Podhale- S Poland - Geothermal District Heating System

Dr Piotr Długosz – PEC Geotermia Podhalanska SA ,
34-500 Zakopane ul. Nowotarska 35A , Poland
pdlugosz@geotermia.pl

1. Introduction

The efforts to find geothermal resources in the Podhale Region were begun in the late 1980's . The well, Banska IG-1, drilled in 1981, served as the starting point for an expansion of those research activities. A pilot geothermal energy plant was put into operation in 1993. In 1993, Geotermia Podhalanska company (GP) was founded, and the pilot project including the first distribution network for 20 customers, was constructed
After the initial phase of project implementation from 1993 to 1995 , developing and operating a pilot plant constructed for demonstration purposes by the Polish Academy for Sciences on the basis of the first geothermal doublet (one production well in Banska Nizna and one reinjection well in Bialy Dunajec) and connection of 200 households through a small DH network – the World Bank got involved in the geothermal district heating project. Since then, significant progress was made to increase the overall heat capacity and geothermal output as well as the service area to the City of Zakopane, which is situated approx. 14 km from the production wells. In November 2001 the first geothermal heat was delivered to customers in Zakopane.

2. The status of the technical implementation .

- Based on the pilot plant with the first geothermal doublet drilled (one production, one reinjection – **doublet # 1**) at Banska Nizna and Bialy Dunajec, and the connection of more than 200 households to the nearby pilot plant through a small DH network, a second doublet (production well PGP 1 and reinjection well PGP 2 – **doublet 2**) was drilled. These two doublets installed up to now have a potential flow rate of 670 m^3/h and are used for covering the base heat demand.

- The **Geothermal Base Load Plant (BLP)** was constructed between 1996 and 1998 in Banska Nizna, including up to now five heat exchangers with a total capacity of 30 MWth.. The BLP is situated between the production and reinjection wells of the second doublet (which are approx. 2,100 m away from each other). Furthermore, other technological units are installed in the BLP, such as a recirculating water treatment system (approx. 50 m^3/h capacity), an expansion system and circulation pumps with a capacity of 3 x 470 m^3/h towards Zakopane.

- The installation of the **Gas Peak Load Plant (PLP)** in Zakopane was started in 1996 and by the year 1998 two gas-fired water boilers of 10 MW_{th} capacity each, together with economizers (1 MW_{th} capacity each) for condensation heat recovery from the combustion gases, were installed. The water boilers are hydraulically separated from the water network system by three heat exchangers with a capacity of 17 MW_{th} each.

  Additionally 3 gas engines with a heat capacity of 3 x 700 kW_{th} and an electric capacity of 3 x 550 kW_{el} were installed in 2001, as well as an additional boiler with a heat capacity of 14.7 MW_{th} to be fired alternatively by gas or oil. The gas motors shall produce parts of

the necessary electricity used for pumping purposes and feed excessive electricity it into the grid.

- The **transmission line** of approx. 14 km length, (constructed as a double-line for the supply water and the return water, DN 400 to DN 500) was finished in 2001, connecting the geothermal plant with the peak load plant and the DH network in Zakopane. Along the transmission line, 3 pumping stations (with a electric capacity of 90 kW each) for the supply water and reduction stations for the return water were installed, because of the considerable ground level differences between the BLP (approx. 670 m above sea level) and the highest location of the system to be connected (approx. 930 m above sea level).

- **District heating (DH) network** : Until the end of 2002 some 56.5 km of DH network have been constructed, connecting approx. 800 customres.The pre-insulated pipes are built as low temperature heating network (90/50°C). All pipelines with diameters of DN 100 and larger are equipped with a leakage detection system. The temperature of the supply water after the heat exchangers in the BLP is about 82-83 °C, and drops by 2 °C as a result of heat losses in the 14 km transmission line to Zakopane, which results in an inlet temperature of about 80 °C at the point of the customer.

