 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 still are 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. The MOU will feature 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 in these years with the existing old district heating systems. It is unclear to what extent the municipalities of e.g. 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 be neither de-jure nor de-facto responsible for maintenance of buildings, let alone energy efficient investments. In the long term it is possible that future homeowner 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.

3.6 References

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3.7 List of Institutions Visitet and Individuals Met

The Danish-Russian Institute for Energy Efficiency (RDIEE)
Mr. Alexander Krolin.

S.C. Geotherm
Dr. Grigory V.Tomarov, Director General

Power Engineering Institute (ENIN)
Dr Michel I. Saparov – Centre for Preparation and Implementation of International Project in Technical Assistance.
Mr. Vladimir Kabakov, Marketing Department, Manager
Dr. Viktor

Energy Carbon Facility
Russian JSC "Unified Energy System of Russia"
Mr. Yuriy Fedorov

Ministry of Fuel and Energy of Russian Federation,
Dr. Prof. Alexey M. Mastepanov, Department of Strategic Development
Mr. Gennady Alexandrovitch Pavlov, Department of Research and Development.

Trade Federation of the Russian Federation in Denmark.
Mr. Igor S. Zhokin

4 Volume II.D: Country Profile - Slovakia

4.1 General Background Information

Founded as an independent country only 8 years ago (1993), the Slovak economic output reached the pre-transition level for the first time in 1999. Indicators such as state finances, current account and balance of payments also developed favourably.

In terms of GDP (table 1), unemployment and inflation however, the situation remained bleak by the turn of the millennium. Adding to this dire situation was the fact that the Slovak crown was liberalised only recently, the exchange rate de facto floating by third quarter of 1999.

Table 1: GDP Growth Rate (Annual Per Cent) 1995-1999

1995	1996	1997	1998	1999
6.73	6.21	6.20	4.10	1.90

Source: www.worldbank.org

While some complexity characterize the recent economic situation of Slovakia, the EU does overall regard the macroeconomic situation a 'stable', the legislative framework needed for business to be 'largely in place', price distortions as being eliminated and privatisation of public utilities to be progressing (EU Commission 2000).

Table 2 presents some energy-economic key figures for the Slovak Republic.

Table 2: Key Figures for The Slovak Republic

Country size in square kilometres	49 035 km²
Population size	5 399 000 (1999)
GDP per capita USD'95	4 073 (1999)
Annual energy use per capita (tonnes oil equivalent – toe)	3.3341 (1999)
Average annual growth rate per cent of energy use per capita (1990-1999)	-2.19(1990-1999)
Annual growth rate per cent of energy use per capita	2.81 (1998/1999)
TPES/GDP (toe per thousand '95 USD)	0.8183 (1999)
TFC/GDP (toe per thousand '95 USD)	0.59 (1999)
CO_2 per tonnes oil equivalent (millions tonnes/TPES - toe)	0.602 (1998)
Annual emission of CO_2 (millions of tonnes)	9.24 (1999)
TPES/TFC	1.40 (1999)
Net Import (Mtoe)	12.36 (1999)
Electricity Consumption (TWh)	26.05 (1999)

Source: A combination of statistics from various sources[22]

[22] Energy Statistics of OECD Countries 1998-1999, IEA International Energy Agency OECD 2000, www.worldbank.org, www.eia.doe.gov (Energy Information Administration), http://www.statistics.sk

4.1.1 Map of Slovakia

Source: www.countrywatch.com

4.2 The Energy Sector

While (only) 57 per cent of towns and villages are connected, about 90 per cent of the Slovak population lives in gasified areas, which means Slovakia has the second densest gas distribution network in Europe. The Slovak national gas company (SSP) is therefore the first among equals, in the energy sector with regard to distribution network. The SSP supplied 1.26 million residential users, through its gas network in 1999. This is an increase from the year before year, owing to 220 new sites being network-connected in 1998. There is a general marked tendency of individual or building heating-sources converting from solid fuels (coal) to natural gas. Gas sales tariffs in 2000 were between 6.4 SEK/m^3 and 3.6 SEK/m^3 for households.

4.2.1 Energy Supply and Consumption

By 2000 the Slovak Republic became a net exporter of electricity. It is estimated that the overcapacity – currently a gross production of 8286 MW minus a peak demand of 4330 MW - will last at least 10 years. Also Poland, the Czech Republic, Ukraine, Russia, Austria and the EU have overcapacity in electricity production.

Annual energy use per capita has dropped by 18.7 per cent on average over a 9-year period (1990-1999). From 1990 to 1994 the decrease was the greatest with the annual energy use dropping by 22.6 per cent per capita, but after 1994 it started to increase slowly (see table 3).

Table 3: Annual Energy Use (toe per Capita)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES/population	4.10	3.73	3.43	3.30	3.18	3.28	3.33	3.24	3.24	3.33

Source: IEA, International Energy Agency

Increase in energy use from 1994 and forward may reflect the growth in GDP, which the Slovak Republic experienced from 1993/1994 and onwards during the 1990's. In the beginning of the 1990's - a period characterised by a decline in GDP - the Slovak Republic saw a decline in energy use per capita. 1998, however, was characterized by a significant increase of 2.81 per cent in energy use per capita and 4.10 per cent in GDP (see table 1 and 4). Despite this periodic coupling between GDP and energy use - as exemplified above – the Slovak Republic generally experiences a relative decoupling between energy use and GDP. This is described in detail later in this chapter.

Table 4: Annual Growth Rate of Energy Use per Capita

1990/1991	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
-9.15	-7.89	-3.86	-3.75	3.27	1.37	-2.65	0.17	2.81

Source: IEA, International Energy Agency
*Example: ((1991-1990)/1990) * 100 = per cent change*
Average • (1990-1999) / 9 = -2.19

The Slovak Republic has during the 1990's managed to cut down on import of energy by 4.41 Mtoe (see table 5) from 16.77 Mtoe in 1990 to 12.36 Mtoe in 1999. This is equal to inland production having gone up by 14.9 per cent during the same time, - except during the period from 1996 to 1999, where a more rapid increase of 21.6 per cent has taken place. Again this could be linked to GDP figures.

Table 5: Total Primary Energy Supply, Net Import and Electricity Consumption

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Net Import (Mtoe)	16.77	14.45	13.46	12.47	11.84	12.49	13.26	12.77	12.56	12.36
TPES (Mtoe)	21.67	19.69	18.22	17.61	17.01	17.61	17.89	17.44	17.48	17.99
TPES – Net Import	4.90	5.24	4.76	3.14	5.17	5.12	4.63	4.67	4.92	5.63
Electricity Consumption (TWh)*	27.44	25.56	23.75	22.66	23.20	25.97	26.86	26.54	25.68	26.05

Source: IEA, International Energy Agency
**Electricity consumption equals domestic supply less distribution losses.*

4.2.1.1 Energy Supply and Consumption in Relation to GDP

As mentioned above, there is a periodic coupling between GDP and energy use. This can be further illustrated by table 6 and table 7, which both show that the Slovak Republic from 1990 to 1999 is undergoing a change concerning the coupling of GDP and energy use.

From 1992 to 1999 the TPES/GDP-ratio decreases with 27.6 per cent (Table 6) TPES – Total Primary Energy Supply decreases by 1.26 per cent from 1992 to 1999, and the 27.6 per cent decrease in TPES/GDP ratio is therefore based on an increase in GDP as well as a decrease in TPES.

Table 6: TPES/GDP (toe per Thousand 95 USD)

1990*	1991*	1992	1993	1994	1995	1996	1997	1998	1999
1.0724	1.1405	1.131	1.073	0.988	0.959	0.917	0.842	0.810	0.818

Source: IEA, International Energy Agency
**: Estimates*

Table 7 illustrates changes in consumption of energy. Also here can a decoupling between energy consumption and GDP be observed, which gives an indication of changing consumer structure and needs.

Table 7: TFC/ GDP (toe per Thousand 95 USD)

1990*	1991*	1992	1993	1994	1995	1996	1997	1998	1999
0.81	0.84	0.84	0.77	0.71	0.67	0.67	0.61	0.59	0.59

Source: IEA, International Energy Agency
e: Estimation

4.2.1.2 Energy Supply and Consumption Based on Energy Source
Changes in energy supply source are illustrated in table 8. The most significant change is a 29.1 per cent reduction in the use of coal and oil from 1990 to 1999.

Energy supply based on gas has gone up by 8.4 per cent and supply of nuclear energy by 8.9 per cent during the same period. Supply of hydro energy has increased by more than 140 per cent, also in the same period, but hydro energy still only accounts for a minor share of total supply of energy (2.17 per cent, 1999).

TABLE 8: PRIMARY SUPPLY[23] / ENERGY SOURCE (MTOE)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Coal	7.71	6.87	6.07	6.05	5.35	5.49	5.30	4.94	4.68	5.16
Oil, including petroleum	4.71	4.07	3.58	3.20	3.18	3.43	3.35	3.27	3.47	3.14
Gas	5.34	5.07	5.10	4.98	4.74	5.08	5.55	5.63	5.73	5.79
Nuclear	3.14	3.05	2.88	2.87	3.16	2.98	2.93	2.81	2.97	3.42
Hydro	0.16	0.12	0.17	0.30	0.37	0.43	0.37	0.36	0.37	0.39
Geothermal, solar, wind*	--	--	--	--	--	--	--	--	--	--
Combustible, renewable and waste*	--	--	--	--	--	--	--	--	--	--

Source: IEA, International Energy Agency
** Energy source is not significant or data not available*

Consumption of natural gas has increased from 1995 to 1998, mainly due to a rising demand from retail consumers and households. The consumption by wholesale consumers on the other hand, dropped slightly between 1996 and 1998. Also in relative terms, did gas increase its share from 29.7 per cent in 1995 to almost 32 per cent in 1997.

4.2.1.3 Consumption of Electricity
Consumption of electricity decreased by 2.5 per cent during the period 1990 – 1999 (see table 9), but from 1993 to 1999 consumption of electricity increases by 12.6 per cent. About half of the total electricity production is based on nuclear energy.

TABLE 9: FINAL CONSUMPTION OF ELECTRICITY (MTOE)*

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2.01	1.88	1.75	1.74	1.78	1.87	2.02	1.96	1.81	1.96

Source: IEA, International Energy Agency
** Nuclear energy delivers 47.7 per cent of the energy for electricity generation.*

Reflecting the whole period back to 1992, - and taking into account the new requirements for thermal quality of new buildings by 1997 - , average energy consumption for heating has dropped significantly from 190kWh/m^2 (apartments) and 340 kWh/m^2 (houses) between 1983 and 1992, to 132 kWh/m^2 and 290 kWh/m^2 respectively in 1993-96 and to 109 kWh/m^2 and 126 kWh/m^2 in 1997-99.

By contrast has household electricity consumption been quite stable, with a 2 per cent annual increase in recent years, in absolute terms. In relative terms, per consumption unit, a slight decline indicates that rising prices, low incomes

[23] Energy sources other than coal, oil and gas are based on 'production' numbers and not 'primary supply'.

and energy campaigns have caused combined effect. As for solid fuels, only wood and other bio-fuels is seen to have a potential for increasing shares, - provided new domestic technological devices find their way to Slovak households.

4.2.1.4 Energy Consumption Based on Sectors

District heating is the dominant heat supply solution. Almost 100 per cent of apartments are supplied from district heating plants, corresponding to 49 per cent of all Slovakian households. By 1996 district heating plants produced 116 PJ, of which 40 PJ was used for space heating in households. District heating supplies 25 per cent of the total energy consumption of the average household. In 1996 nearly 700 000 apartment building flats were connected to the district heating systems – about 84 per cent of all apartment building flats, and about 42 per cent of all flats. While only about 6.5 per cent of flats have individual heat sources, most family houses have an individual heat source. By contrast does 70 per cent of the 870 000 flats in family houses have central heating, the rest individual sources in each room.

Currently, there is a trend of flat owners disconnecting from district heating networks. Further liberalisation of prices and privatisation of heat plants cannot be expected to stop that. The absence of exact technical standards to regulate price calculation obscures payments for energy consumed, and consumers do not want to subsidize the producers' heat losses caused by the bad condition of the piping.

Energy use for the industry sector has been reduced by 34.2 per cent from 1990 to 1999. Changes in production and introduction of more energy efficient technology is the main reasons. This corresponds positively to the TFC-ration mentioned earlier (see table 7). The transport sector has experienced an increase in energy use by 38 per cent from 1990 to 1999. Moreover, the residential sector and the communal and public services sector are still significant consumers of energy (see table 10). Here fossil fuels are major sources of energy production.

Table 10: Annual Energy Consumption - Mtoe (TFC) per Sector

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industry	8.94	7.71	7.46	6.54	6.05	6.01	6.33	6.16	6.05	5.88
Transport	1.08	0.95	1.01	0.99	1.23	1.37	1.26	1.27	1.48	1.49
Others*	5.44	5.21	4.79	4.77	4.57	4.44	4.87	4.56	4.48	4.92

Source: IEA, International Energy Agency
**'Communal and public services' and 'residential' sectors are main 'consumers'*

4.2.1.5 Energy Supply and Consumption – Summing Up

The Slovak Republic has an energy supply, which for heating and electricity production, is based mainly on fossil fuel. For electricity supply, nuclear energy constitutes about half. The Slovak Republic imports 'energy', but has during the last decade reduced imports by approx. 25 per cent. Hydro-based energy is the only present renewable energy source of any significance.

While total primary energy supply has decreased, GDP has conversely 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.

The residential sector and communal and public services sectors consume about 40 per cent of total energy. In terms of consumption, the trend is a movement towards greater use of gas in both industry and households, and this applies for both heat and electricity. Solid fuels are expected to keep a stable share, or – as far as brown coal is concerned – to be slightly reduced. At the same time, the role of nuclear power is expected and planned to increase, as Mochovce Nuclear Power Plant is put into operation. Already, Slovakia generate 44 per cent of its electricity from Nuclear Power Plants (NPP), 38 per cent from conventional power plants (CPP) and 18 per cent from hydropower plants (HPP) (1998 figures). It is interesting to note that HPPs had an installed capacity of 2 393 MW by the end of 1999, corresponding to more than 30 per cent of total installed capacity for electricity production in Slovakia.

With an EU surplus production of electricity in the area of 40.000 MW in 2000, electricity prices in the international market may be expected to remain low.

By 1997 and 98 heat prices for households were still partly subsidized. Also the electricity and gas prices were (and remain) distorted. The result has been tendencies for consumers to disconnect from the district heating system, and to prefer individual heating based on gas or electricity.

Caused by more efficient energy technologies, implementation of the new building codes and industrial transformation, energy demands are generally expected to decrease until 2010. As far as electricity consumption is concerned however, the forecasts project that demand will increase due to more appliances. So far, such forecasts – at least one made in 1996 by the gas company SPP - have not been confirmed by real trends though. On the contrary, even electricity consumption has not increased, as could be expected based on increase in GDP[24].

4.2.2 Energy Efficiency

Energy efficiency in the Slovak republic remains by and large unchanged from 1990 to 1999. This indicates that the Slovak Republic has hardly improved the process for extracting, producing and distributing energy significantly during the last decade (see table 11). Nevertheless is Slovakia the most energy efficient CEEC, probably due to the fact that Slovakia has the second densest gas distribution network in Europe.

Table 11: TPES/TFC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES (Mtoe)	21.67	19.69	18.22	17.61	17.01	17.61	17.89	17.44	17.48	17.99
TFC (Mtoe)	16.28	14.55	13.57	12.58	12.18	12.23	13.08	12.68	12.68	12.92
TPES/TFC	1.33	1.35	1.34	1.40	1.40	1.44	1.37	1.38	1.38	1.40

Source: IEA, International Energy Agency

[24] The decline reflect that while forecasts were typically based on old-fashioned methods assuming a simple relationship between GDP and electricity demand, the Slovak economy today has already begun "*decoupling*", meaning that further economic growth is taking place with a relatively declining energy intensity.

Geothermal energy is rated as one of the most energy efficient energy sources to exploit - using today's technology.

4.2.3 Energy Infrastructure

4.2.3.1 Energy Infrastructure in General

As of 2000, the installed capacity of nuclear power in Slovakia was 2640 MW or 32 per cent of total national capacity installed. In 1999 the Slovak government decided to shut down two old units of the NPP V1 Bohunice by 2006 and 2008 respectively[25]. A Decommissioning Plan has been prepared and EURO 30 million committed to the shutdown, by the EU. Meanwhile, NNP V2 Bohunice is being upgraded (2001-2008), at a total budgeted cost of 8 billion SEK.

