



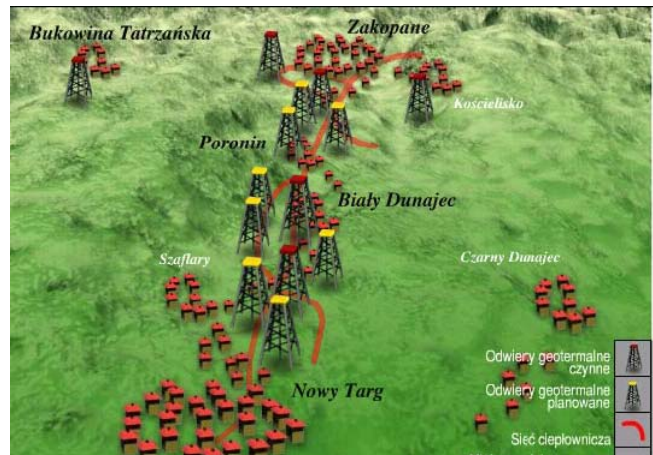
Utilization of thermal energy in the Podhale region *Przesiębiorstwo Energetyki Ciepłej* **GEOTERMIA Podhalańska Spółka Akcyjna, Poland**

Summary

The main components of this energy project are:

A. Production and Transmission of Heat, including:

- seven geothermal wells - three for production and four for reinjection. The production wells extract low-enthalpy (~ 85 to 87.5°C temperature) geothermal waters in the Podhale basin to cover the base-load heat demand for the entire project area;
- a base-load geothermal district heating plant with a capacity of approximately 38 to 43 MWt delivering 1,015 TJ/year of geothermal heat;
- two gas-fired hot water boilers and a gas network pressure reduction station; with a total capacity of 33 MW, the plant will deliver 355 TJ/year of heat - 60% produced by gas firing and 40% by extracting additional heat from geothermal waters;
- a 48 MW_t peak-load natural gas plant in Zakopane (22 MWt) and a similar plant in Nowy Targ (14 MWt planned) for a combined production of about 73 TJ/year of heat;
- small-scale acquisition of land for new drilling sites, constructing new buildings and expanding existing buildings for the production facilities.



Location of the geothermal wells in the Podhale valley Red boreholes- existing wells, yellow boreholes planned wells

B. Heat Distribution Network Development

- constructing a new heat distribution network (about 80 km) for the Podhale area and connecting customers to this network.
- district heating infrastructure in the Podhale - 20 km of new pipelines for the transmission of hot water, two gas transmission pipelines, electric connections, and pumping stations;

C. Installation of Heat Exchangers and Meters in individual households and other buildings; this component also includes provision of miscellaneous tools and vehicles for the implementing company.

End-user area

- New buildings
- Refurbishment of buildings
- Transport and mobility
- Financial instruments
- Industry
- Legal initiatives (regulations, directives, etc)
- Planning issues
- Sustainable communities
- User behaviour
- Education
- Other

Target Audience

- Citizens
- Households
- Property owners
- Schools and universities
- Decision makers
- Local and regional authorities
- Transport companies
- Utilities
- ESCOs
- Architects and engineers
- Financial institutions
- Other

Technical

- Energy efficiency
- Heating
- Cooling
- Appliances
- Lighting
- CHP
- District Heating
- Solar energy
- Biomass
- Wind
- Geothermal
- Hydro power
- Other



Context

The primary development objective of the Project was to reduce air pollution from local coal-fired space-heating boilers through increased utilization of clean energy resources such as geothermal heat and natural gas in the Podhale region. This objective was supposed to be achieved by developing a geothermal DH system with supplemental gas-fired peaking capacity to provide heat to seven municipalities of the Podhale area. This was done by connecting individual heating systems to an efficient DH system supplied by clean and renewable fuels. Replacing polluting fuels was done to provide cleaner air and greater comfort for the inhabitants. Significant reductions in respiratory disease were anticipated from the decreases in emissions of particulates from coal and coke combustion. The proposed improvements were also to reduce the environmental damage to the biota in the neighboring national parks and protected areas. The improved environmental quality of the Podhale area was also expected to make it more attractive for tourism.

Objectives

The summary of aims of the project is presented in then Table 1 below.