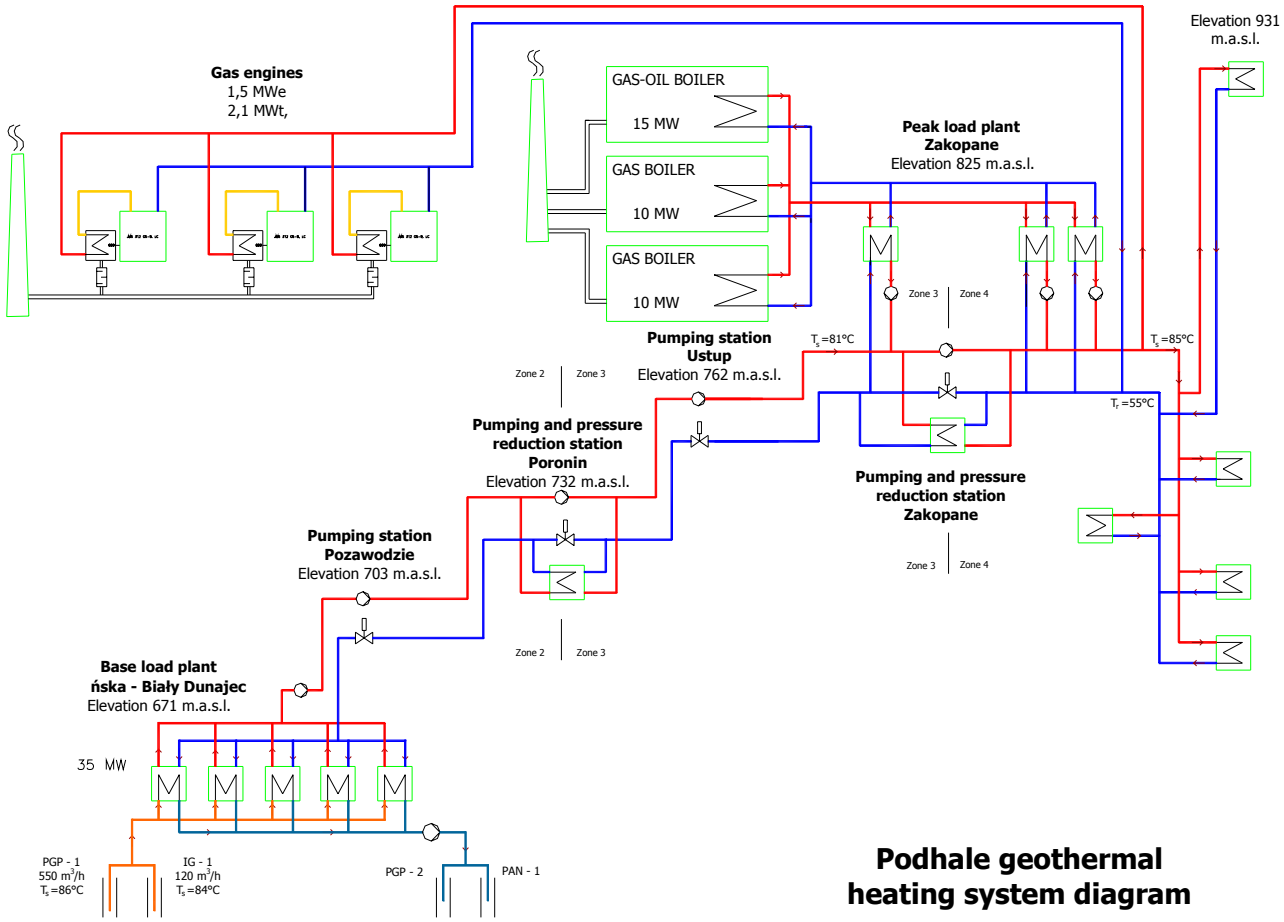

Fig.1 General layout of Podhale geothermal district heating system

3. Reservoir properties:

The geothermal district heating system in Podhale is exploiting very rich geothermal reservoir, consist of limestone and dolomite of the Tertiary age, located at depth of 2200 to 3400 m.b.g.l. Water temperature is 87º C, and a yield from a single well can reach 550 m3/h. Average permeability in the reservoir zone is in range of 900 (mD), effective thickness is about 150 m.