At the newly constructed NPP Mochovce, the first (and most likely by now also the second) of two nuclear reactor units are in operation. By 1998, more than 34 billion SEK was spent on building these units, – more than 5 billion over budgeted costs. Now, the completion of the planned 3rd and 4th unit of Mochovce is discussed. Only a foreign investor is expected to be able to provide the 51 billion SEK needed to complete these units. A 3rd and 4th unit will create difficulties for unit one and two to sell its electricity on a saturated market and since the Slovak Power Utility is burdened by interests on loans for these unit constructions (interest payments reportedly in the area of 7 billion SEK), this is a problematic situation. Simple maintenances of the construction costs 100 million SEK annually, and some analysts estimate that in order to be economically feasible, the production price of any NPP Mochovce 3 and 4 would have to be above 5 US cent/kWh – against the current market price of about 2 cent[26]. New EU safety standards will complicate any use of the planned structure (or even make using the planned and partly constructed structure impossible).

4.2.3.2 Transmission Systems

By 1998 the Slovak Power Utility (SE) – with its three regional distribution companies (ZSE, SSE and VSE) covered 80 per cent of domestic consumption, operated 86 per cent of domestic capacity and covered a significant share of heat supply to the domestic sector. The Slovakian

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[25] Gradual reconstruction of Jaslovske Bohunice V-1 Nuclear Power Plant was completed in June. As concluded in discussions with the European Commission the Government of the Slovak Republic approved by its Resolution No 801/1999 realistic dates for Units of V-1 Jaslovske Bohunice Nuclear Power Plant decommissioning. In its Resolution No 257/2000 the Government of the Slovak Republic expressed its disapproval of any form of state guarantee for the construction and operation of Unit 3 and 4 of Mochovce Nuclear Power Plant.

[26] Not included in this calculation is the total "stranded cost" in Mochovce NPP units 3 and 4, estimated at 14 billion SEK. Also not included is the costs - between SEK 68 billion (open fuel cycle) and SEK 240 billion (reprocessing) related to nuclear waste disposal. Probably it is assumed that such future costs could be covered by the *Slovak State Fund of Nuclear Energy Facilities and Radioactive Waste Disposal.* Current contributions to this fund, however, are already insufficient and subsidies from the state budget is proving necessary. In the current and future electricity market there seems to be little, if any, difference for Slovakia between import from abroad and purchase from a foreign NPP owner, except perhaps that the former solution avoids the risk and "external" costs of having an NPP within its borders.

electricity transmission system is well interconnected with neighbouring countries and works with the CENTREL and UCTE framework[27].

4.2.3.3 Combined Heat and Power Plants
Combined Heat and Power Plants (CHPs) are expected to have an increasing role in Slovak electricity and heat supply. CHPs generated 5.615 GWh in 1999, or 24 per cent of total production. The production stems from by the Slovak gas company SPP. Interest for co-generation units have increased in recent years, partly due to new legislative support (Energy Act No.70/98). While, under market conditions, district heating and CHP are the most efficient, with the lowest prices for consumers, the current (distorted) prices remain a barrier to wider spread of CHPs and an incentive for individual gas boilers.

Most (80 per cent) of the households supplied by district heating plants are located in towns, where gas distribution is present. In Kosice, for instance, Heat Power Engineering Kosice supplies 80 000 apartments with heat and 500 GWh of the electricity per year. On the national level, are district heating systems fired by natural gas (71 per cent), coal (16 per cent), oil (7 per cent) and other fuels (6 per cent).

The central location of Slovakia's natural gas transit pipeline, makes Slovak Republic a key player in the European natural gas market. SPP plan to construct an additional (fifth) transit gas pipeline and as of 2000, about 200 kilometres of that new pipeline had been constructed.

4.2.4 State-Owned Energy Enterprises

The Slovak Republic and gas transit system is an integrated part of the European gas network, importing natural gas from Russia. Also 99 per cent of crude oil is imported, mainly from the Russian Federation. Privatisation (into a joint-stock company ownership with 51 per cent of shares remaining with the state) of the national gas company SSP has been approved. The national electricity company (SE) and oil company (Transpetrol) are being privatised as well, together with the distribution sector. Steps towards an independent regulatory authority have been taken.

4.2.5 Prices and Regulation

By 2000 (February) the Slovak Government approved price increases for electricity averaging at 40 per cent for households and 5 per cent for businesses, and increases of natural gas prices and heating price ceilings as well. Thus, for example, the ceiling prices for electricity by august 2000, was 2.3 SEK/kWh (normal rate, though also with a lower tariff at 0.6 SEK/kWh) for consumers with a 4 room dwelling. By contrast, "big" consumers above 25 000 kWh annually, pay 3.3 SEK/kWh (low tariff at 0.9). Both categories pay a monthly standard fee: SEK 300 for the 4-room dwelling and between SEK 195 and SEK 1 110 for big consumers, progressively increasing with volume of consumption. Tariffs thus display a progressive rate, where the price decreases with increasing consumption. Preparations are made for further opening up of the domestic energy market.

[27] CENTREL: Central European Energy Companies Electricity System and UCTE, the West European system.

4.2.6 Environmental Issues

Among the many areas in which Slovakia strives to conform to EU standards, most environmental priorities have only been addressed to a very limited extent, according to the EU Commission (EU Commission 2000). However, a signatory to the Kyoto Protocol, Slovakia is committed to have reduced its emissions by 8 per cent in 2012, compared to the 1990 baseline level.

4.2.6.1 Main Sources of Air Pollutants
Energy consumption and production is one of the most severe sources of pollution in the country. Slovakia has been among the 20 countries with the highest amount of greenhouse gas emissions per capita in the world with 11 t/year. However, industry recession, decreasing energy consumption, installation of desulphurisation units at large power plants and fuel substitution (from solids to gas) brought a *decline* in air emissions in the 1987-1994 period. These trends have continued: The annual reduction was marked for SO_2 (from 148 603 + 25 926 tonnes in 1994 to 130 425 + 12 087 tonnes in 1998) and NOx (from 84 539 + 3 692 tonnes in 1994 to 51 877 + 5 177 tonnes in 1998). For CO and particulates, the picture was less pronounced (based on ECB 2001, tables 6.1 and 6.2, i.e. small and large sources, combined).

The central and district heating sector emits 22 per cent and the commercial and residential heating another 22 per cent of Slovakia's CO_2 emissions. Solid fuels are the main contributor to CO_2 emissions and also to ash material (from coal combustion).

4.2.6.2 Established Emission Limits
The Slovak Republic has established a set of dynamic emission levels combined with economic Instruments, fining pollution in excess of certain emission limits, and reduction targets have been established for a range of substances.

4.2.6.3 International Environmental Agreements
Besides the European Energy Charter, the SR is a signatory to the Convention on Climate Change (FCCC) and the international agreement to control transboundary emissions, including the Helsinki and Sofia Protocols (Sulphur and NOx reduction).

4.2.6.4 Emissions
The Slovak Republic has during the last decade reduced Carbon Dioxide emissions from consumption and flaring of fossil fuels by 15.8 per cent, which further has been accompanied by a reduction in SO_2 (67 per cent), NOx (42.2 per cent) and CO_2 (35.7 per cent) emissions (see table 12 and 15). Still the Slovak Republic has a high emission rate of SO_2 per capita compared to other European countries.

TABLE 12: CO_2 EMISSIONS FROM THE CONSUMPTION AND FLARING OF FOSSIL FUELS

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
Million metric tonnes of Carbon equivalent	---	---	---	10.97	10.71	11.57	11.95	11.15	10.52	9.24

Source: EIA, Energy Information Administration
** Preliminary*

CO_2 per capita emissions has from 1993 to 1998 dropped by about 5 per cent from 2 054 kg. to 1 952 kg. (see table 13). This corresponds to data (from table 14), where CO_2 emission per TPES, million tonnes oil equivalent also has dropped by approx.3 per cent. Inland energy production and imported energy has thus become more efficient concerning CO_2 emission per produced unit of energy.

Table 13: CO_2 (kg. of Carbon Equivalent) per Capita

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
---	---	---	2 054	1 998	2 155	2 221	2 069	1 952	1 711

Source: EIA, Energy Information Administration
IEA, International Energy Agency
** Preliminary*

Table 14: CO_2 (kg. of Carbon Equivalent) / TPES (Mtoe)

1990	1991	1992	1993	1994	1995	1996	1997	1998
---	---	---	0.623	0.63	0.657	0.668	0.639	0.602

Source: EIA, Energy Information Administration
IEA, International Energy Agency

Table 15: SO_2, NOx, and CO Emissions in Slovakia, 1990-2010 (in 1000 tonnes)

Component	1990	1991	1992	1993	1994	1995	1996	1997	1998	2005	2010
SO_2	543	445	380	325	239	239	227	202	179	210	210
NOx	225	204	190	183	173	181	130	124	130	n/a	n/a
CO	487	437	382	408	412	401	346	336	313	n/a	n/a

Source: http://fossil.energy.gov/international/

The Slovak republic is situated in the area of Europe with the greatest atmospheric pollution and acid rain. Ninth among European states in Sulphur Dioxide emissions, Slovakia produces four times the SO_2 emissions of neighbouring Austria (See also table 15).

4.2.7 Renewable Energy

The Slovak Republic has declared in the state energy policy that a goal for the Slovak Republic, is to base 6 per cent of total energy production on renewables.

As shown in table 16, only 2.6 per cent (1999) of total primary energy supply is based on production from renewable energy sources, whereof the majority comes from hydropower. Also solid biomass contribute to this figure although solid biomass has been reduced from supplying 162 kilo tonnes oil equivalent of energy to 76 ktoe, a reduction of 53 per cent over a 9 year period. Biomass is in other Eastern European countries considered as being an alternative to hydro- and geothermal energy.

Table 16: Contribution From Renewable Energies and Energy From Wastes.[28]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES (Mtoe)	21.67	19.69	18.22	17.61	17.01	17.61	17.89	17.44	17.48	17.99
Per cent contribution from renew. And wastes	1.5	---	1.6	---	3.2	2.9	2.5	2.5	2.5	2.6
Hydro	162	---	167	---	370	427	370	356	370	390
Solid biomass	166	---	118	---	171	78	75	83	72	76

Source: IEA, International Energy Agency

[28] Data other than per cent of contribution and TPES is worked out in ktoe (kilo tonnes oil equivalent).

4.2.8 Energy Situation

Defined as primary energy consumption relative to GDP, the Slovak *energy intensity* is still 2.3 times higher than the EU average. This is caused by a high share of energy intensive industry, since household consumption is low, compared to developed countries, and a 35 per cent decrease in total energy consumption in the agricultural sector, was evident by the first half of 2000. According to the EU Commission (EU Commission 2000), the energy efficiency in Slovakia is rather low and measures in favour of efficiency, energy saving and use of renewable energy needs to be undertaken rapidly. A low energy efficiency according to the EU Commission is contrasting to this report findings based on TPES/TFC figures, but of course, if split up on type of energy and technology, then some systems can be rated as inefficient – e.g. single household use of brown coal.

While Slovakia is a gas and oil importer, it is a producer of *brown coal*, which is the most utilised local energy resource. With a share of Primary Energy Supply (PES) of 29 per cent and overall consumption of 9 736 x 10^3 tonnes, coal is still the basic fuel. Of this, 5 376 x 10^3 was brown coal, 74 per cent of it mined locally and representing about 7 per cent of total PES consumption. In Slovakia, the department of coal mining, alone, employs more than 8 000 people, and brown coal is important since SR covers only 13.7 per cent of its PES domestically – the majority from brown coal. Staff reductions in the coal sector are expected in the magnitude of 3 600 to 7 160 people. From 2006 and due to the emission limits of *new environmental legislation*, the locally produced coal will only be possible to burn legally in special (wet gas desulphurisation or fluid combustion) boilers, of which Slovakia has only one at the moment. While the current decline in use of brown coal, is caused by a relatively high price compared to gas and the high coverage of the gas network, a new act (N0. 401/98) has been introduced, featuring environmental fees that will make brown coal economically ineffective as early as 2002. Another "disadvantage" for domestic SR brown coal is that the price is unregulated, while the regulated prices of electricity, gas and heat are probably still below market prices. While, since 1993, coal prices increased only 7 per cent, industrial commodities rose 39 per cent and consumer price index 70 per cent. This may explain why in 1999 SR imported brown coal from the Czech Republic. *Coal market prospects* are that by 2004, 62 per cent of small and medium sized coal costumers will convert go gas and – at 51 per cent - this also applies to consumers of dust coal.

Policies and Programmes
A 1992 state programme aim to reduce energy consumption among households. 10 937 flats were insulation between 1992 and 1997, and 158 projects improved efficiency of central heating sources, saving 1 331 TJ of heat and 466 MWh from 1993-98. More recently, as more and more flats have been bought by residents, private owners have proved less willing - or perhaps less able - to improve their buildings. While the new building code has contemporary requirements, an estimated 96 per cent of the Slovak dwelling stock does not have a satisfactory thermal quality.

4.3 Geothermal Energy in Slovakia

From archaeological findings in Slovakia it is known that, the use of GE in the form of thermal spring dates back to very early times, where the springs were a location factor for man. The use of GE proper dates back to 1879 where the first geothermal well was drilled in Ganovce, followed by a second in Kovacova 20 years later. In 1958 the first examples of direct use for space heating was seen (three different systems and several areas), followed by more extensive research. Slovakia's economy depends on energy import, which causes a tendency to use non-traditional renewable energy sources, of which geothermal energy represents 18 per cent. The Slovak Republic is one of the few CEEC where *installed capacity* is over 100 MW.

The *use* of GE in Slovakia today is for multiple purposes, including for 13 agricultural farms (about 27 ha of greenhouses and some soil heating), fish farming, space heating and recreational purposes. While the total use figure is 130.97 MW (and 846.4 l/s of Geothermal water) the total yield from the sources is 269.95 MW (and1 672 l/s of Geothermal water, respectively). The effectiveness and technological level is fairly low, due to seasonal use and low efficiency of the technical installations.

Today, 26 prospective areas and structures with exploitable geothermal energy potential have been identified, based on work carried out by the Dionyz Stur Institute of Geology in the 1980´s (now Geological Survey of the Slovak Republic). The potential resources represent 5 538 MW and are located at depths between 200 and 5 000 metres, with water temperatures ranging from 20 to 240°C. In 14 of the prospective areas, further explorative work has been done. While the remaining 12 areas still await verification by drilling, 6 of these have been geologically assessed.

4.3.1 Areas and Projects

As per June 1999 8 *counties* in Slovakia had GE utilities, yielding and/or using geothermal water and thermal power. These were Trnava (11 localities), Nitra (9 localities), Zilina and Banska Bystrica (5 localities each), Trencin (3 localities), Presov (2 localities) and Kosice (one locality). Bratislava is included in this list, but based on potential only and with no use figures (see table 17).

Table 17. Distribution of Utilised Geothermal Energy Sources in Counties of The Slovak Republic

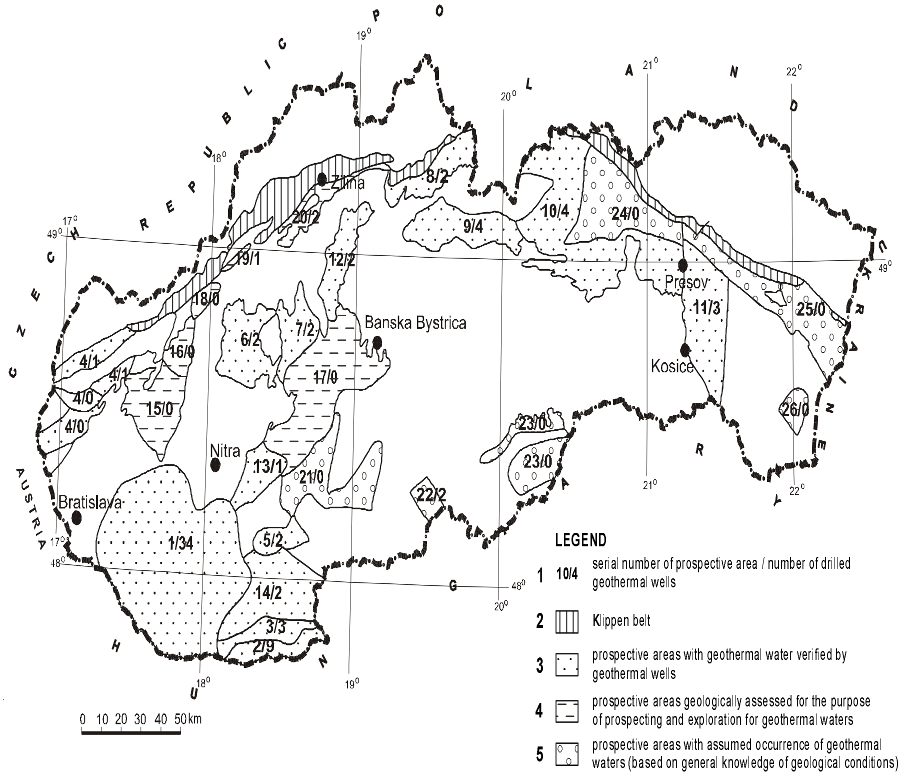
County	Number of Localities in Utilisation	Yield [L/S]		Thermal Power [MW]	
		Total Yield	Utilised Yield	Total Thermal Power	Utilised Thermal Power
Bratislava	0	30.2	0.0	4.42	0.00
Trnava	11	332.2	211.2	72.27	44.47
Nitra	9	469.2	295.7	57.57	40.13
Trencin	3	30.9	30.2	4.54	4.49
Zilina	5	312.6	184.0	35.25	25.56
Banska	5	131.3	54.2	9.39	5.15
Bystrica	2	172.6	70.5	26.87	11.16
Presov	1	195.6	0.6	33.54	0.01
Kosice					
Total Amount	36	1672.0	846.4	269.95	130.97

Source: (Fendek, Franko, Cavojova, 1999)

In spite of the high level of geological research and investigational studies in Slovakia, the effectiveness and technological level of geothermal energy utilisation is very low. The first reason is the seasonal utilisation, the second is the low efficiency of geothermal installations.