Table 1: Summary of project aims

| Benefits | Measured in Terms of: | Target Population |
|--|--|---|
| Cost savings; cleaner and more comfortable heat | <ul style="list-style-type: none"> ▪ Improved efficiency ▪ Reduced labor, fuel costs and other operating costs ▪ Deferred capital investments | <ul style="list-style-type: none"> ▪ 4,243 households in Zakopane and the villages ▪ 172 large customers in Zakopane and the villages ▪ Customers of former DH company in Zakopane (Tatry) ▪ Customers of DH company in Nowy Targ |
| Improved air quality and improved health as a result | Reduced local concentrations of air pollutants, mainly TSP/PM10 | <ul style="list-style-type: none"> ▪ All residents living in seven municipalities, but especially in Zakopane and Nowy Targ ▪ Tourists in the Podhale region |
| Global benefits | Reduced CO ₂ emissions | Global community |
| Demonstration of geothermal energy | Commercially and economically viable geothermal project | Poland and elsewhere in Central and Eastern Europe |

Process

Phase 1 (1993 – 1995):

- 1.1. Developing and operating a pilot plant on the basis of the first geothermal doublet (two wells, one for production, one for reinjection - Doublet #1) at Banska Nizna and Bialy Dunajec.
- 1.2. Connecting over 200 households to the nearby pilot plant through a small DH distribution network.

Heat sales of 0.1 million GJ/year at the end of Phase 1.

Phase 2 (1996 – 2000):

- 2.1. Drilling of a second geothermal doublet (Banska PGP 1 and Bialy Dunajec PGP 2, i.e. (Doublet #2 a) (done).
- 2.2. Construction of a geothermal base-load plant in Banska Nizna (done).
- 2.3. Construction of 3.5 km of DH transmission line to Zakopane (done).
- 2.4. Expansion of the DH distribution network of Bialy Dunajec (done).
- 2.5. Conversion to heat-exchangers of 27 households in Bialy Dunajec (done).
- 2.6. Construction of a 22 MWt gas-fired peak-shaving plant in Zakopane (done).
- 2.7. Expansion of DH distribution network in Zakopane (ongoing).
- 2.8. Conversion of nine coal-fired boilers to heat exchangers and connection to the DH network (done).



- 2.9. Conversion of large customers and connection to the DH network (ongoing).
- 2.10. Hydro geological tests of geothermal wells (in Poronin, Bialy Dunajec, Furmanowa, Chocholow and Banska) for estimation of resources (done).
- 2.11. Completing of the DH transmission network to Zakopane (about nine km).
- 2.12. Expanding the peak-load plant in Zakopane to 32 MWt.
- 2.13. Conversion of 18 boilers to heat exchangers and connection to the DH network in Zakopane and 75 large scale customers.
- 2.14. Drilling of injection well PGP 3 (Doublet #2 b).
- 2.15. Continuation of the DH distribution network in Zakopane (about 2100 individual customers).
- 2.16. Construction of a new administration building.

Heat sales of 0.7 million GJ/year at the end of Phase 2.

Phase 3 A (2000-2001):

- 3.1. Bringing on stream one new geothermal doublet (well PGP 4, well PGP 5 - Doublet #3).
- 3.2. Expansion of DH distribution networks in Koscielisko, Bialy Dunajec and Poronin (3 large scale and about 130 individual customers).
- 3.3. An absorption heat pump plant (AHPP), a pressure reduction station and two gas pipelines built.

Heat sales of 0.8 million GJ/year at the end of Phase 3A.

Phase 3 B (2001-2004):

- 3.4. Expanding the peak-load plant in Zakopane to 48 MWt.
- 3.5. Continuation of the DH distribution networks in Poronin and Bialy Dunajec (mostly individual customers (1,200)).

Heat sales of 0.9 million GJ/year at the end of Phase 3B.

Phase 4 (2001-2004):

- 4.1. Construction of the main DH transmission line to Nowy Targ (7 km) - 2001.
- 4.2. Construction of a DH distribution network in Szaflary (almost 600 individual customers).
- 4.3. Construction of the geothermal base-load plant for Nowy Targ.
- 4.4. Construction of a gas-fired peak-load plant at Nowy Targ (14 MW_{th}).
- 4.5. Extension of the existing DH distribution network in Nowy Targ (about 3 km).

Heat sales of 1.2 million GJ/year at the end of Phase 4.

So far the realisation of phase 4 has been suspended, the network is not likely be extended in the direction of Nowy Targ. Instead new ideas for the utilization of heat demand were elaborated such as utilization of geothermal waters in spas in Zakopane and Bańska Nizna. The heat sales were updated and assumed a few times lower than the original ones.

Financial resources and partners

In 1995 the World Bank initiated its engagement in the Podhale District Heating and Environmental Project. This engagement led to a granted loan of US\$ 38.2 million. Beneath the World Bank and other national and international financing institutions the Global Environment Facility has entered the project with a grant of US\$ 5.5 million. The GEF paid attention to the high amount of carbon dioxide (CO₂) to be reduced by switching from fossil fuels to geothermal energy. It was estimated that 110,000 tons of CO₂ annually and more than 2.6 million tons over the project lifetime was supposed to be reduced.