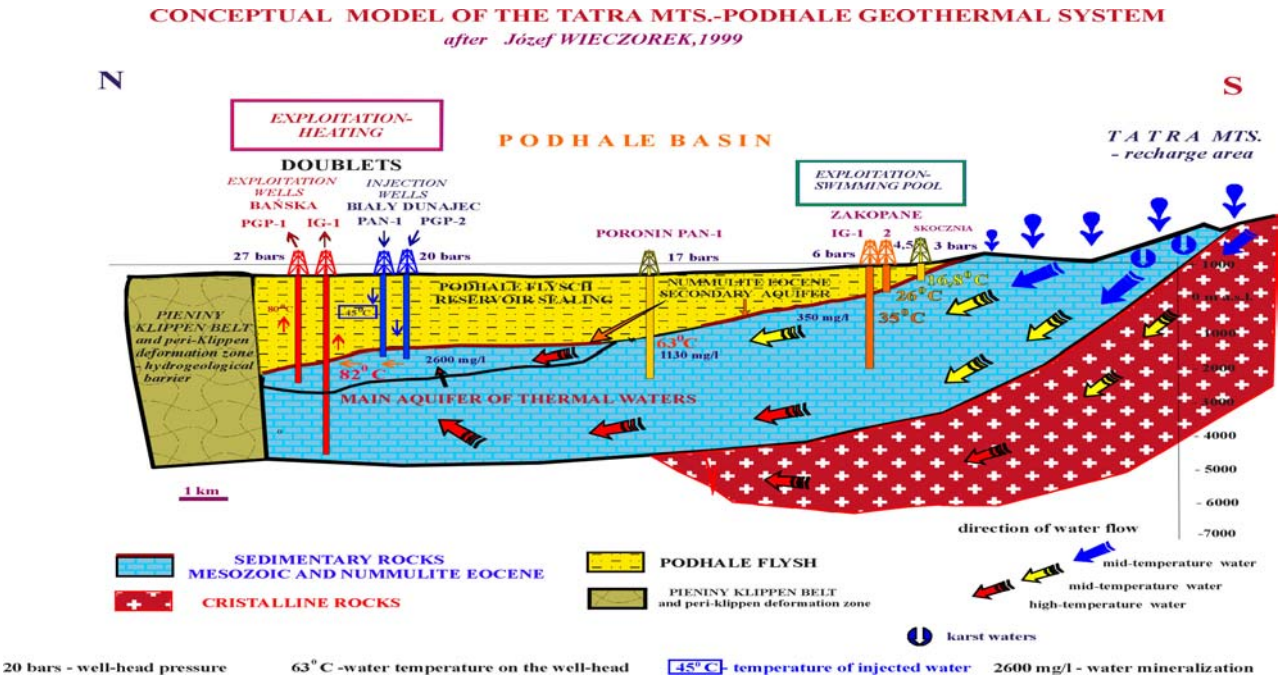

Fig.2 Geological cross-section of Podhale geothermal basin

3. Heat production

Heat is being produced in the following plants:

- Geothermal Base Load Plant
- Gas and Gas CHP Peak Load Plant

In November 2001 a first geothermal heat was delivered to customers in Zakopane. Investment costs has already reached level of 52 700 (kEuro). Installed capacity is 67 MW_t, heat production in 2002 reached 250 TJ/year, with a target production of 500 TJ/year in 2005.

4. Investment expenditures till the end of the year 2002

	Investment costs in (1000Euro)
Wells	3 500
Seismic survey 3D	1 500
Geothermal Base Load Plant	1 800

Peak Load Plant Zakopane	5 250
Transmission pipeline to Zakopane	10 000
Distribution network	20 000
Connections of customers	1 450

Project financing (end of 2003)

Sources of financing		(kEuro)
Foreign	**Local**	
EU Phare		17 700
The World Bank		10 525
GEF		2 500
US AID		1 750
DEPA		525
	Share capital	9 900
	National Fund for Environmental Protection	2 650
	Ecofund	1 050
	Bank PKO	6 100
Total		52 700