Geothermal water is used in 13 agricultural farms (greenhouse heating, soil heating), in four localities for heating of service buildings, in one locality for sport hall heating, in two localities for fish farming, in one locality for restaurant heating and on 30 localities for recreational purposes. Distribution of geothermal energy sources in districts of the Slovak Republic is shown on Fig. 1. The total amount of geothermal energy utilised in 36 localities represents thermal power of 130.97 MW and 846.4 l/s of geothermal water (Table 17).

Figure 1: Geothermal Potentials in Slovakia



Utilisation of heat in agriculture provides great possibilities for early production of vegetables (cucumber, tomatoes, peppers, aubergines, etc.) and flowers. Use of fossil fuels is however too costly and geothermal water can provide an economic answer. The total area covered by greenhouses is about 27.36 ha. It follows from Table 4 that the highest amount of the utilised sources of geothermal waters is situated in Trnava County and represents 44.47 MW (Fendek, Franko, Cavojova, 1999). Slovakia does not use GE for electricity generation yet, but funds have been allocated for geothermal electricity production in the order of 6 GW/yr, projected for use by 2005. In northern Slovakia a company "*Esgeoterm*" is said to be involved in a Polish-Slovakian collaboration on this front.

The geothermal energy potential does in many cases fulfil economic 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. Up to 1995, 27 perspective geothermal areas have been identified whereof 22 are situated in the Inner West Carpathians. The remaining 5 are situated in Neogene basins (3) and in volcanic rock (2).

TABLE 17: EXISTING GEOTHERMAL PROJECTS AND SITES

Geothermal Utilisation Project	Geothermal Province	Area km²	Temperature °C*	Drilling Depth Metres
Galanta Town	Danube Lowland	N.A.	78 – 100 °C	Approx. 2000
Košice Town / Durkov Poprad Liptov Skorusina	Inner Carpathians	N.A.	(115) – 120 °C	Approx. 2100 – 3200
Ziar Nad Hronom	Neovolcanites	N.A.	100 °C	Approx. 2500

Source: www.geothermie.de and Bulletin d'Hydrogéologie, no 17, 1999
** The source seems to have no indication of whether this is reservoir or wellhead temperature.*

4.3.1.1 Danube Lowland
The Danube basin is mainly characterized by Neogene clastic rocks and sand deposits. The aquifers have a high permeability, which determines the transmissivity of geological formations.

4.3.1.2 Inner Carpathians
The *Inner Carpathians* are characterized by limestone and quartz as top layer sediments and Mesozoic rock as underlying layer. Sub regions often have unique conditions due to geological activity, which can cause faults, depressions and ridges that require special prerequisites for utilisation of geothermal water.

The geothermal power plant supplies the town of *Košice* with geothermal heat in the amount of 100-110 MW is based on 8 production wells and 8 re-injection wells. The perspective for the utilisation of geothermal energy in this region is about 300 MW. Surveys also suggest a potential use of geothermal waters for production of electricity. The Košice basin is filled with Quaternary sediments on the surface and underneath is Neogene sediments, with a base layer of Mesozoic rock. Geothermal energy utilisation in Poprad, Liptov and Skorusina basins all have to complement the existing energy production in their respective regions, which mainly supply the tourist trade sector (hotels, spas, ski and water sport facilities etc.). Geothermal water in these areas is suitable for space heating of homes and other buildings, for the heating of ponds in which fish are raised, and for greenhouse heating.

4.3.1.3 Neovolcanites
Potential utilisation of geothermal energy in the Ziar basin is based on results from feasibility studies (1999) showing water temperature at around 100 °C in a depth of approx. 2 500 m. in Triassic dolomites and limestones. So far the water has not been extracted for energy use.

4.3.2 Organizations Responsible for Geothermal Energy Development in Slovakia

At the level of government, the Slovakian *Ministry of Economy* is the governments' 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 its 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, Slovak household electricity prices do not yet (as of early 2000) cover production costs. 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 the SR. 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. With project contributions in 1995, 1999 (Ziar nad Hronum) and 2000 (Kosice), Denmark (DANCEE) allocated a total of DKK 11.9 million for geothermal projects in Slovakia

At the regional level the most intense use of geothermal energy is in town of Galanta, where geothermal is the primary energy source for the district heating system.

The two most important *private sector* players in the geothermal energy field in Slovakia are *Slovgeoterm* and *Galantaterm*. (See also case studies of Kosice and Galanta). Currently, Houe & Olsen from Denmark, is participating in work on the geothermal project in Kosice city, Eastern Slovakia. Not so long ago, two companies formed a group Geoterm Kosice together with Slovak Gas Company and Kosice Municipality.

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 the 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 organizational “landscape” of organizations with capacity and experience in the field of geothermal energy planning, there is good reason to assume that in the case of geothermal energy, the prospects for efficient collaboration, between the central and local governments and the private and non-governmental sector in Slovakia, are excellent and very promising indeed.

4.3.3 Institutional Factors Governing Geothermal Energy in Slovakia.

4.3.3.1 Laws and Regulations

Indirectly, the “Air Protection Law” will give GE a relative comparative advantage over other – more polluting – technologies. The law is founded on the principle of “best available technology” and determine emission quotas. These principles not only apply to newly built sources of air pollution, but also existing sources have assigned terms to fulfil stricter criteria and regulatory standards, with fees increasing every year to reach a high level set for 2004.

4.3.3.2 Policy Instruments in Place, Directly or Indirectly Promoting GE

It has been said that in Slovakia, there are few effective legislative, economic and fiscal instruments in place to influence energy consumption and to reduce the energy intensity of the national economy (ECB 2001). However, the following existing instruments can be mentioned:

- 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 one innovative financing mechanism. Finally, joint implementation or allowance trading is included in the available instrumentation[29]. The funds allocated in the state budget for support of improved energy efficiency are relatively small, however, compared to Europe at large.

This mix of instruments may be too modest to induce energy efficiency as a feasible alternative to adjusting fuel and energy prices to market levels. However, numerous acts and directives do illustrate the increasing understanding of the necessity to be energy efficient. Thus, 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)[30]. Also the income tax act (No. 286/92) imply some advantages to installation of RE in the first five years of operation. The air protection act also employ fines to unauthorized polluters, and these fines are progressively depending on the volume and nature of pollution.

4.3.3.3 Energy Policy and Strategy

The 1999 *Slovak Energy Policy* focus 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 turn focus on market liberalisation, including a schedule for energy price adjustment and tariff modifications, as well as regulation of monopolies and establishment of an independent regulatory body. In concrete terms, this means that in the future, anyone who fulfil standard technical requirements will be given access to the energy grid, and have the right to produce, buy and distribute power, gas and heat. State intervention in the sector is meant to be minimized. In effect, the new act implement all EC Commission (White Book) requirements, except full third party access to the Slovak energy market.

The policy will allow big energy consumers in Slovakia to trade directly with energy suppliers. The definition of "big" in this context is dynamic, scheduled to decrease from above 100 GWh by January 2002 to >20 GWh by January 2004. Further, the policy address energy conservation, announcing a

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[29] These two mechanisms allow transfer of (foreign) investments into more energy efficient/renewable energy generation/use technologies.

[30] That is: renewable or secondary heat sources, from combined heat and electricity production and from heat suppliers. This is provided that the price of the supplier does not increase or energy efficiency of other heat sources in the system does not lower. Also, the law determines that connection of heat sources into the delivery systems is made on financial costs of heat producer from renewable or secondary heat sources or from combined heat and electricity production.

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.

Energy price increases have triggered an increasing public awareness about energy issues, including environmental awareness of the effects of high-sulphur, coal fired power plants. The new energy act is aimed at liberalising the energy sector in accordance with the European Energy Charter, ratified in 1995. The energy act replaces the 1957 electricity act, the 1960 gas act, the 1987 acts on energy inspection and the act on production, distribution and consumption of heat (also 1987).

The overall strategic aim of the SR energy sector policy is to satisfy national energy needs in a reliable, safe, effective and ecologically acceptable way, while fulfilling international agreements, reducing energy intensity to the EU level and increasing the share of RE in PES coverage. In general, renewable energy (RE) has been included in the energy planning documents of the Slovak Republic, according to which, RE has a potential of 4 per cent of the primary energy resources available for the 2005-2010 period – equivalent to 40 000 TJ/year. At 18 per cent, GE ranged 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, particularly biomass whereof only about 30 per cent of the potential is currently used (1997 figure), may not be realized in the absence of direct or indirect support through energy legislation.[31] It is planned though, to establish an "Energy Savings Fund" and make some amendments to the tax regulation, increasing the "excise tax" on fuels and energy, and exempting "non-traditional" energy sources and CHP from costumes regulation.

As for GE in particular, the Ministry of Environment and the Ministry of Economy of the Slovak Republic jointly prepared a "Conceptual proposal of geothermal energy utilisation 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.

4.3.3.4 National Funding Sources for GE Development

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 (www.sea.gov.sk/projekty_source.htm).
- Support from the State Environmental Fond (www.zpnet.sk/sfsr.html).

[31] RE in Slovakia covers only about 3 per cent of PES consumption, primarily in the form of hydropower. Compared to say Sweden's 18 per cent biomass share of PES, Slovakia's is at 0.16 per cent. The Slovakian Energy Policy, however, is to raise the share of RE from the current 23 PJ to about 55 PJ in 2010. In Slovakia, GE was estimated to generate 338 GWh/year (and 1 217 TJ/r) and have a "technical usable energy potential" in GWh/y of
6 300 and in TJ/y 22 680. This means that GE constitute about 23 per cent of the RE potential in Slovakia (Based on table 5.2, ECB 2001).

- Support from National Agency for Development of SMEs, including a Supporting loan programme and a micro loan programme (www.nadsme.sk/financne.htm).

4.3.3.5 Status Vis-a-vis EU Assession

With Slovak exports to EU accounting for 60 per cent of all its exports, the Slovak economy is de facto highly integrated with the European Union. Politically, the Slovakian National Programme for the Adoption of the Acquit (NPAA), 2000 version, outlines a strategy for its accession. Financial assistance from EU to Slovakia planned for the 2000-2002 period reached a target figure of more than 100 million EURO (EURO 49 million from Phare, EURO 18.3 million from SAPARD and annually between EURO 36.4 and EURO 57.2 million from ISPA).

Slovak aspiration for EU membership is also shaping the course of its energy sector, and already in 1995, Slovakia accessed the European Energy Charter[32]. However, the approximation in this area, as in others, has been complicated by economic restructuring and its social impacts.

Achievements in Terms of Harmonizing Energy Sector Standards with the EU

The (amended, 2001) Energy Act will serve as the basis for the further implementation of the relevant EU Directives governing the internal energy and gas market and opening of the market to eligible customers. The key piece of legislation governing the field of energy efficiency will be the Act on Energy Efficiency. The Act will enter into force in 2002. With the adoption of this act, a legal framework for energy efficiency will be established and the Slovak legislation governing this field will be in compliance with the European *Acquis* Communitaire. An independent Regulatory Authority is expected to start its activity (licensing, price regulation and antimonopoly, competition) on 1 January 2002.

4.4 International Collaboration on Geothermal Energy Development in Slovakia

Danish companies in the field of geothermal energy have longstanding experience working with district heating in Slovakia, and in particular the company Houe & Olsen has extensive credentials in this regard. With three geothermal projects in the 1995-2000 period, Denmark and the Slovak Republic have a well established record of collaboration in the field of geothermal energy use and development.

Further to the projects already implemented, the international unit of the Slovak Ministry of the Environment has received several expressions of

[32] The Energy Charter Treaty is the basis for an energy community between east and west and provides for improved conditions for investment and trade in the energy sector.
Signed in December 1994, the Energy Charter Treaty unites 49 states.
The Charter facilitate energy co-operation and the creation of a stable and reliable legal framework and improve the security of energy supply. The Energy Charter Treaty covers, trade, investment protection and transit rules as well as binding dispute settlement procedures on a multilateral basis. The Energy Charter Treaty, therefore, could significantly improve the climate for sound investments and secure and undisrupted trade.

interest with regard to future geothermal projects, including one in Dolny Kubin, submitted by the independent expert Mr. Juraj Franko.

Besides city councils, government authorities and private companies with a record of making geothermal investments in Slovakia, a number of foreign companies and international finance institutions are already investing (or have shown interest in investing) in GE in Slovakia. So far demonstrated assistance from international finance institutions to geothermal energy has been given by the Nordic Environment Finance Corporation (NEFCO) and the Nordic Investment Bank.

It is yet unclear to what extent the EU may support GE in Slovakia under the SAPARD, where GE may be seen as contributing to sustainable rural development, increasing jobs opportunities, - both directly and indirectly (horticultural uses, etc).

The same does apply to ISPA, though ISPA has declared interest in the geothermal company Slovgeoterm, with an application for assistance in the order of EURO 20 million, for drilling an additional 7 + 6 wells in the Kosice geothermal area.

4.5 Summing Up

This analysis confirms that in Slovakia, actions are well underway to restructure the formerly state-owned, now partly privatised energy sector and implemente long-term policies, as well as provide more oversight and coordination of the sector. As a result, one can 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, and that harmonisation of the Slovak energy legislation with the EU energy policy 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-industrialized society with generation of GDP from the tertiary sector and other less consuming businesses.

Thanks to current surplus capacity 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 does however 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 this goal is to be reached, 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 geothermal 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, it 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 somehow indirectly improved the conditions for geothermal project investors. The new laws have opened up to 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 prepared for development by new actors, - be they private or public. Traditionally, the Slovakian municipalities have committed themselves financially to geothermal project investments. The municipalities, however, 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. In order to bring about a “take off” situation, external financial support and investments are needed. The existing government programmes and economical policy instruments (green taxes) are insufficient to trigger geothermal energy development, without such investments from outside Slovakia.

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4.7 List of Institutions Visited and Individuals met

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4.8 The Case of Kosice

Name of Project: Kosice Project Phase I and II	
City/Country: Slovak Republic	
Name of Local/National Project Counterpart: Slovgeotherm/ Houe & Olsen (NEFCO and NIB)	
Status of Project: Ongoing	
Initiation of Project (date): January 2000	
Completion of Project (date): Ongoing	

People met during the mission: Representatives of Slovgeoterm, Bratislava

I. Project Background

In 1996/97 geotechnical tests investigated the potential for geothermal plants in Slovakia. Promising localities were found, including Kosice and Ziar nad Hronum and DKK 3.55 million were granted for geothermal projects in the country. The Kosice project was promising, but local politicians disagreed among themselves about the future of heat planning and the city administration followed several plans at the same time, one involving technical collaboration with and grants from Denmark and another with France. At the time, therefore, a decision was made from the Danish side to "pull out" of Kosice.

Four years later, in January 2000, the Danish Environmental Protection Agency granted its support to a project described in Houe & Olsens' application of December 1st 1999, following earlier assistance to the implementation of geothermal district heating in Kosice, Slovak Republic.

In April 2001 a technical (geological and geophysical) test carried out by the company Slovgeoterm confirmed the technical viability of using GE in the Kosice basin (Slovgeoterm. 2001. The well testing in Durkov Geothermal structure. Bratislava). In brief terms, the test confirmed that the temperature, hydraulic and hydro-chemical properties of the reservoir were stable (the test enabled modelling reservoir conditions for 30 years ahead) and could thus supply the 60 000 dwellings to be served under the planned Kosice project.