The grant of the GEF was approved in 2000 and based on the expected reduction of 2.6 million tons of CO₂ during the lifetime of the project at an incremental cost of about US\$ 3.00 per ton. In order to justify the real amount of the support, a monitoring and evaluation (M&E) reporting was required from 2001 to 2004.



Table 2: PEC Geotermia Podhalanska: Financing Plan for the years 2000 to 2004

| Applications | PLN Million | | | US\$ Million | Percent |
|---------------------------------|--------------|--------------|--------------|--------------|---------------|
| | Local | Foreign | Total | | |
| Project Investment | 153.3 | 94.6 | 247.9 | 56.7 | 80.9% |
| Financing Costs | 3.2 | 24.8 | 28.0 | 6.2 | 9.2% |
| Changes in Cash/Working Capital | 27.1 | - | 27.1 | 5.9 | 8.8% |
| Miscellaneous | 1.2 | 0.5 | 1.7 | 0.5 | 0.5% |
| M&E of GHG Abatement | 0.8 | 0.8 | 1.6 | 0.4 | 0.5% |
| Total | 185.5 | 120.7 | 306.2 | 69.6 | 100.0% |
| Sources | PLN Million | | | US\$ Million | Percent |
| | Local | Foreign | Total | | |
| Internally Generated Funds | 50.1 | - | 50.1 | 10.7 | 15.4% |
| Equity | 7.3 | - | 7.3 | 1.7 | 2.4% |
| Grants | - | 80.8 | 80.8 | 19.0 | 27.3% |
| Phare II | - | 45.0 | 45.0 | 10.5 | 15.1% |
| GEF | - | 22.6 | 22.6 | 5.4 | 7.8% |
| USAID | - | 10.5 | 10.5 | 2.5 | 3.6% |
| DEPA Grant | - | 2.6 | 2.6 | 0.6 | 0.9% |
| IBRD Loan | - | 168.0 | 168.0 | 38.2 | 54.9% |
| Total | 57.4 | 248.7 | 306.2 | 69.6 | 100.0% |

Results

In 2003 The Geothermal District Heating system consisted of:

District heating (DH) network: The total length of the DH network amounted to some 60 km

Heat Boilers: Geothermal Base Load Plant (BLP): located in Banska Nizna, installation of 3 heat exchangers with a capacity of 7.5 MWth each. The BLP is located next to the production and reinjection wells, and includes the technological system comprising of a recirculating water treatment system, expansion system and circulation pumps with a capacity of 3x470 m³/h.



Gas fired Peak Load Plant (PLP): Located in Zakopane, 2 gas-fired boilers with 10 MWth installed capacity, together with economizers (1 MWth each) for the condensation heat recovery from the combustion gases. 3 heat exchangers with 17 MWth each to separate the primary system from the distribution system. Additionally, 3 gas engines with a thermal capacity of 3x700 kW and an electric capacity of 3x550 kW, in addition to another boiler with a capacity of 14.7 MWth, to be fired alternatively by gas or oil.

Peak load boilers

Former Tatry Boilers: 28 boiler houses that have been taken over by Geotermia at the beginning of the project, and that have mostly been switched from fossil fuels (coal/coke, oil, gas) to receive heat from the geothermal system. At the end of 2003, only one boiler house ("Pardalowka") was not connected (using natural gas). The following Table 3 gives the number of Former Tatry boiler houses using different energy sources. It explains the actual development of the consumption of fossil fuels being used by those boiler houses which were still not connected to the geothermal DH system.



Table 3: Energy sources Former Tatry Boiler Houses (actual development)

| Energy source former tatry boiler | | 1999 | 2000 | 2001 | 2002 | 2003 |
|-----------------------------------|---------------|-----------|-----------|-----------|-----------|-----------|
| coal/coke | Number | 12 | 5 | 3 | 0 | 0 |
| gas | Number | 5 | 5 | 4 | 2 | 1 |
| oil | Number | 2 | 2 | 2 | 1 | 0 |
| geothermal sys | Number | 9 | 16 | 19 | 25 | 27 |
| Total | Number | 28 | 28 | 28 | 28 | 28 |

Table 4: Fuel Use 1999-2002: Actual

| Heat Production Actual | Unit | 1999 | 2000 | 2001 | 2002 | 2003 |
|------------------------------|-----------|----------------|----------------|----------------|----------------|----------------|
| Geothermal Plant | GJ | 22,450 | 22,600 | 41,428 | 160,927 | 205,400 |
| Peak load plant total | GJ | 70,158 | 97,594 | 132,958 | 76,342 | 49,945 |
| Gas boilers | GJ | 70,158 | 97,594 | 112,000 | 42,703 | 48,775 |
| Oil | GJ | | | | | 1,170 |
| CHP | GJ | 0 | 0 | 20,958 | 33,639 | 0 |
| Tatry Boilers | GJ | 60,699 | 41,165 | 31,532 | 20,918 | 13,943 |
| Heat Production total | GJ | 153,307 | 161,359 | 205,918 | 258,187 | 269,288 |