5. Revenues vs. expenses

These two graphs shows planned heat sales revenues and expenses in Euro

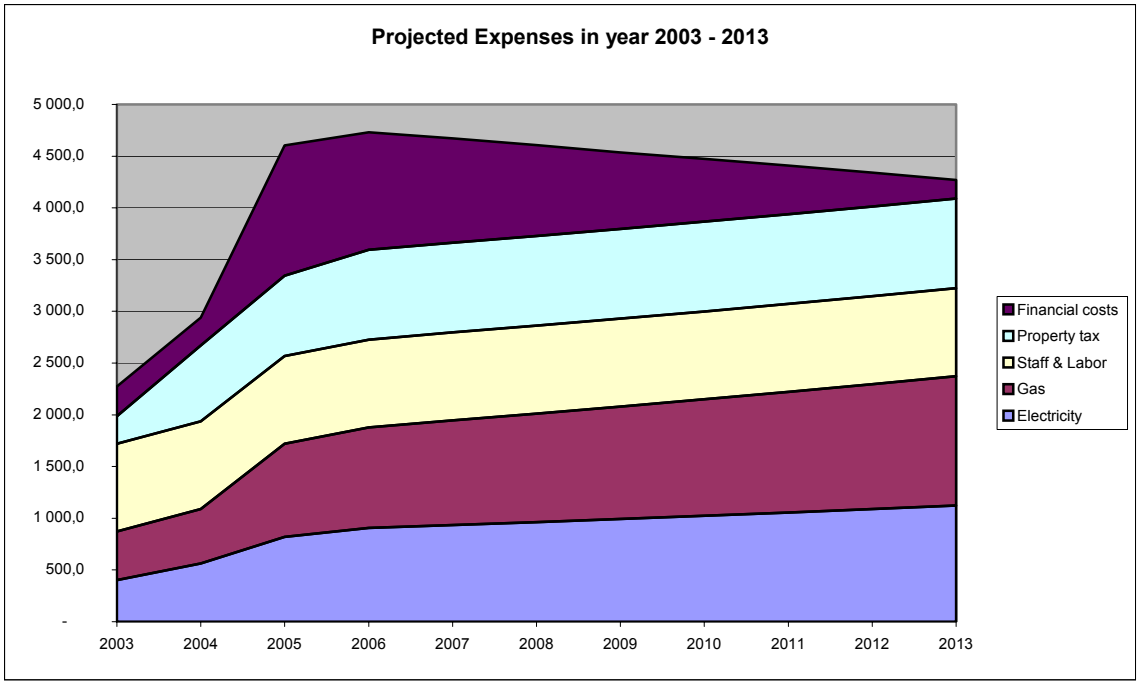

Fig.3 Projected expenses in years 2003 2013 of the project (in kEuro)