II. Project Description

With SLOVGEOTERM as the beneficiary and Houe & Olsen the project holder, the project (phase I of two phases) covers equipment for erection of a pilot plant and technical assistance to the project. Phase I, completed in year 2000, included testing; elaboration of technical solutions; contracts with local stakeholders in order to ensure commitment; establishment of Geoterm Kosice (shareholders should be identified); investigation of existing installations; district heating systems and plants; and finally identification of investors. Phase II (year 2001-2004) included design; procurement; installation of equipment; drilling and test of new wells; financing; organizational set-up; contracts (heat price structure); and the first year of operation.

Main Project Objectives
The main objectives is to establish a geothermal system in the city of Košice to exploit a local environmental friendly energy resource in order to decrease the emission of polluting elements from the existing coal fired boiler plants. In addition the geothermal project should demonstrate that geothermal energy can substitute fossil fuels and at the same time be cost effective.

The implementation of the project is divided in two phases (Phase I and Phase II).
The tangible objectives of Phase I (2000), was to:

- Provide equipment (worth 1476.000,00 DKK) for erection of a pilot plant and technical assistance to the project.
- Perform long term testing of the existing geothermal wells (GTD-1, GTD-2 or GTD-3).
- Elaborate technical solutions for exploitation of geothermal fluid with a high content of CO_2.
- Contract with the local electricity company, district heating company, municipality etc. in order to obtain local commitment to a geothermal system.
- Establish the new shareholder company GEOTERM Kosice a.s. Shareholders shall be identified during Phase I.
- Investigate the existing district heating system, consumer installations and district heating plants located in the city of Kosice.
- Identify investors.
- Make conclusions and Recommendations.

The conclusions and recommendations formed in Phase I are considered as a milestone, which will determine if Phase II shall be initiated or not. The evaluation of different options will be based on both technical and economical criteria.

Phase II (year 2001 - 2004) comprises the following main activities:
1. Design, procurement, implementation of technical installations like pipe network, renovation of substations, new heat central, well-site installations etc.
2. Drilling of new wells
3. Test of wells
4. Financing (international investors)
5. Organizational set-up (new heating company)
6. Contracts (heat price structure)
7. Commissioning of the different technical facilities in steps
8. First year of operation

Project Inputs
The Danish input is a grant of DKK 1 476 000 (Equipment only). According to Slovgeoterm Project Manager Vladimir Benovsky, completion of the project will require USD 60 million. A loan of USD 15 million is to be provided by the World Bank, with some resources to come from shareholders of Geoterm Kosice, and the rest to be covered by bank loans. EURO 15 million from the ISPA fund have also been allocated for the project.

III. Project Effectiveness

The environmental effects from the project (reduction in emissions) have not yet been quantified. Likewise, the economic/financial effectiveness in terms of cost/benefit or results versus resource inputs, has not been quantified.

IV. Project Results/Impact

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. The geothermal waters have a relatively high TDS (30 g/l) which has to be taking into consideration when drilling, extracting and distributing the geothermal water.

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. This was the case for instance for a Danfoss flow meter, Grundfoss surface pumps, calibration equipment and valves and transmitters so far totalling "Danish" equipment deliveries at a minimum of DKK 577 300. (Of course, in cases where more suitable equipment could be delivered from other suppliers these were chosen, e.g. the French made Heat Exchanger Unit).

Equipment for the pilot plant was purchased and delivered in early 2000 and by mid 2000 the pilot plant was in operation, with various technical tests being made. A high content of CO_2 in the geothermal fluid was one of the results found. Temperature and pressure changes in wells during reinjection was also monitored. By end 2000 the long-term test in Durkov location was successfully performed. The evaluation of well test data is in process at the moment, and in 2001 the plan is to perform the same test on GTD-3 as production well, GTD-1 as reinjection well and GTD-2 as monitoring well.

The following parameters of geothermal water utilisation were verified:

- Up to the re-injected water temperature 70 – 71°C the system worked regularly, the reinjection well absorbed both water and all of the dissolved gas.
- Above 70°C the system becomes labile and gradually the pressures at GTD-2 and GTD-1 wellheads equalize and flow rate decreases until a complete stop.

The long-term test proved that it is technically possible to solve the problems at Durkov with scaling and corrosion[33], as well as with the reinjection of geothermal water with a high gas/water ratio.

[33] Elaboration of technical solutions for exploitation of geothermal fluid with a high content of CO_2. The technical problems with the corrosion/scaling problems in a geothermal fluid with a high content of CO_2 have been discussed with French, Icelandic, Polish and Danish specialists. No final solution has been found, but during the pilot period several samples of material and construction have been tested. A technical solution will be elaborated.

V. Project Sustainability

Financial/Economic Sustainability: Based on the April 1999 feasibility study of geoterm Kosice and new data from tests carried out in 2001 (Durkov), an application for ISPA (and NIB) funds in the order of EURO 20 million, have been prepared, using a updated version of the feasibility study[34]. Output of the (complete) project is expected to be 100-125 MW.

Provided that this funding is secured, the following will be established:

- 5 additional production wells
- 6 additional reinjection wells
- A heating centre
- Field stations
- Heat exchanger
- Additional pipeline (- the existing heat distribution network is OK)

The owner of TEKO is the electricity company, which has some very "bad" loans related to nuclear power, and will not likely be able to invest in renovating those parts of the TEKO plant, which is 30 years old and need some renovation.

In Kosice, some stakeholders with interests in gas fired heat plants do exist. Gas, however, 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.

In terms of *organizational sustainability*, Slovgeoterm is assessed as a professional and solid geothermal company. Owned by one of Slovakia's major companies (the Gas Company SPP is a joint stock company owned by the Slovak Government, planning to sell 49 per cent of shares to the private sector), Slovgeoterm has a long record of geothermal projects – from Podajska (now used for greenhouses of 3 ha) and Galantaterm, which is now a separate company.

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, including road administrations, water management authorities, district and municipal authorities, river basin authorities, etc. In addition, discussions with the local district heating producer, TEKO (owned by the Slovak electricity works), has been conducted in constructive fashion and include technical and economic analyses and prognosis of heat price development until 2005 and beyond. On 11 April 2001 the Slovak Government approved the "Plan and Process of Privatisation of Distribution Companies and Heating Company SE-TEKO Košice" to be realized by the end of 2001. *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. Currently, TEKO sells to consumers at 300 SEK and the production price for heat producers are generally about 350 SEK/gigajoule.

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[34] This study has not been available to Kvistgaard Consult. However, its reference reads as follows: Compagnie Francais Pour le Developpement de la Geothermie and des Energies Novelles, Slovgeotherm a.s., Virkir engineering Group hf. 1999. Geoterm Kosice: Geothermal Energy for Kosice District Heating: Feasibility Study. April 1999.

Build as a demonstration project, TEKO is a state of the art CHP plant, the heat bought from geoterm Kosice can be used both for electricity and heat.

In terms of *technological sustainability*, between 1998 and 1999, geological and geophysical investigation and testing of “Durkov Geothermal Structure” [in the Kosice basin] was performed by the Company Slovgeoterm a.s. (Slovgeotherm. 2001. *The Well Testing in Durkov Geothermal Structure.* Bratislava). Three geothermal wells (GTD-1, GTD-2 and GTD-3) were tested, with the aim of simulating the operational conditions for adjustment of the pressure, temperature, hydraulic, and hydro-geochemical properties of the reservoir, and finally the technical properties of the warm water. Based on the test, reservoir conditions and temperature could be modelled and projected for a 30-year period. The result confirmed the probability of a free flow production from GTD2 and GTD3. During the test the well-head temperature of GTD-3 increased to 134°C. Based on the various technical results, the investigation foresee that by way of district heating.

60 000 dwellings in Slovakia’s second biggest town can be heated by the project proposed. While the existing CO_2 problem is to be solved by reinjection, the high level of CO_2 in the water will remain a point requiring attention. Further modelling will be done to assess how long the warm water supply will be sustainable and to assess the advantage of reinjection.

In terms of technological risk, the main obstacle is the character of the geothermal fluid. It is absolutely necessary to solve the corrosion/scaling problems before any major investment.

VI. Lessons Learned

Contracts with the local electricity company, district heating company, municipality etc. must be signed in order to obtain and probe local commitment to a geothermal system.

4.9 The Case of Ziar nad Hronum

Name of Project: Ziar Geotermal Project (Slovakia), Phase 2 (Contract Agreement, 7. December, 1999)	
City/Country: Slovakia/ZSNP Factory Area/Town of Ziar	
Name of Local/National Project Counterpart Houe & Olsen I/S	
Status of Project: Cancelled	
Initiation of Project (date): 1995	
Completion/Cancellation of Project (date): 2000	

People met during the mission: Lars Toft Hansen, Houe & Olsen

I. Project Background

In 1995 co-operation was initiated between ZSNP Aluminum Works a.s., the Municipality of Ziar nad Hronom and the Danish company Houe & Olsen, in order to investigate different heating strategies based on geothermal energy. In 1997 geophysical surveys were conducted and different scenarios were elaborated to prove the technical and economical viability of using geothermal energy in the Ziar nad Hronom area. The potential of the thermal resources located in the Ziar area was expected to be sufficient to meet base load demand of the town of Ziar nad Hronom, ZSNP aluminum work a.s. and small industries.

By 1997 the body of information available was substantial. In addition to the technical scenarios, a pre-feasibility study included detailed analyses of heat demand in the area (city and the ZSNP aluminium factory); the projected costs of the geothermal loop itself; the district heating circuit; and consumer installations and financial analyses of these total projected investments; and finally demonstrating different financial and economic rates of returns under different assumptions subjected to sensitivity analysis. These scenarios included a natural gas scenario, envisioning a gas fired boiler plant in the vicinity of the existing ZSNP coal fired boiler.

In 1998 a feasibility study was submitted to potential investors including the EBRD. To develop and implement the geothermal project, a project management team was established consisting of Slovakian experts, Polish experts and Danish experts who had co-operated for more than three years.

By april 1999 a project document was prepared, reflecting the project status after completion of the first production well; establishment of the new district heating company (ZSNP Geothermal s.r.o); and initial evaluation of the proposal by EBRD. The project document added new information on the existing district heating system in Ziar nad Hronom, from the coal fired plant by 47 substations to flat blocks. It is also mentioned that natural gas supply a small area through a small pipeline, which however is not expected to be enlarged in the future. Finally the report confirmed wishes by the City of Ziar nad Hronum to implement the geothermal project, based on both a letter of intent from the Mayor of the city and the formation of the geothermal district heating company.

II. Project Description

Drilling and construction of the first production well was completed at the beginning of 1999. The project received a grant of USD 600 000 for establishment of the first well. But in a Progress Report of April-September 2000, geologists concluded that the first well can be used neither as production well nor as re-injection well. The well has been drilled in a “chimney” and deviation of the well would not be possible due to the shape of the “chimney”. Project financing of the entire project was temporarily stopped. The project team now focus on financing the “second production well”, considered the most important objective for the moment.

The drilling company, Nafta Gbele, has from ZSNP received only around 25 per cent of the payment due for establishing the first production well. Due to the economical situation of the ZSNP and the municipality of Ziar, it is not likely to assume that Nafta Gberly will receive its outstanding debt if a second production well is not produced.

Output and Results (expected):

Establishment of a geothermal system was expected to generate the technical results presented in the following:

- Establishment of an environmentally friendly heating system to decrease the emission of polluting elements to surroundings.
- Introduction of a district heating system based on new equipment with a high efficiency
- District heating system based on a local renewable energy source
- Transferring of Danish know-how related to district heating systems (design, implementation, financing and operation)
- Introduction of a geothermal system based on the principle of re-injection
- Retrofitting of existing ZSNP heat installations and substations in Ziar nad Hronom to abate the heat losses

In terms of economic results, use of geothermal energy would decrease the dependence of fuel supply from foreign countries and international fuel prices, which will make the geothermal system even more economically viable.

Inputs (expected):

Phase I: DANCEE grant (21. September 1995, Jnr. M-127-0769)
Phase II: DANCEE grant (7. December, 1999, Jnr. M 124/037 –0035): DKK 3 886 435 (EBRD loan: DKK 112 558 000) (Danish Export Credit Fund: DKK 6 740 000)
Grants: DKK 4 044 000
Grants DEPA (consultancy): DKK 3 886 435
Total: DKK 127 228 435

ZSNP established a new company named ZSNP Energy S.R.O. (limited responsibility) with the aim of investigating the possibility of implementing gas turbines for electricity production.

ZSNP has no funds for paying Nafta Gbely its outstanding debt for establishment of the first production well. At present it is hard to predict if Nafta will receive its outstanding debt from ZSNP Geothermal S.R.O.

Establishment of a new production well will cost approx. SEK 40 million. Assuming the new owner of Nafta Gbely request Nafta's outstanding debt to be paid, this claim can only be met if a second production well is established enabling ZSNP Geothermal S.R.O. to gain revenue in the future. Nafta Gbely could be offered shares in ZSNP Geothermal S.R.O. as payment for establishment of the two geothermal wells.

Main Project Objectives

1) To implement and operate a geothermal system in Ziar nad Hronom demonstrating that utilisation of an environmental friendly renewable energy resource can be technically possible and cost effective compared with conventional fossil fuels like coal, oil and gas.

2) To prove that geothermal energy will abate the emission of polluting elements to the surroundings, which in turn will benefit the local economy, lower mortality, improve the health situation, visibility and decrease dependence on foreign fuel supplier and world market fuel prices.

In terms of *Environmental Benefits*, exploitation of geothermal energy would generate a heat production up to 713 TJ/year and emission of CO_2 will decrease with approx. 72 000 tonnes/year. In quantitative terms and based on a coal reference the scenarios implied reductions up to perhaps as much as 101 800 tonnes of CO_2 per year.

III: Project Effectiveness and Impact

Economic/Financial

Depending on the scenario, the feasibility study forecasted a high economic viability with a financial rate of return (FRR) up to 15,3 per cent and an economic rate of return (ERR) of up to 36 per cent.

The price of natural gas is projected to increase from 3.6 SEK/Nm^3 (August 2000) to 4.1 SEK/Nm^3, which will make utilisation of the geothermal energy resources located in the Ziar nad Hronom area even more economical viable.

Environmental

The environmental benefits of the project (scenarios) were calculated and projected, in terms of CO_2, SO_2, and NOx reductions. These reductions were then valued, at between USD 1.6 and 3.2 million per year, using a rate of 45 USD/t CO_2, 1 100 USD/t SO_2 and 2 200 USD/t of NOx. (Houe & Olsen 1997. Ziar nad Hronom, Slovakia, Geothermal Project, Project Summary, Houe & Olsen. Thisted). In absolute terms, the following reductions in air emissions are achieved:

- CO_2 100 000 t/year
- SO_2 1 400t/ year
- NOx 270 t/ year

New Slovakian environmental legislation demands a reduction in polluting elements from the existing, coal fired ZSNP boiler plant.

IV. Project Sustainability

Organizational Sustainability

As far as the organizational sustainability of the Geothermal project organization is concerned, this was set up with a Project Management with Lars Toft Hansen, H&O as Managing Director, assisted by a Secretary of Management, as well as technical, geological and financing and economy subsections. The roles and assignments of the project management team were defined in details, with phases and milestones. In anticipating possible "pitfalls" for the project, the main emphasis was on managerial challenges and risks.

The Municipality and the ZSNP Aluminium works, formed a new district heating company in 1997, with the following participants (names in brackets):

- ZSNP Geothermal s.r.o. (recipient),(Jan Majersky)
- Mesto Ziar nad Hronom (Juraj Procka)
- Nafta Trade a.s. (Juraj Franko)
- Nafta Gbely (Jan Smetana)
- Geologiska Sluzba SR (Anton Remsik)

The project envisioned a reorganization of the heating supply organization and reorganization of the energy sector, locally. It was envisioned to create a "Ziar Heating Company" – a combined private and public joint venture, including public county and municipality owners in collaboration with a private company. The company was named ALGOTERM.

In terms of institutional and political sustainability, an institutional component was planned in order to strengthen financial management and reporting systems, and implement a "modern" tariff structure, adequate for the governments privatisation plans of phasing out energy subsidies. By September 2000 Nafta Gbely was expected to be taken over by SSP, - the Slovakian national gas company - , which was scheduled to be partly privatised by 2001 through international tender. At this time it appeared, that no initiatives regarding implementation of a gas turbine facility had been taken. However, by early October 2000 it was clear that ZSNP Geothermal S.R.O. was financially very weak or even bankrupt and not capable of financing further geothermal work, let alone pay for the drilling performed by Nafta Gbely. A new company - ZSNP Energia S.R.O. – had been formed, and on 18. October it was announced that the ZSNP Energia S.R.O. had signed a contract for establishing a CHP plant (gas turbine) for the production of 800 TJ heat per year, budgeted at SEK 160 million.