The actual operating inputs in the years 1999 to 2003 are described as follows:

| Operating Inputs Actual | Unit | 1999 | 2000 | 2001 | 2002 | 2003 |
|-------------------------|------------|---------------|---------------|---------------|---------------|---------------|
| Electricity | MWh | 1,082 | 1,002 | -2,903 | -2,191 | 6,354 |
| Natural Gas | TCM | 2,768 | 3,529 | 5,205 | 3,521 | 1,969 |
| | MWh | 29,334 | 37,399 | 55,149 | 37,312 | 19,307 |
| Coal, Culm | Tons | 1,721 | 515 | 86 | | 0 |
| | MWh | 13,292 | 3,980 | 663 | | 0 |
| Oil | Tons | 62 | 103 | 67 | 24 | 33.4 |
| | MWh | 759 | 1,256 | 823 | 293 | 409 |
| Total | MWh | 44,467 | 43,637 | 53,732 | 35,414 | 26,070 |

Contribution to Sustainable Development: The primary development objective of the Project has been to reduce air pollution from local coal-fired space-heating boilers through increased utilization of clean energy resources such as geothermal heat and natural gas in the Podhale region of southern Poland. This objective was to be achieved by developing a geothermal district heating system with supplemental gas-fired peaking capacity to provide heat to seven municipalities of the Podhale area. This was to be raised by the displacement of individual heating systems by connecting their users to an efficient DH system supplied by clean and renewable fuels. Replacing polluting fuels was supposed to provide cleaner air and greater comfort for the inhabitants. Significant reductions in respiratory disease are anticipated from the decreases in emissions of particulates from coal and coke combustion. The proposed improvements will also reduce the environmental damage to the biota in the neighboring national parks and protected areas. The improved environmental quality of the Podhale area was also expected to make it more attractive for tourism.

Environmental data: While generally not bad in comparison with some industrialized areas of Central and Eastern Europe, the air quality in Zakopane, and especially Nowy Targ, was characterized by elevated levels of suspended particulate matter due to coal combustion during the heating season.



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The impact of the Project on other environmental media also needs consideration. Improperly designed or operated geothermal systems may pose some risk of contaminating drinking water. However, this Project employs a closed-loop design, in which this risk is minimized. The water is supplied to heat exchangers and then reinjected back into the reservoir without being in direct contact with the consumer or the environment. The mineralization of the geothermal waters used for the project is mostly in the range of 0.2 - 0.4 g/l, but in some strata of the geothermal reservoir it may reach about 3.0 g/l. This level of salinity is still remarkably low by comparison with other geothermal reservoirs currently under development in Poland and elsewhere in Europe. Nevertheless, the discharge of geothermal water into the mountain streams in the vicinity of a National Park is considered undesirable. For this reason, the system was designed as a closed-loop system.

Project GHG-emissions: The associated global environmental objective was supposed to reduce CO₂ emissions in order to help Poland meet its international obligations under the United Nations Framework Convention on Climate Change (UNFCCC). The reduction of greenhouse gas (GHG) emissions such as CO₂ was supposed to provide an additional motive for the Government of Poland to pursue the Project. It was expected that, for the whole area to be covered by the Project, CO₂ emissions will be reduced by 2.7 million tons over the period from 1995 to 2024.

Lessons learned and repeatability

The indirect benefits of demonstration of the commercial-scale and economically viable utilization of geothermal energy accrues to the entire country and the region. The positive experience with the realisation of the project was supposed to contribute to replication of large scale DH geothermal projects not only in Poland but in the whole Central and Eastern European region.

Geothermal projects are capital intensive with large investment costs up-front that were difficult to predict accurately due to the uncertainties of drilling costs and reservoir yields. Thus, while the drilling costs and well yields to date have been better than anticipated, the plan for completion of the Project envisaged a reduced need for geothermal resources by incorporating gas-fired peak load plant into the project design. Because of the large investment needs, financial viability depends critically on the tariff level and rate of market penetration achieved. The merger with the Tatry DH Company assured conversion of 28 boiler houses serving the Zakopane district heating system. Intensive market analyses have been used to tailor proposals to 172 large loads and to develop realistic estimates of the share of the household market that can be reasonably expected to convert to geothermal energy. Incremental profitability studies were used to select the sequence and limits to the service areas selected for geothermal service. These planning procedures merit replication in other comparable Projects.

Contact for more information:

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