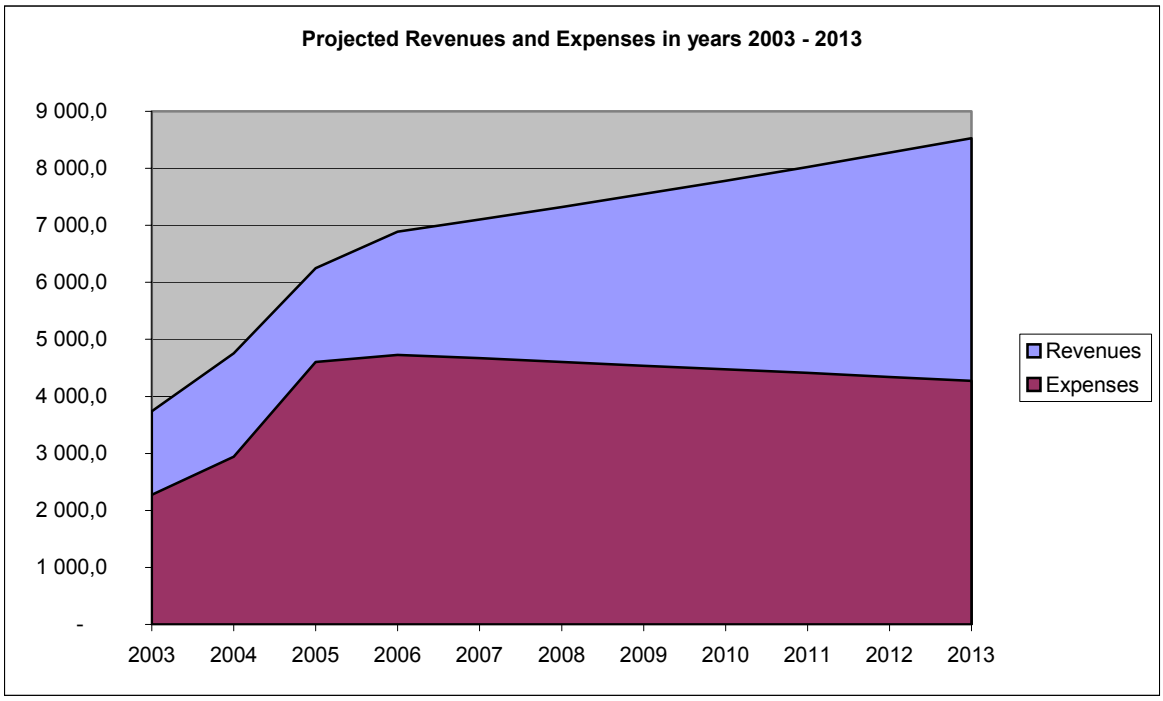

Fig.4 Projected revenues and expenses in years 2003 –2013 of the project (in kEuro)

6. Comparison of cost of heat for customers in Zakopane, produced from different sources

The results show that coal is still the cheapest energy source in Zakopane. Depending on heat demand, total costs for coal are between 1% and 4% per annum lower compared to geothermal energy. All other energy sources are more expensive than geothermal energy. Coke is about 10% more expensive than geothermal energy, natural gas between 17% and 43%, oil between 50% and 75%. The following diagram gives an overview on the cost situation.

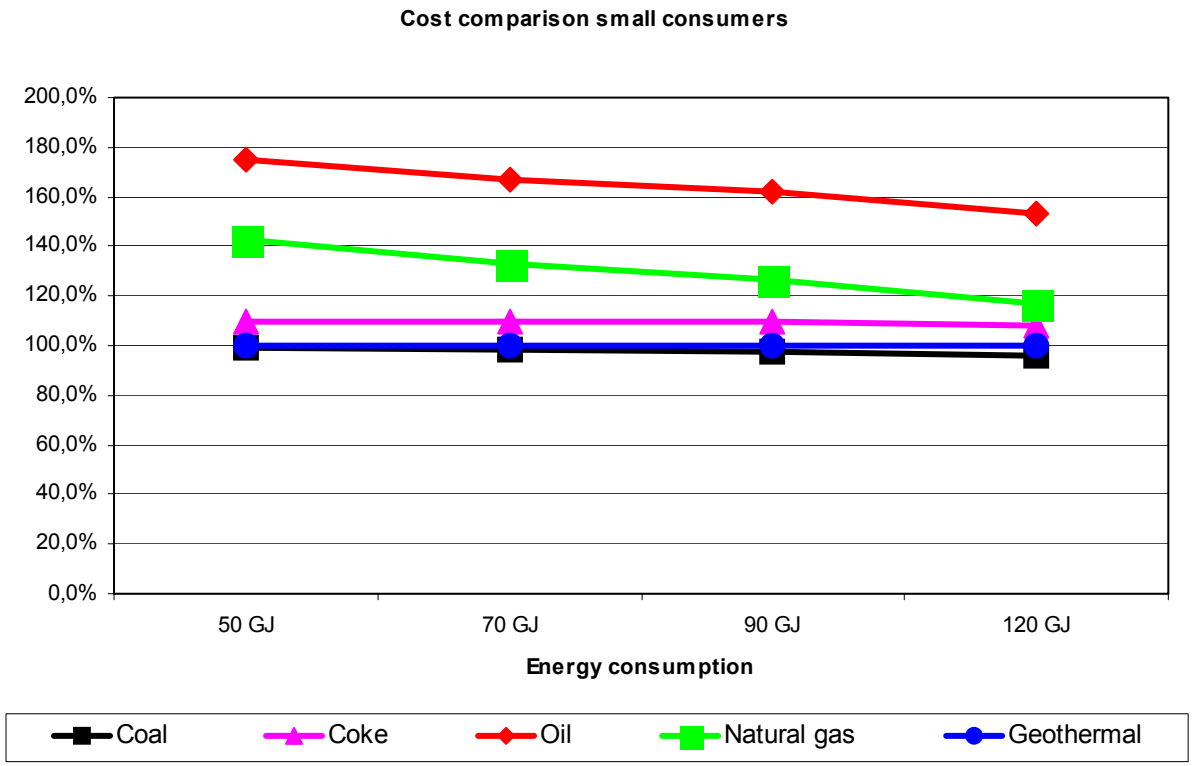

Figure 1: Cost comparison for small consumers with labor costs

The biggest influence on annual energy costs of coal and coke are the assumptions regarding labour input. The comparison above is based on labour costs of 9 USD per MWh. Depending on the energy demand, labour costs have a share between 25% and 30% of total energy costs for coal and coke.