It is important to point out that the town of Ziar is not among the shareholders in Energia, which is owned by MVV (51 per cent), ZSNP (30 per cent) and by a company called "designers" (19 per cent). Energia delivers heat to ZSNP, and ZSNP in turn delivers heat to the town based on a 15 years heat purchase agreement. The heat sales price to town is 190 SEK/GJ + increases in exchange rate, gas price, inflation etc.

V. Lessons Learned

The most direct lesson of this project is perhaps the confirmation that geological risk is indeed real. The drilling of the first production well simply failed completely, despite all the technical precautions, data collection, tests and ex-ante preparations.

Secondly, and equally important, the project has demonstrated that "institutional risk" is real. Despite apparent commitment to the project, by the city of Ziar, in the end, the city decided to support a "competing" project. This outcome – a cancellation of the geothermal project - left the town of Ziar nad Hronum without influence on the new heating company. Whether it is the best and most feasible for the town and ZSNP is beyond this analysis to judge.

In most respects, the Ziar Geothermal Project – as far as it went – can be characterised in many ways as a best practice project. The preparatory work, stretching over several years, two phases and including thorough investigations in terms of technical analyses and pre-feasibility studies, has been extensive and of a high quality.

While close to a "take-off" situation, the project was finally cancelled. This happened not only due to the fact that the aluminium factory is a powerful and dominant economic and political player on the local scene, but also because the geothermal scenarios were not "the only game in town". Other foreign interests with other strategies in mind eventually persuaded the factory and other local agencies to invest in a gas driven combined heat and power plant. In a competitive world, such competition is a legitimate risk factor and suppliers of geothermal technologies do compete with suppliers of other technologies, both renewables and conventional energy suppliers

As far as lessons learned are concerned, one pressing question of course is whether and to what extent, the rather sad outcome of the Ziar geothermal project could have been foreseen. It is evident from the project documents that while in 1997 risk analysis focused on technical and managerial issues, in 1999 there was some attention to critical assumptions, including "risk beyond the control of the project". It appears that the project had perhaps sensed some such risk "in the Slovak public sector", but the project had then felt assured by the fact that the same public sector had donated money to the project. Based on two years of good performance, the project apparently did not see any relevant "killer assumptions", and was taken by surprise when informed in October 2000 about the contract between ZSNP and MVV.

The current strategy of the project is that the project financing of the entire project has been temporarily stopped. The project team is focusing on financing of the second production well, which is considered the most important subject for the moment. The first production well, established in 1999, can't be used as production well or re-injection well.

4.10 The Case of Galantaterm

Name of Project: Galanta
City/Country: Slovakia
Name of Local/National/International Project Counterpart: NEFCO and NIB
Status of Project: Ongoing
Initiation of Project (date): 1995
Completion of Project (date): ongoing

People met during the mission: Mr. Stefan Grell, Director of Galantaterm and Ms Lydia (secretary and translator).

I. Project Background

With its wells drilled under a (1972-99) state programme, the Galantaterm plant and company is really a result of a complexity of "projects". Galantaterm, however, can officially be dated back to 1995, when the company was founded and 1997, when the heated water started flowing.

The possibility to obtain geothermal water for the purpose of power utilisation in Galanta was verified by the research geothermal borehole FGG-2 Galanta. The Dionyz Stur Institute of Geology Bratislava drilled the borehole in the years 1982 to 1983, in the framework of the research of geothermal power of the central depression of the Danube basin. Based on positive results from this borehole, a survey-exploitation borehole - FGG-3 Galanta - was drilled in 1984 by the Bratislava branch of the IGHP, s.p. Zilina company (Franko et al., 1985). The temperature of the rock environment in the depths of 1 000 m and 2 000 m was confirmed at 51 and 91°C, respectively. Water temperatures at the wellhead of the FGG-2 borehole with a free outflow of 27.3 l/s is 80°C and at a wellhead of the FGG-3 borehole with free outflow of 25.0 l/s amounts to 77°C.

In 1996 the first geothermal heating plant, with capacity of 8 MW, in Galanta town was put on line. Galantaterm Ltd. – a legal entity has been formed to supply the 1236 flats of the "Sever" residential area - together with its public service sector and the hospital of Galanta, which will be supplied with heat and hot service water (Fendek, Halas, 1997). Geothermal power is used to provide the heat and hot service water. A natural-gas boiler house is used to heat the water when average daily temperature drops below -2°C. The whole primary system and the secondary circuits of the heat exchanger station are equipped with a control system, which will enable gradual, future connection of particular boilers to the system: First the peak boiler, then the gas boiler and hospital exchanger stations and lastly, it is planned to interconnect the points of heat abstraction in the flats. Following the construction of geothermal Energocentre in Galanta the coal-based boiler station in town hospital was closed. This boiler station consumed 6 200 t yearly of coal and produced 330 t SO_2, 36 t NOx, 159 t CO_2, 600 t breeze. The charges according to pollution was SEK 156 000. The consumption of gas in the boiler station on the habitation „Sever" was decreased from 3 million Nm^3 to 1.2 million Nm^3 gas, which in turn decreased the emissions with 60 per cent (Takacs – Grell, 2000).

Galanta-term is Co-owned by NEFCO and the Icelandic company Heitaveita (later Orkuveitor) and from 1995, Galantaterm is today owned by the following:

- Slovak Gas Company (SPP)
- Slovgeoterm
- City of Galanta[35].
- Orkuveitor
- NEFCO

Further, *Orkustofnun* (Iceland) is a shareholder in Slovgeoterm.

II. Project Description

The Galanta power plant is based on two geothermal wells, which were both drilled during 1993 and 1994. Flow rate exceeds 25 l/s and the water has a temperature of approx. 78 °C. The salinity (TDS) is relatively low, ranging from 4.3 to 5.9 g./l
The power plant was build in 1996 and has a capacity of about 8 MW, which can supply 1236 flats, a district hospital and deliver domestic hot water for the housing quarters and the hospital.

Main Project Objectives
Substitution of conventional heating in an estate with 1 243 flats (earlier heated by gas) and a hospital (earlier heated by solid fuels – lignite).

Project Inputs
The Galanta geothermal project was carried out partly based on a loan from NIB, taken through THE GAS COMPANY SPP. Further, the NEFCO is a co-investor, and local sources of finance – from the city to local companies – has invested in the enterprise.

III. Project Results

With its 2 geo-wells of 20 MW from 78°C hot water, Galantaterm today heat approximately 1 300 flats and a hospital.

In 2000, Galantaterm produced the Following:

	Production of Water and Gas Consumption	Heat Generated (GJ)
Thermal Water (78° C).	537 008 m^3	84 093
Gas for Heating	209 400 m^3	4 814
Gas for Steam	638 739 m^3	16 166
Total	N.a.	105 073

V: Project Impact
In terms of environmental benefits, the two geothermal wells has proved sufficient to provide enough heat until outside temperature goes below +2°C, in which case gas is used to add some heat to circulation water. The project therefore, has eliminated emissions from solid fuels and reduced emissions from gas.

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

On the potentially negative side, the following two aspects are relevant:

The so-called “inhibitors” used to protect geothermal equipment from corrosion and scaling, has been tested for possible impact on the environment. It was found, however, that the inhibitors used are classified as “non-toxic”, and that they are only used in low concentration.

Classified as “waste water” 537 008 m^3 of warm water (26 – 36°C, depending on the season) flows into a “drain”, and from there (at 9 – 16°C) into the river. At this time, all “values” (in terms of temperature and dissolved minerals) of the water are in accordance with the decree of the environmental department of the regional office in Trnava.

As for emissions from the gas fired (supplement, when outside temperature is under 2°C), they are as follows:

Solids: 0.0679 kg/tonnes of gas
SO_2: 0.0081 kg/tonnes of gas
NO_2: 1.4927 kg/tonnes of gas
CO: 0.5004 kg/tonnes of gas

The environmental fees for these emissions will amount to SEK 1 800 000.

VI. Project Sustainability

In terms of financial/economic sustainability, while the gas company SPP is paying back the loan to NIB, Galantaterm is not able to pay SPP, because in turn, the Galanta State Hospital does not pay the full amounts charged for supplying heat to the hospital. This situation, of course, represent 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 monthly billed. 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 stably, because the city-owned flat-building enterprises do pay their bills. Galantaterm supplies heat to 1 243 households or 4 900 inhabitants.

In 1999-2000 Galantaterms’ prices developed as shown in table 19:

TABLE 19

	Cost + 9 per cent Profit	Price Allowed to Charge Consumers
Steam (including by GAS)	1999: 390 SEK/GJ 2000: 427 SEK/GJ	1999: 311 SEK/GJ 2000: 311 SEK/GJ
Heat (Volume at 98 GJ in 1999 and 89.000 GJ in 2000)	1999: 257 SEK/GJ 2000: 329 SEK/GJ	1999: 250 SEK/GJ 2000: 260 SEK/GJ

VI. Environmental Sustainability

The environment sustainability of the project is satisfactory. However, 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 increases over 1999.

In terms of *technological* sustainability, the company has been able to solve all technical issues so far. Interestingly, a potential has been identified for further improving the technological sustainability of the operation, by re-injecting the water now discharged.

In terms of dissemination, the Galantaterm enterprise seems to have good prospects for "replicating" the project in other areas within the Galanta region, which is renowned for its significant geothermal potential.

VII. Lessons Learned (Consultants findings, based on visit to Project)

The Galantaterm enterprise demonstrates that exploiting geothermal energy in Slovakia is indeed feasible, given the proper conditions. The project may be considered a "best practice" project. At the same time, of course, Galantaterm suffers from the general socio-economic conditions and developments currently affecting the Slovakian energy sector in general. These include the problem of customers currently not being willing or able to pay their heating bills.

5 Volume II.E: Country Profile - Ukraine

5.1 General Background Information

Ukraine has a population of 49 million inhabitants and the country covers an area of 603 700 square kilometres. The country is rich on mineral and natural resources, including gas, petroleum, coal and iron.

Since its independence from the Soviet Union in 1991, Ukraine has been in a difficult process of shifting from a central-planned economic system towards a market-based economy. From 1991-99, Ukraine suffered from a contracting economy, experiencing eight consecutive years of economic decline, with negative GDP growth rates (see table 1). Moreover, has high inflation, unemployment (estimated to be 35-40 per cent of the workforce), incompliance with debt payments and undue state interference in the private sector contributed to a risky investment climate, further impeding economic development in the country.

Table 1: GDP Growth Rate (annual per cent) 1995-1999

1995	1996	1997	1998	1999
-12.15	-10.04	-2.99	-1.9	-0.4

Source: www.worldbank.org

However, there are now an increasing number of positive signs that Ukraine might finally be about to recover from its long economic crisis. In year 2000, the economy started to grow for the first time in a decade and the aspiration for a free and democratic society has developed. The EBRD, in its "Investment Profile 2001" for Ukraine, states that "with a resurgence in domestic investment, an improved financial balance, substantially reduced inflation, a growing economy and restructured international debts, the prospects for investors in 2001 look more promising than ever since the transition began". See table 2 for energy economic key figures on Ukraine.

Table 2: Key figures for Ukraine

Country size in square kilometres	603 700 km^2
Population size	48 760 474 (2001)
GDP per capita USD95	867 (1998)
Annual energy use per capita (tonnes oil equivalent – toe)	2.84 (1999)
Average annual growth rate per cent of energy use per capita (1990-1999)	-6.09 (1990-1998)
Annual growth rate per cent of energy use per capita	-4.05 (1997/1998)
TPES/GDP (toe per thousand 95 USD)	3.27 (1998)
TFC/GDP (toe per thousand 95 USD)	2.03 (1998)
CO_2 per tonnes oil equivalent (millions tonnes / TPES - toe)	0.69 (1998)
Annual emission of CO_2 (millions of tonnes)	98.34 (1998)
TPES/TFC	1.61 (1998)
Net Import (Mtoe)	62.52 (1998)
Electricity Consumption (TWh)	10.17 (1998)

Source: A combination of statistics from various sources[36]

[36] Energy Statistics of OECD Countries 1998-1999, IEA International Energy Agency

5.1.1 Map of Ukraine

Source: www.countrywatch.com

5.2 The Energy Sector

Currently, the Ukrainian energy sector is facing a range of problems. The country suffers from one of the highest levels of energy intensity in the world and the country's heavy dependence on coal makes it correspondingly high in carbon intensity. Coal is the source of nearly half of Ukraine's carbon emission, natural gas (38 per cent) and oil (15 per cent) the rest.

Moreover, equipment and installations within the energy sector in Ukraine are often in a critical condition. This causes big losses in energy output and unsustainable conditions in relation to national energy production. The Ukrainian nuclear power sector is on the verge of a collapse and the coal mining industry in the country is considered the world deadliest, killing 300-400 workers each year.

5.2.1 Energy Supply and Consumption

Annual energy use per capita dropped 32 per cent (see table 3) from 1992 to 1998. This can be linked to the bad economic situation the country has seen throughout the decade. The year 1994/95 was the only year characterised by growth in energy use (see table 4).

Table 3: Annual Energy Use per Capita (toe per capita)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES/capita	--	--	4.19	3.74	3.18	3.21	3.16	2.96	2.84	--

Source: IEA, International Energy Agency

Table 4: Annual Growth Rate of Energy Use per Capita

1990/1991	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
--	--	-10.74	-14.79	0.94	-1.56	-6.33	-4.05	--

Source: IEA, International Energy Agency
*Example: ((1991-1990)/1990) * 100 = per cent change*
Average • (1990-1999) / 9 = -6.09 per cent

OECD 2000, www.worldbank.org, www.eia.doe.gov (Energy Information Administration)

Ukraine reduced import of energy from 1992 to 1998 by approx. 44 per cent, which corresponds to a similar reduction in TPES for the same period namely 35 per cent (see table 5). The same energy reduction is again reflected in electricity consumption (37 per cent) for the same period. In 1998 import constituted about 44 per cent of TPES. In 1992 imports made up about 51 per cent of TPES – a reduction in import dependency of about 7 per cent point.

Table 5: Total Primary Energy Supply, Net Import and Electricity Consumption

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Net Import (Mtoe)	--	--	111.52	90.27	75.30	82.50	80.83	68.88	62.52	--
TPES (Mtoe)	--	--	218.38	194.91	165.24	165.50	161.49	150.08	142.94	--
TPES – Net Import (diff.)	--	--	106.86	104.64	89.94	83.00	80.66	81.20	80.42	--
Electricity Consumption (TWh)	--	--	224.66	206.00	180.14	172.24	155.97	149.44	142.14	--

Source: IEA, International Energy Agency

5.2.1.1 Energy Supply and Consumption in Relation to GDP

From 1992 to 1998 Ukraine increased its use of energy per GDP unit by 31 per cent (table 6).

Table 6: TPES/GDP (toe per thousand 95 USD)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
--	--	2.49	2.59	2.84	3.24	3.52	3.37	3.27	--

Source: IEA, International Energy Agency

The same development trend can be registered for the TFC/GDP ratio, except that this ratio is based on consumption figures. Table 7 illustrates that the Ukrainian energy use (TFC) increased by 25 per cent during the period 1992-1998, a 6 per cent point lower figure than in table 6 above. Hereby it is possible to 'cut out' losses from production, electricity generation, distribution etc. and just look at changes in end user habits. This means that energy efficiency in Ukraine has worsened during the period.

Table 7: TFC/GDP (toe per thousand 95 USD)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
--	--	1.63	1.67	1.77	2.04	2.06	2.04	2.03	--

Source: IEA, International Energy Agency

5.2.1.2 Energy Supply and Consumption Based on Energy Source

Mainly due to the negative economic development, Ukraine followed a continual trend of reduced energy consumption through the 1990's. Use of fossil fuels was cut down by 38 per cent (coal), 56 per cent (oil) and 31 per cent (gas) during the period 1992-1998 (see table 8). Nuclear energy remained at approx. the same level, thus accounting for a growing share over the period. Hydro energy increased by 98 per cent - still only accounting for a small fraction of total primary energy supply though.

In 1998, the main fuels used for energy consumption were natural gas (42 per cent), coal (30 per cent) and Oil (13 per cent). Whereas oil and gas are mainly imported, most of the coal used is produced in Ukraine and accounts for almost half of the domestic energy production. However, the coal industry is plagued by numerous problems (unsafe mines, labour strikes, inefficiency and low productivity, non-payments etc) and it is therefore considered cheaper for the country to buy coal abroad.

Thermal power plants account for around 50 per cent of the electric power produced in Ukraine. Most of the power plants are old with obsolete equipment and much of the electricity produced is lost in an inefficient transmission and distribution network, forcing Ukraine to rely on Russia for import of electricity. The other half of the electric power supply in Ukraine is produced at five nuclear power plants.

TABLE 8: PRIMARY SUPPLY[37] / ENERGY SOURCE (MTOE)

	1992	1993	1994	1995	1996	1997	1998	1999
Coal	70.59	64.60	50.78	52.53	45.22	43.53	43.70	--
Oil, including petroleum	41.90	29.21	23.80	25.26	20.23	18.44	18.58	--
Gas	86.12	80.41	71.50	68.46	74.47	66.31	59.48	--
Nuclear	19.22	19.61	17.94	18.38	20.74	20.70	19.61	--
Hydro	0.69	0.95	1.04	0.86	0.74	0.85	1.37	--
Geothermal, solar, wind	--	--	--	--	--	--	--	--
Combustible renewable and waste[38]	0.30	0.27	0.27	0.26	0.26	0.26	0.26	--

Source: IEA, International Energy Agency

5.2.1.3 Consumption of Electricity

Consumption of electricity dropped by 37 per cent during the 1992-98 period. Nuclear energy generates 43 per cent of all electricity.

TABLE 9: FINAL CONSUMPTION OF ELECTRICITY (MTOE)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
--	--	16.05	14.90	12.92	12.34	11.11	10.68	10.17	--

Source: IEA, International Energy Agency

5.2.1.4 Energy Consumption Based on Sectors

Industrial energy consumption dropped by about 49 per cent, transport by 42 per cent and 'other sectors' by 18 per cent over the period 1992 – 1998. There has been a change in the pattern of consumption from 1992 where industrial energy use accounted for approx. 55 per cent to 1998 where the share is reduced to 44 per cent, and with residential and communal/public sectors now being the largest consumers (see table 10).

TABLE 10: ANNUAL ENERGY CONSUMPTION - MTOE (TFC) PER SECTOR

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industry	--	--	77.46	64.80	46.42	48.09	40.89	40.19	39.12	--
Transport	--	--	11.88	9.89	8.63	8.62	7.36	6.72	6.92	--
Others*	--	--	50.99	49.50	46.53	46.41	44.67	42.76	41.95	--

Source: IEA, International Energy Agency
**: Residential (61 per cent) and Communal and public services (23 per cent) are main 'consumers' (84 per cent).*

[37] Energy sources other than for coal, oil and gas are based on 'production' numbers and not 'primary supply'.
[38] These data are not 100 per cent reliable since stock changes and import/export of energy are not included.

5.2.1.5 Energy Supply and Consumption – Summing Up
Energy use dropped by about 32 per cent from 1992 to 1998. Imports also decreased (44 per cent). Ukraine therefore got less dependent on energy from 'outside'. However, the TPES/GDP ratio increased by 31 per cent leaving Ukraine more locked in an energy intensive situation – more energy has to be consumed in order to produce one unit of GDP. The use of fossil fuels was cut down while nuclear energy remained the same. Hydro energy, being the only measurable renewable energy source increased by 96 per cent, but still only accounts for a small fraction of total energy production. The industry sector, - being the most energy consuming in 1992 - , reduced energy consumption by about half and is by 1998 second in energy use next to the residential/communal and public sector.

5.2.2 Energy Efficiency

Ukrainian energy efficiency worsened from 1992 until 1996 by 13 per cent but then began to improve (6 per cent). For the whole period, efficiency worsened by 6 per cent (see table 11).

Table 11: TPES/TFC

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TPES Mtoe)	--	--	218.38	194.91	165.24	165.50	161.49	150.08	142.94	--
TFC Mtoe)	--	--	143.60	125.79	102.93	104.18	94.25	90.81	88.98	--
TPES/TFC	--	--	1.52	1.55	1.60	1.59	1.71	1.65	1.61	--

Source: IEA, International Energy Agency

5.2.3 Energy Sector Structure

Ukraine is highly dependent on foreign oil and gas supplies (imported, mainly from Russia). Moreover, Ukraine is the main transit route for Russian gas shipment to Europe and instead of cash payment for use of the transit, Ukraine has received gas in exchange from Russia. Through the 1990's, Ukraine encountered increasing difficulties in complying with its payments to Russia for the oil and gas supplies. As a result, Russia imposed a blockade, which caused shortage of energy supplies in Ukraine.

In order to reduce its independence on Russian oil and gas imports, Ukraine has recently been looking for alternative solutions for energy supplies and has started to look for other suppliers of energy. Ukraine's dependence on energy import is high, with some 44 per cent of TPES is based on imports.

5.2.4 State-owned Energy Enterprises

The Ukrainian Government did in 1994 initiate a reform of the power sector aimed at improving commercialisation and competition within the sector. Progress has been achieved, but the government is still interfering excessively within 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 company. Naftogaz Ukrainy controls 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 by which model has still not been decided.

Few reforms have so far been implemented in the Ukrainian district heating sector, - neither by governmental authorities or the municipalities who are responsible for heat production. The main problems in this area are: Poor cash collection (in particular from the industry), low tariffs combined with an inefficient subsidy structure, lack of clarity in commercial arrangements between district heating companies and municipal owners and lack of an operational strategy by government or municipal authorities to address district heating reform.

The outlook from an investors point of view, may now look more positive than a couple of years ago, due to recent successful implementation of political and economic reforms in the country. However, it will probably take some time to convince investors to put money into the energy sector. Concrete results need to be seen. Such results may require coherent, integrated and sustainable energy planning, - addressing both financial, political, institutional and technical issues.

Ukraine has developed a national programme "Oil and Gas of Ukraine to the year 2010" to meet at least half of the country's oil and gas needs, within the next 11 to 12 years. Under this plan, foreign investment will be used to finance the majority of this effort. For the most part, foreign investment in Ukraine's oil and gas sectors has been limited to joint venture agreements rather than privatisation.

5.2.5 Prices and Regulation

Although improvements have been made over the last couple of years, energy prices in Ukraine are still not reflecting 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 put together has left the heating sector with big losses and deficits.

Energy prices in Ukraine will soon have to be aligned with production costs in order to obtain a functioning, market based economy, as required by the international financial institutions. New, economically attractive and sustainable solutions for the heating sector are therefore urgently required in the country.

5.2.6 Environmental Issues

Ukraine's consumption of renewable energy is relatively low compared to other CEECs. However, renewable energy forms are now beginning to find a market in Ukraine.

Ukraine recently established a Ministry of Environment and introduced a pollution fee system that levies taxes on air and water emissions and solid waste disposal. The resulting revenues are channelled into environmental protection activities, but enforcement of this pollution fee system is lax. An environmental policy document "Main Directions of State Policy for the Protection of Environment, Use of Natural Resources and Environmental Safety" was finalised by the government in 1998.

Ukraine relies heavily on coal for its energy consumption and a possible economic rebound will therefore likely result in increasing total carbon emissions. From 1992 to 1998 Ukraine managed to reduce CO_2 emissions by about 37 per cent, but foresights estimate a future increase (see table 12).

Table 12: Carbon Dioxide Emissions from the Consumption And Flaring Of Fossil Fuels

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
Million metric tonnes of Carbon Equivalent	--	--	155.71	144.83	120.58	123.72	108.10	102.00	98.34	104.30

Source: EIA, Energy Information Administration
** Preliminary*

From 1992 to 1998 Ukraine increased CO_2 emissions per TPES by about 3.2 per cent (see table 13), thus improving the rate of emission of CO_2 per available unit of energy (toe) in the overall period. But from 1996 and onwards this trend was reversed and Ukraine's rate of CO_2 emissions per energy unit was worsened, consequently making Ukraine's potential for CO_2 savings greater.

Table 13: CO_2 (kg. of Carbon Equivalent) / TPES (Mtoe)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
--	--	0.713	0.743	0.730	0.748	0.670	0.680	0.690	--

Source: EIA, Energy Information Administration
IEA, International Energy Agency
** Preliminary*

5.2.6.1 Convention on Climate Change (FCCC)

Ukraine signed the Kyoto Protocol in 1999 and the country is thereby committed to maintain the CO_2 emission for the period 2008-2012 at the 1990-level. Given the decreased industrial output, the country is expected to meet this target. However, a period with renewed growth in the country will challenge the target and increase the importance of a sustainable future development of the energy sector.

The Joint Implementation mechanism, as dealt with by the Kyoto Protocol, may enable Ukraine to attract beneficial forms of co-financing for certain projects which lead to reduction in GHG emissions.

5.2.7 Renewable Energy

Ukraine's renewable energy consumption is very low, also in comparison with neighbouring countries. A main reason for this has been Ukraine's heavy reliance on nuclear power for electricity production. The close down of Chernobyl, together with new general increases in national energy consumption, has however brought a new focus on the potential for use of renewable energy sources in the country.

The Government of Ukraine is increasingly concerned about the problems related to the energy sector and is aware that one possible way to meet future challenges is through increased use 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 within 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 tool for regional energy planning.

The plan develops scenarios for regional renewable energy development up to year 2015. Some regions show impressing potentials for development of geothermal energy, such as the regions of Zakarpatsky and Crimea, where between 75 and 80 per cent of the heat demand could be covered by geothermal energy.

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 (10-12 million USD per year) is dedicated to develop wind power in Ukraine. Of this amount, 95 per cent goes to developing production techniques for wind power, while around 5 per cent is for scientific work. The programme is implemented within the Ministry of Industrial Policy.

Due to this comprehensive programme, wind energy development in Ukraine is gaining a comparative advantage compared to other renewable energy sources. From a purely economic point of view it may, however, seem difficult to justify this strong support to wind energy. The rational behind this strategy seems to be of more political character than based on real strategic decision making.

3) *"Ecologically Clean Geothermal Power Engineering in Ukraine".*
In 1996 the first 5-year programme to support scientific geothermal activities in the country was approved by the Cabinet of Ministers. The Institute of Engineering Thermophysics (IET) of the National Academy of Science was appointed the leading institution of the programme, which is to be implemented within the Ministry of Science. The first 5-year programme will be ended by year 2001, but 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 project 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 which degree - , renewable and non-traditional energy forms will begin to find their own markets in Ukraine.

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. Moreover, commercial alliances and other economic support mechanisms have during the last years, been discussed with foreign companies and bilateral donors in order to boost the wind energy sector in the country. Even though some progress has been achieved, the results have not so far fulfilled the expectations.

5.2.8 The Energy Situation

Being one of the largest countries among the CEEC, Ukraine has during the last decade experienced serious changes within both the political and economic system. This affects upon the energy sector, which again bring related environmental problems to surface.

Ukraine has proven oil reserves of 395 million barrels, but is currently importing nearly 80 per cent of its oil. Similarly, Ukraine has large natural gas reserves but imports around 80 per cent of domestic use. Under the "Oil and Gas of Ukraine to 2010 Programme", the country aims to meet at least 50 per cent of domestic demand by year 2010 by development of new wells, more efficient production and increased foreign investment. Nuclear power accounts for about half of the energy used for electricity generation, but power plants are old and in bad condition.

5.3 Geothermal Energy in Ukraine

5.3.1 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, though 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 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. 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 located in urban areas where they could benefit from existing distribution systems.

The assessment of geothermal potential for the whole territory of Ukraine has been ongoing for several years now, supported by the governmental scientific programmes. 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 the best 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 °s 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 makes it feasible to produce electricity from low temperature water. The potential for electricity production, and related cost-benefit estimations, have not yet been fully investigated.

5.3.2 Organizations and Institutions Responsible for Geothermal Energy Development in Ukraine

5.3.2.1 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 finance, the scientific 5-year programme on Geothermal Power Engineering implemented through IET.

The Ministry of Industrial Policy is responsible for 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. In practice the eco-tax does however function 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.

5.3.2.2 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 "commercial acceptance" compared to other energy sources, as for instance wind power.

For the wind energy sector, 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, just as well be used for production of equipment for geothermal energy products and does thereby represent an important resource for the country.

5.3.2.3 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.

5.3.3 Institutional Factors Governing Geothermal Energy in Ukraine

5.3.3.1 Laws and Regulations

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

The Ukrainian legislation does on the other hand not permit penetration of potable water reservoirs. This will in practice impede realization of some potential geothermal projects where the geothermal reservoir is placed under such water reservoir.

5.3.3.2 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 also to geothermal projects. One example is the "ecological" tax on electricity consumption (0,75 per cent), mainly dedicated to developing of wind power in Ukraine. Another example is a fee system, although still not very operational, implemented by the Ministry of Environment, which levies taxes on air and water emissions and solid waste disposal. These revenues are channelled to environmental protection activities.

5.4 International Collaboration on Geothermal Energy Development in Ukraine

Ukraine considers membership of the European Union (EU) and other European institutions its primary foreign policy objective. The EUs Partnership and Cooperation Agreement (PCA) with Ukraine went into force on March 1, 1998. The EU has encouraged Ukraine to implement the PCA fully before discussions begin on an association agreement. The EU Common Strategy toward Ukraine, issued at the EU Summit in December 1999 in Helsinki, recognises Ukraine's long-term aspirations, but does not discuss association.

Ukraine has friendly relations with its western neighbours, especially Poland, with whom it cooperates closely. Relations with Russia are complicated by energy dependence and by payment arrears. However, the relations have improved with the 1998 ratification of the bilateral Treaty of Friendship and Cooperation. Ukraine became a member of the Commonwealth of Independent States (CIS) on December 8, 1991, but in January 1993 refused to endorse a draft charter strengthening political, economic, and defence ties among CIS members. Ukraine is a founding member of GUUAM (Georgia-Ukraine-Uzbekistan-Azerbaijan-Moldova), the group of western-oriented former Soviet states that would prefer to limit the CIS to economic relations.

5.4.1 EU - TACIS

The European Union is providing substantial assistance to Ukraine through the TACIS programme. From 1996-99, TACIS concentrated its support to furthering the development of democratic society and the nascent market economy in Ukraine. Particular emphasis in the programme was given to Ukraine's high energy dependence. In 1999, 46 million EURO were provided through TACIS.

For the current period (2000-2003) TACIS is operating with a budget of 200 million EURO. The current programme is focusing on three main areas:

- Institutional, legal and administrative reforms
- Private sector and assistance for economic development
- Addressing the social consequences of transition

Within this framework, TACIS will continue to support reform of the energy sector. In particular, future assistance will focus on improvements to the regulatory framework and organisational level in the energy sector, the privatisation and restructuring of strategic energy companies, notably power sector distribution companies, and on improving cash collection.

The EU has been implementing a development project, strengthening a national information network for energy conservation. Project capacity development was recently supported by TACIS, which has been supporting a project preparation unit in the Ministry of Environment.

5.4.2 EBRD

EBRD business in Ukraine has grown considerably. In year 2000, deals were signed for 293 million EURO, 20 per cent more than the year before. In total, EBRD portfolio in Ukraine stands at 811 million EURO, however only around 1/3 has been disbursed. This represents 9 per cent of all foreign direct investment in the country and 7 per cent of total global EBRD commitment, and the EBRD is thereby the largest investor/lender to Ukraine.

The slow pace of disbursement of funds may, according to EBRD, be attributed to a range of factors. These include: legal and institutional constraints; lack of coordinated decision making by local authorities; local counterpart contribution not being effected and changes in implementing agency.

The amount to be invested by the EBRD in Ukraine during the years to come will depend on developments in business conditions and the pace of reforms. The current project pipeline to be developed over the next year or two, stands at more than 500 million EURO, not counting the power sector.

The Banks clear strategy is to promote diversification in Ukraine's economy and the energy sector is one of the target sectors for intervention. The EBRD project portfolio includes a number of municipal utility and district heating projects. The EBRD has also initiated the creation of a multilateral Energy Task Force aimed at raising cash collections and accelerating privatisation in the energy sector.

At the same time the EBRD states in their strategy for Ukraine that opportunism with an eye to strong demonstration effect will need to be a principle underlying the Bank's search for new business regardless in the sector in which they occur.

Regarding the DH sector, the EBRD finds that with the prevailing problems in the DH sector it remains difficult to attract private sector finance or to identify financially viable projects in which the Bank may invest.

The EBRD conclude that "In the long-term, the Bank believes it is a correct objective to help Ukraine increase its indigenous sources of energy, as well as use them more efficiently"

5.4.3 World Bank/GEF

Ukraine became a member of the World Bank in 1992. By year 2000, the World Bank's commitments amounted to over 3 billion USD, of which 2 billion USD had been disbursed.

In its new Country Assistance Strategy (CAS) for Ukraine, covering the period 2001-2003, the World Bank stress the importance of moving Ukraine closer to European Union standards, fostering environmentally sustainable development.

According to the CAS, Ukraine can obtain lending of up to USD 1.8 billion for the 3-year period through a mixture of adjustment lending under a Programmatic Adjustment Loan (PAL) and a number of institution-building operations. The PAL, a USD750 million loan and corner stone of the CAS, consists of three separate loans, each of USD250 million, to be disbursed depending on the pace of implementation of reforms envisioned in the Government's economic programme. The programme includes removal of obstacles that have hampered reforms in the past, such as non-payments and barter, lack of transparency in privatisation, and poor budget control. The CAS is also designed to capitalize on the Bank's comparative advantages and maximize synergies with other donors and international financial institutions.

A number of WB projects have focused on support and promotion of reforms within the energy sector and the energy sector is by the WB considered crucial to the development process in Ukraine. Generally, the World Bank's programme within the energy sector is designed to complement Ukrainian and G7 initiatives. The WB project list includes a Hydropower Rehabilitation Project (USD114 million), a District Heating Improvement Project in Kiev (USD200 million), a Public Buildings Energy Efficiency Project in Kiev (USD18 million), a Coal Pilot Project (USD16 million), and a Coal Sector Adjustment Loan (USD300 million). Recently, in March 2001, a USD28 million loan was approved for a Heat Supply Improvement Project in Sevastopol.

5.4.4 USAID

Ukraine receives more USAID assistance than Russia and total US Assistance to Ukraine in 1999 was USD 180 million. USAID will continue to give high priority to Ukraine and for year 2000 a total assistance of USD 216 million was planned.

U.S. technical assistance to Ukraine has been focussed on supporting the transition process to a market based economy, primarily regarding economic restructuring, development of the private sector, and energy-sector reform. Within the energy sector, USAID has helped develop a multi-faceted programme for Ukraine, which focuses on:

- Power sector restructuring, which has helped transform the power sector from a vertically integrated monopoly to a market system with regulatory oversight of tariffs and licensing, and power distribution based on financial bids;
- Assisting the Government of Ukraine to privatise the power sectors, starting with 27 distribution companies;
- Development of a coal bed methane industry;
- Improving energy production and conservation by introducing new technologies, management techniques and applying market principles; and
- Supporting Ukraine's nuclear safety performance and improving nuclear sector regulation and inspection.

USAID is also assisting Ukraine in the improvement of the environment with activities to coordinate with other donors to address social, environmental and energy efficiency issues related to the closure of the Chernobyl Nuclear Power Plant.

The Alliance to Save Energy began its operations in Ukraine in 1997 under a cooperative agreement with the USAID. The objective of the Ukraine programme has been to develop energy efficiency as a means of helping the country manage its rising energy demands in an environmentally sustainable and cost-effective way.

With the cooperation of its Ukrainian partners, the Alliance is striving to implement results-oriented projects and build the capacity of stakeholders in the government, private and civil sectors. These efforts are focused at both the local and national levels.

5.4.5 Other Donors

Beside USAID, the largest volumes of bilateral funding for Ukraine are provided by Canada and Germany.

Among the EU member states Denmark, France, Netherlands, Italy, Germany, Sweden and UK are the most active in Ukraine.

5.5 Summing Up

Ukraine has just recently started recovering after nearly a decade of recession and struggling through a difficult transition process towards a more liberalised 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 recognised by the international financial institutions, which have credited the country by increasing their loan portfolio significantly.

Ukraine has traditionally been very dependent of 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 in 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 on a 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. Production capacity for equipment is available in Ukraine as well as technical geothermal engineering expertise. Moreover, the government has demonstrated its competence and willingness to introduce eco-taxes on energy production (for the Wind Energy Programme) in order to support development of renewable energy forms.

With a view to current conditions and the situation in Ukraine, it is therefore recommended that support is 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 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 quite 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.

5.6 References

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IET. 1997. *Geothermal Power Engineering in Ukraine.*

Schurchkov A., Zabarny G., Razakov A., Zadorozhna A. 2000. *Promising undiscovered thermal waters potential of Ukraine planned for commercial utilization.*

World Bank. 2000. *Ukraine - Country Assistance Strategy.*

5.7 List of Institutions Visited and Individuals Met

Ukrainian National Academy of Science, Institute of Engineering Thermophysics:
Mr. Anatoly A. Dolinsky, Director of Institute
Mr. Anatoly Schurchkov, Head of Department of Thermal Energy Utilization
Mr. George Zabarny, Head of Department of Technology of Geothermal Energy Production

Ministry of Environment:
Pyotr Blinov, Chief of Department of Natural Resources
Olga Stepanova, Vice-head, Department of International Affairs

Ministry of Science:
Mr. Vyacheslav Botvynov, Head of Department for Science and Technology
Mr. Mikhailo Khvodrov, Chief of Department

Ministry of Fuel and Power Engineering:
Mr. Juliy Kutsan, Chief of Department, Ecologic and Technical Policy

Ministry of Industrial Policy:
Mr. Stepan A. Kudrya, Director, Department of Renewable Energy Development
Mr. Lev S Dulnev, Deputy General Director, Windenergo ltd

World Bank:
Mr. Yury Miroshnichenko, Operations Officer, Energy Sector

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6.1 Bulgaria

The Bulgarian energy sector was reorganized in 2000 as called for in the Energy Efficiency Act of July 1999. The state-owned electricity company (NEK) was transformed and is now the grid operator, the single buyer of electricity from the six Independent Power Generators, and the only supplier of electricity to the seven distribution companies.

Bulgaria's primary domestic energy resources are coal and hydroelectric power, but with regard to supplies of oil and natural gas, Bulgaria is heavily dependent on imports. Bulgaria has one nuclear power station, which in 1998 generated 40.3 per cent of all electricity produced.

A national energy policy is under development by the Bulgarian State Energy Agency. The government's latest energy strategy from 1998, "National Strategy for Development of Energy and Energy Efficiency Till 2010" was recently updated with a forecast till 2015.

6.1.1 Geothermal Energy in Bulgaria

6.1.1.1 Areas and Projects
Bulgaria has more than 137 geothermal sources. More than 50 geothermal sources, interesting from a thermal energy point of view, have been registered and the total thermal capacity freely flowing geo-thermal waters is estimated to about 488 MW. Currently, Bulgaria's geothermal waters are used mainly for health and recreative applications, though bottling and household heating use of some sources take place in Kyustendil, Sapareva Bania, Momin prohod, Velingrad and Varna.

In the 80´s investigations and developments were conducted for the use of geothermal energy in the town of Velingrad, the town of Kyustendil, the city of Varna (resort " St. Konstantin and Elena") and the resort ' Golden Sands" (Nevestino). In this period, 17 geothermal installations for the use of geothermal energy with total installed capacity of 35 MW were designed and installed for the following use:

- 160 health care units
- 41 swimming pools
- 47 public and 45 companies laundries
- Heating of 232 000 green houses
- 54 buildings and 3 chicken incubators
- 4 wool textile and 4 linen factories.

The highest capacity of geothermal water is found in one source near Varna – 478 l/sec - and the lowest capacity in Kumaritza (Sofia) – 0.5 l/sec. The average capacity in the country per source is about 28 l/sec. As for the chemical composition, Bulgarian geothermal waters are weak in mineralisation, with contents of soluble mineral substances under 1 gr/l. The highest rate of mineralisation is found in the water from Dolni Dubnik, with 26 gr/l. The lowest rate of mineralisation is in the water of Gorna Bania deposit. Bulgarian geothermal water contains most hydro carbonates, sulphates, chlorides, sodium, potassium, calcium, and magnesium. Besides this, some water contains gas- nitrogen and noble gases, fluorine, CO_2, sulphur hydrate and methane.

6.1.1.2 Laws and Regulations

In Bulgaria, geothermal waters are under the jurisdiction of the Constitution and the Waters Law. The use of geothermal waters for energy purposes depends directly on the following laws:

The *Waters law* stipulates the rules for use of water and water objects. It states that the sole right for use of water is fully owned by the State, and that the state may provide the water for generation of hydro electricity and geothermal energy.

The *Concession Law*, which regulates the conditions and order for delivery of concessions states that concessions may be delivered for the use of waters, including mineral ones – which are exceptional state property.

The *Energy and Energy Efficiency Law* envisages that the transmission or proper distribution company are purchasing electric and thermal energy, produced by RES and by CHP plants in amounts and of preferential prices, defined by order and terms of a Regulation, accepted by Council of Ministers (Regulation for formation and application of prices and tariffs of electric energy – published in State Gazette vol. 37/ 5.5.2000, enforced since 01.01.2002). Art.41, items 1, 2 and 3 state out that no issue of licenses is required in the following cases – generation of electric energy of power below 5 MW, thermal energy production of power up to 1 MW and generation of thermal energy for own needs. The law on energy and energy efficiency from July 1999 treats the problems of the independent electricity producers and promotes accelerated development of all kinds of renewable energies, incl. geothermal energy.

Territorial Structure Law includes the rules for construction of energy supply networks and equipment- thermal pipelines, subscriber stations and in-door heating installations.

6.1.1.3 Energy strategy - Perspectives for Energy Use of Geothermal Energy

The state policy on energy saving and development of renewable energy sources, incl. geothermal energy is implemented by the State Energy Efficiency Agency (SEEA). The SEEA has developed a draft of a national RES programme, which includes 38 projects for geothermal energy use at a total value of USD384 million. Out of these, 4 projects at a value of USD231 million has already been approved by relevant ministries and 34 projects at a value of USD153 million has been approved by regional governments of the country.

In 1997 the PHARE project ‘Feasibility study on RES in Bulgaria” was finalized. Within the frames of this project a pilot geothermal installation for the schools Hristo Botev, was constructed in the town of Velingrad.

6.1.1.4 National Funding Sources and Activities for GE Development

Bulgaria has a long tradition for national funding supporting the development of geothermal energy, and plan to invest as much as USD 1 400 million in geothermal energy by 2010 (forecasts). This figure, however, includes both the forecasted local investments and expected foreign investments, from Phare, ALTENER, SAVE–II, ESCO, performance contracting, joint implementation and the GEF. Further, fiscal support in terms of a VAT reduction by 2 per cent a profit tax reduction by 3 per cent and expected reduction of taxes in general, is being discussed in the context of renewable energy.

There are a significant number of companies and institutions working on the geothermal energy field, which are delivering investigations, design, installations, operation and service of geothermal equipment and installations. Bulgarian technologies for geothermal installations include heat exchangers, thermal pumps and pipelines.

Bulgaria has domestic capacity to carry out investigations with different type of heat exchangers at different geothermal springs in order to clarify the processes of corrosion and the efficiency of the anti-corrosive plating at real operational conditions. Locally available are different types of thermal pumps with capacities of 25 – 250 kW, and there is also a local production of enamelled tubes with small length that may be used at some geothermal sources. For the small geothermal systems (up to 100 kW) the local production share of equipment may reach 90 per cent. However, at large geothermal systems or for systems with thermal pumps, the local production share is more limited, at about 10 per cent.

6.2 Czech Republic

The energy policy of the Czech Republic is based on a number of strategic targets. One of the main targets is to determine the energy sector's basic policy of long-term development. Moreover it is seen as important to determine the essential legislative and economic environment in which electricity utilities and distributors may be encouraged to act environment-friendly.

Focusing on the consumption side, the state wishes to support new production technologies and efficiency in use of energy and raw material. Importantly, it is a target to reduce the energy demand by supporting energy saving programmes that lead to energy savings and increases the use of alternative energy and raw material sources.

6.2.1 Geothermal Energy in Czech Republic

6.2.1.1 Areas and Projects

Data used for estimating the geothermal potential for the Czech Republic has been collected from 498 measured bore holes on the whole territory of the Czech Republic. The geothermal potential is primarily based on temperature measures.

In contrast to the vast geothermal potential of neighbouring Slovakia, the Czech republic has only few proper geothermal water reservoirs. These few reservoirs have water temperatures above 60°C at a depth of 1 500 metres, and a geographical location that has not prompted immediate or major interest in their development. In contrast to geothermal energy proper, the Czech Republic does have a confirmed potential for exploitation of heat pumps. However, development and dissemination of heat pumps are beyond the scope of this particular study.

It is in the northern part of Bohemian Massif and West Carpathian Fore deep that the largest potential for utilizing the geothermal energy is found. Of course, local anomalies of warm and hot waters occur and these areas have conventionally been used as spas.

Up until now, the geothermal potential of the Czech Republic has not been exploited on a larger scale. This is because the geothermal resources are of low enthalpy character for most parts and, therefore, are not really interesting when looking at geothermal energy with intentions of mass consumption application.

6.3 Hungary

Hungary is a producer of all types of energy; the country produces coal, oil and gas, and was in the past a producer of uranium. Domestic production has been able to cover a large part of the (declining) coal demand, but has also increased the degree of import dependence in oil and the growing degree of import dependence in gas since 1977. One major reason for increasing import of oil and gas is due to the shock of adaptation to a market regime, total Hungarian energy production fell below its 1970 level in 1994. The outlook for coal, oil and gas production is a decline: for coal because of the scarcity of economic resources, for gas and oil because of depletion of reserves. The Government expects the reduction in domestic production to be replaced by greater imports of all three fossil fuels. This should be a strong incentive for Hungary to investigate further in development of renewable energy.

6.3.1 Geothermal Energy in Hungary

The use of geothermal energy in Hungary is significant. Due to abundance of low and medium enthalpy geothermal energy source, present utilization is mainly for agriculture, bathing, space heating, industrial use and drinking. Albeit resent studies show that geothermal sources with temperatures above 160° C exists (SE part of Hungary) and utilization for power generation therefore is possible. No electricity has been generated yet.

In Hungary geothermal energy utilization is economically profitable. Compared to prices for natural gas, geothermal energy is much cheaper to produce energy from. With an average price of approx. 1 USD /GJ on geothermal energy (depending on type of source and technology applied) it is possible for geothermal energy to compete with prices for natural gas, which is about 3.5 times more expensive. This comparison only accounts for heat energy since no generation of electricity produced from geothermal waters takes place in Hungary at the present stage. Looking at data for 1995 Hungary is fifth in the world, when it comes to utilization of geothermal heat. Concerning specific utilization Hungary is third - and first in utilizing geothermal energy for agricultural purpose.

While Hungary has a good quantitative utilization, the efficiency lacks behind caused by a number of circumstances. First of all, the necessary unambiguous legal basis isn't present, the thermal water production and direct use are of extensive nature and the efficiency of the seasonal type of geothermal heat utilization is low. Moreover no reinjection is applied.

Geothermal energy utilization in Hungary is estimated to 179.1 MW of geothermal capacity. Geothermal heat pumps represent 4.0 MW of installed capacity. The quantity of the produced thermal water for direct use in 1999 was approximately 15.63 million cu.m. with average utilization temperature of 31°C.

The main consumer of geothermal energy is in agriculture (67 per cent). The proportion of geothermal energy utilization in the energy balance of Hungary, despite the significant proven reserves, is low (0.16 per cent). According to results of the different assessments (Boldizsár, 1967 and Bobok, 1988) of the geothermal reserves, Hungary has the biggest underground thermal water reserves and geothermal energy potential of low and medium enthalpy in Europe.

The number of geothermal heat use organizations was 70 in 1999, the number of the settlements using geothermal energy was 44, and the number of spas utilizing geothermal heat for direct use was 4 in 1999.

6.4 Latvia

The geothermal energy potential in Latvia was mapped in connection with the exploratory exercise known as the "Baltic Geothermal Energy Project" that lead to a geothermal project in Lithuania (Klaipéda), where the Danish Oil and Natural Gas (DONG) is involved. This initial mapping study reported in 1992, was followed by feasibility studies, the final reports of which were issued in March 1994. [39]

The initial study mapped geo-scientific and heat demand data from 51 wells and 14 urban areas in Latvia and Lithuania. While the geological data of the study is likely to be valid today, the results of the heat demand and economic investigations may be much less useful, because of the political, economic and legal-institutional transformation in the Baltic countries since 1992. What is important, therefore, is that the feasibility study that followed, in 1994, identified Klaipéda and Liepaja (Latvia) as the most interesting "Baltic" potentials to pursue all things considered, including geothermal heat production potential, expected heat demand, existing district heating networks and calculated heat production costs.

In the case of Liepaja, the geothermal potential was demonstrated in the "Liepaja Geothermal Pilot Project" initiated in 1996 by DONG, funded by the DEPA with DKK 3.5 mill. A "Proposal for Appraisal and Development" of the Liepaja Geothermal Pilot Project, was submitted to the DEPA in May 2000 by Petroleum Geology Investigators (PGI). PGI wishes to use experiences gained in the implementation of the Klaipéda project, to "optimise" inputs (in terms of capital expenditures and time) in the proposed

[39] A wealth of technical reports resulted from this study. The most important are: 1) Tallbacka, Lars. 1992. Baltic Geothermal Energy Project. Initial Study. Final Report. Copenhagen.

project. These experiences have just been published: DONG E&P A/S. 2001. “Klaipeda Geothermal Demonstration Project: Implementation Phase”, Danish Technical Assistance Component, Final Report. Copenhagen. August 2001.

6.5 Lithuania

Lithuania is continuing to rely primarily on nuclear power for its electricity, and the state-owned Ignalina nuclear power plant is being upgraded. Except for Ignalina, Lithuania has pursued a gradual path toward privatisation of energy, with the formation of joint stock companies for the electric grid (Lithuanian Energy Company) and various oil and gas companies. The Vilnius Power Station and other local combined heat and power plants were recently placed under municipal control and separated from the Lithuanian Energy Company. Lithuania imports crude oil and natural gas. It exports gasoline from the Mazeikiai refinery and electricity from the Ignalina power plant.

One of the overall objectives of Lithuania’s energy strategy is to diversify the energy production structure in the country. An integrated part of this strategy is to continue the institutional reforms, which have led to implementation of market economic mechanisms. This has raised energy prices in the country and brought them closer to market levels and real production costs. A concrete objective of the national energy strategy in Lithuania is to develop and increase utilisation of local energy resources, including hydropower, biogas, wind power, sun energy and geothermal energy.

In 1992, DEPA financed (DKK 7 million) a Baltic Geothermal Energy Project. Danish consultants carried out a comprehensive study to determine size and quality of geothermal resources in Lithuania and Latvia and to assess the potential for utilizing geothermal energy to replace currently used fossil fuel for heat generation. The study, which focused on areas where central heating networks were already established, confirmed that substantial geothermal aquifers occur within the Devonian and that the largest and most promising storage areas are located in Lithuania.

It is conceivable that the experiences that are currently gained in the auspices of the Klaipéda Geothermal Demonstration Project (see case study), may lead to other projects in the same region, either on the Latvian or Lithuanian side. However, taking into consideration the difficult process experienced in Klaipéda, it is also considered that further geothermal project implementation in Lithuania may await the outcome and solving of the problems discovered during project implementation in Klaipéda.

6.6 The Case of Kleipéda

Project title: Kleipéda Geothermal Demonstration Project
Country/locality: Lithuania/Klaipéda
Date of start: June 1996 (Award of Danish Grant for TAC, World Bank/GEF approval of Funds)
Date of closure: 31/07/01 (World Bank, Closing Date)

People met during mission to Klaipéda, 21-23 May, 2001:

UAB Geoterma:
Vytautas Kropas, Project Manager
Alfonsas Bickus, Plant Manager
+ technical staff

Klaipéda District Heating Company (Klaipédos Energija):
Vytautis Valutis, General Director
Juozas Kregzdys, Deputy General Director
Leonardas Jokubauskas, Head of Supply and Sales Department
Andrius Misiunas, Foreign Relations Executive
Vidmantas Picturna, Deputy Chief of Consumers Unit

Klaipéda Municipality:
Antanas Balsys, Director of Energy and Infrastructure Unit

Klaipéda County Govenor's Administration:
Vidas Karolis, Vice-Governor
Kestutis Vaitiekunas, Administration and Regional Development Department, Director
Dalia Makuskiene, Regional Development Department, Chief Specialist of Foreign Relations Office

I. Project Background

In 1992, DEPA financed (DKK 7 million) a Baltic Geothermal Energy Project. Danish consultants carried out a comprehensive study to determine size and quality of geothermal resources in Lithuania and Latvia and to assess the potential for utilizing geothermal energy to replace currently used fossil fuel for heat generation. The study, which focused on areas where central heating networks were already established, confirmed that substantial geothermal aquifers occur within the Devonian and that the largest and most promising storage areas are located in Lithuania.

DEPA was requested by the Government of Lithuania to extend the Baltic study to include the preparation of a feasibility study for construction of a geothermal demonstration plant in Klaipéda, which was identified as being the best location for a demonstration project. In Klaipéda (population: 210 000), the district heating company provides heat to 98 per cent of the inhabitants.

The feasibility study indicated that a suitable size of a project plan should provide approximately 530 TJ annually, or around 10 per cent of total heat demand in Klaipéda. During summer time, the geothermal plant should have a capacity to cover all heat demand to the city.

A World Bank/GEF identification mission for the geothermal project was made in February 1994, plus a pre-appraisal mission in September 1994 and an appraisal mission in March 1995. In between, a number of preparatory field visits were made to review specific issues. These missions and visits have also included representation from the Danish Ministry of Environment. The World Bank and GEF approved funds and grant for the project in June 1996.

II. Project Description

Main Project Objectives

– Demonstrate the feasibility and value of using *low temperature geothermal water* as a renewable indigenous energy source for use in district heating systems.

– Reduce emission of greenhouse gasses and SO_2 by replacing gas and heavy fuel oil (mazut).

– Promote sustainable management and development of environmentally sound and non-polluting geothermal resources.

The project is expected to contribute to energy security, highlighted as a priority in the National Energy Strategy. The project implementing agency in Lithuania is UAB Geoterma, a joint stock company, with the Lithuanian Government as main shareholder.

Project Financing

The project consists of two components:

1) A Technical Assistant and Training Component (DEPA grant)
2) An Investment Component (World Bank/GEF/EU Phare)

Total budget: 18 mill USD

World Bank (5.9 mill USD)
GEF (6.9 mill USD)
Local Contribution, Government of Lithuania (GOL) (2.6 mill USD)
EU Phare (0.1 mill USD)
DEPA (2.5 mill USD)

The Danish support comprises four major fields of activities:

1) Project steering, coordination and supervision of the start-up of the project plant
2) Engineering and specifications with regard to the aquifer development and surface demonstration plant
3) Procurement and contracting with regard to required goods and services
4) Training of UAB Geoterma staff and associated personnel

The Danish TAC is provided by DONG E&P and it's subcontractors, Petroleum Geology Investigators and Houe & Olsen I/S. The magnitude of the Danish TAC has been revised upwards from 32 000 man-hours initially to 35 000 man-hours, due to problems related to the injection capacity.

Feasibility (Economic/Financial)
According to World Bank economic estimates, the proposed demonstration plant would not be economic viable without taking into account related environmental benefits. However, grants from the DEPA and GEF should allow the project to meet its recurring costs and debt-service obligations under the expected circumstances. If global and national environmental benefits are included, the Economic Rate of return is calculated to 11.7 per cent. The projects' economic viability will be sensitive to development in energy prices and to the quantity of heat extracted and the price at which it will be sold.

Given the high investment costs for the geothermal plant, a "take or pay" contract for a period of 25 years was signed in April 1996 between UAB Geoterma and Klaipéda District Heating Company, at that time owned by the Lithuanian Power Company (later on, the heating company was sold to the Municipality of Klaipéda and renamed to *Klaipédos Energija).* The contract should ensure that UAB Geoterma, upon project completion, would have a ready buyer for its geothermal heat and at prices already agreed upon.

Environmental Benefits
The DEPA-financed feasibility study in Klaipéda showed that geothermal energy, compared to other indigenous energy resources, had a much larger development potential and a lower heat generation cost based on a production capacity of 530 TJ.

Annual Reductions (tonnes) in Consumption and Related Emissions of Mazut/Natural Gas in The Klaipéda Heating System when Substituted by Geothermal Energy (530 TJ)

Fuel type	Annual Reduction	CO_2	SO_2	NOx	Particulate
Mazut	16 500	51 940	1 160	110	18
Natural Gas	19 500	48 000	0	0.05	0

Source: World Bank

As it can be seen from the table above, the potential global environmental effect from the geothermal energy use is considerable in this project. Substitution of gas and mazut will result in significant reductions in CO_2emission. Moreover, in the case of mazut, the substitution will also have positive local environmental effects through savings in SO_2 and NOx emissions. Since the geothermal water is re-injected into the aquifer, there are no reverse environmental effects from using the geothermal energy.

Technology and Transfer of "Know How"
According to the original project schedule, the geothermal plant should be working under full capacity (55.7 MW) from January 1999, delivering around 530 TJ annually. It was anticipated that 600 m^3/h geothermal water of 42°C would be pumped up from about 1 200 metres depth and circulated via a closed geothermal loop, utilizing heat exchanger and heat pumps for retrieval and subsequent supply of heat into the existing district heating system in Klaipéda. The geothermal water would be extracted from two production wells and returned with reduced temperature to the same depth.

The technical risks related to the project were mainly defined as: 1) Suitable level of geothermal water that can be extracted and, 2) Temperature of the geothermal water extracted. To reduce impact of these risks, the feasibility study was based on an energy extraction, 30 per cent less than anticipated maximum.

III. Project Effectiveness

Economic/Financial
The project still has not provided the expected economic returns due to a range of factors, - some of which are closely interrelated.

The signed Take or pay Contract is currently under dispute due to Klaipėdos Energija's unwillingness to comply with the conditions for payment pursuant to the contract. This dispute could seriously jeopardise the economic fundament and the opportunities for future Lithuanian geothermal development.

Due to continuing technical problems (see below) the geothermal plant is currently only working at half capacity. During summer time (2001) the plant would supply the produced heat to Klaipėdos Energija according to a special, provisional agreement, where KE will buy the geothermal heat from UAB Geoterma but at a price less than the one calculated in the "take or pay" contract. However, according to Klaipėdos Energija, geothermal heat still has not proven to be a reliable source of energy supply for the company, as originally anticipated.

Institutional arrangements required for the World Bank loan and the subsequent effectiveness with regard to the loan and GEF grant, caused initially some delay, basically due to internal Lithuanian institutional factors. Moreover, a planned and confirmed EU Phare grant of 850 000 EURO, was suddenly withdrawn on August 1999 without any further explication from the EU. Consequently, equipment had to be re-procured pursuant to World Bank conditions, which caused a 5-months delay in the implementation.

Environmentally
Since the geothermal project plant just recently has started to supply energy to the district heating system in Klaipėda, and at reduced capacity, the direct environmental effects from the project are still very limited and far from the expected levels.

Technology and Transfer of "Know How"
One out of 23 contracts (tenders) for this project was won by a Danish company (HECO) (water filters).

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 and it is still unsure when and if the plant will be fully operational as originally predicted. Several technical issues have influenced this delay.

It was found that the temperature of the geothermal water was 38-39°C instead of the originally anticipated 42°C. It was however concluded that there was opportunity to increase the production of geothermal water from 600 m^3/h to 700 m^3/h. This would result in the same amount of heat produced.

During 1998 it was deemed necessary to drill a second injection well since the injection capacity in the first one was insufficient for the injection of all the geothermal return water (700 m^3/h). Delay and problems related to installation and use of equipment have also prolonged the project implementation process and caused abruptions in the plant functioning.

A serious, continuing problem for the project plant is that a gradual increase of the injection pressure has been deteriorating the injection capacity. Experts are currently working on how to resolve this problem and it is hoped that the problem could be solved shortly. Heat exchangers and economizers are being installed in order to enable the plant to provide heat even if there should be a temporary problem with the absorption heat pumps and to extract more heat from the boilers.

Manuals for plant operation were delivered to project site with significant delay and this has made it more difficult for the local staff to operate the plant. Moreover, the project staff in Klaipéda claimed that practical training in plant operation had until now been insufficient in order for them to operate efficiently the geothermal plant.

IV: Project impact

Economic/Financial

The DEPA study carried out in 1992 showed a significant potential for geothermal heat in Lithuania if technical and economic exploitation of resources could be confirmed. 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.

Moreover, it is expected that subsequent geothermal plants could be build at a lower capital cost by maximizing local engineering and other technical skills developed through transfer of technology under the Klaipéda Demonstration Project. This would probably also be required since new plants cannot be expected to receive similar amounts of grants.

Although Klaipédos Energija was unable to provide figures on the employment effects from implementation of geothermal energy supply, it was admitted that an adverse effect could be expected. Taking into consideration that employment opportunities in Klaipéda are scarce, rationalisation in the district heating company must be expected to be a difficult social task.

Environment

Continued development of Lithuanian geothermal resources, according to the DEPA 1992-study, could produce an inherent reduction in the CO_2 emissions related to the heat production in the order of 750 000 tonnes and in SO_2 emission of around 22 000.

Technology and Transfer of "Know How"

It is expected that the new technology and technical skills developed at the geothermal demonstration project in Klaipéda could be used for future geothermal projects in the country.

V. Project Sustainability

Financial/Economic

The economic/financial sustainability of the project in Klaipéda will first of all 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 might 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 on 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 (f.ex. 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 prices anticipated. During the Consultants' interviews it was emphasized by Klaipédos Energija that they will require a guarantee that the geothermal project plant is a *reliable energy supplier*, before they will consider relying on geothermal energy.

Environmental

The future environmental effect from the project will of course depend on how much geothermal energy the project plant will be able to supply to the heating system in Klaipéda. As already explained above, this is still pending resolving of some technical, economic and political/institutional issues.

The relative environmental benefits will also depend on the alternatives to geothermal heat. The calculated savings of CO_2 and SO_2 in the project are based on substitution of mazut respectively coal. However, if these fuel sources can be partly or totally substituted by cleaner energy sources in the future (e.g. wood) the relative savings will be less than anticipated.

Finally, implementation of complementary energy initiatives in Klaipéda could influence future effects from the geothermal plant. For instance, in 1997 the Danish Energy Agency financed a demonstration project on Energy Savings in buildings in Klaipéda. One central argument for implementing this project was, that it would increase the effect of the geothermal plant through lower return temperature of the geothermal water and thereby a more efficient energy use. The energy equipment and the energy saving concept is now being installed in more buildings in Klaipéda and is thereby strengthening the potential impact of geothermal energy in the area.

Organisational/Institutional

It was the general impression from the Consultants meetings with local and regional representatives in Klaipéda, that the geothermal project is lacking local (political) support. At the local level the project is very much considered as a *Governmental* prestige project and not as a project implemented to benefit the area. Obviously, Klaipédos Energija does not feel any incentives to buy the geothermal energy from the state-owned company unless it is offered them 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. During the Consultants' consultations with local representatives it was criticized that the geothermal project plant had been developed without including adequately the physical and organizational integration with the Eastern Boiler House in Klaipéda, placed right next door to the geothermal plant. Visually, it is obvious that the new, very modern equipped office facilities for the geothermal, S*tate*-owned, project, represents a sharp (psychological) contrast to the old, poor-equipped *Municipality*-owned Eastern Boiler House in Klaipéda.

Technology
For the time being, the technologic future of the project is still unsure and will depend on further investigations on project site.

Dissemination
Before and during project start-up, the project was presented in Lithuanian Television as well as in newspapers and journals. These presentations added to creation of general high expectations to project performance.

Lately, articles published in local medias have mainly dealt with remaining technical problems related to the project plan and the dispute between UAB Geoterma and Klaipéda Energija regarding payment conditions. Naturally, this has influenced negatively on the opinion regarding the project and the related investments.

VI. Lessons Learned (Consultants findings, based on visit to Klaipéda Geothermal Demonstration Project)

1) Stronger focus should be put on *institutional issues*, as well during the preparation phase as during project implementation. This should include analysis of legal aspects, institutional structures and capacity, both at the national and at the local level, and recommendations and support on institutional project set-up. In particular, it must be emphasized that local project involvement is of utmost importance, including financial and political responsibility. In the Klaipéda project, it is evident that the local anchoring of the project is not very strong, and this is indeed threatening the sustainability of the whole project.

2) More attention should be paid to obtain general *local support* and "acceptance" for these kinds of projects that represent new technologies and big-money investment. This should include information campaigns, seminars, workshops etc, at the local level where project concept and, in particular, related environmental benefits could be explained and discussed. In the case of Klaipéda, it must be questioned if the local area actually has been "mentally prepared" and geared for implementation of this kind of project (compared to the situation in e.g. Poland).

3) *Technical analysis' and project design* should be more carefully prepared in order to avoid significant delays, unreliability and insecurity. Especially, when it is a demonstration project, as this one in Klaipéda, it is of utmost importance to have a positive case

presented since the project is expected to be a catalyst for further development of geothermal energy potential in Lithuania,

4) More efficient support on *management/organisational issues* should be given both in order to create sustainable, local capacity but also to secure smooth project implementation at 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. (The Klaipéda project staff explained that they often had felt "left alone" with the problems on the project plant and in disputes with foreign companies. They felt that their (Lithuanian) "voice" did not weight as much as would have done an interfering "voice" from "an EU member company").

5) More *transparency* and improved *training/preparation facilities* should be provided to the local project staff in order to make them comfortable with the new technologies and working procedures. This could include early visits/practical training on already functioning project plants and early provision and instruction of relevant manuals and material.

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