7. Impact on Environment

Thanks to the implementation of the geothermal heating in 2002 annual and wintertime ambient concentrations of particulate matter (PM_{10}), sulfur dioxide (SO_2) in Zakopane has dropped by 50 % in comparison to the situation before the geothermal heating was in place.

The average yearly concentrations of SO_2 for the period 1994-1998 (before the Geothermal project was started) amounted to 32.6 µg/m³. In comparison to this period, the average concentration has been 23.6 µg/m³ (reduction of 27.6 %) in 2000 and 17.8 µg/m³ (minus 45.3 %) in 2001.

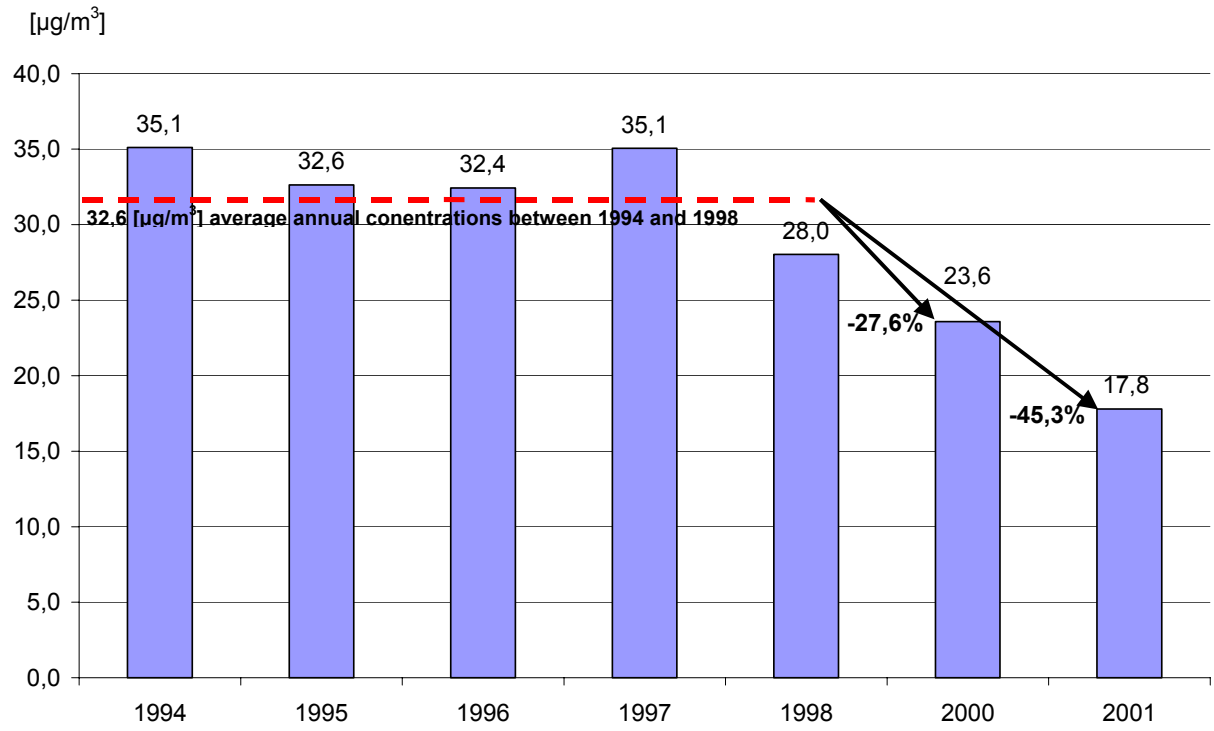

Figure 2: Annual average concentrations of SO_2

The annual yearly concentrations of PM_{10} for the period 1994-1998 (before the geothermal project was started) amounted to 54.3 µg/m3. This means that the annual average concentrations dropped by 49.3% in 2000 and 48.8 % in 2001 compared to average value in previous years. The slight increase of ambient concentrations of PM_{10} between 2000 and 2001 can be caused by local climate conditions like pressure, direction of wind etc. It could also be caused by an increasing number of cars coming to Zakopane, which are also regarded a significant source of emission of PM_{10}.

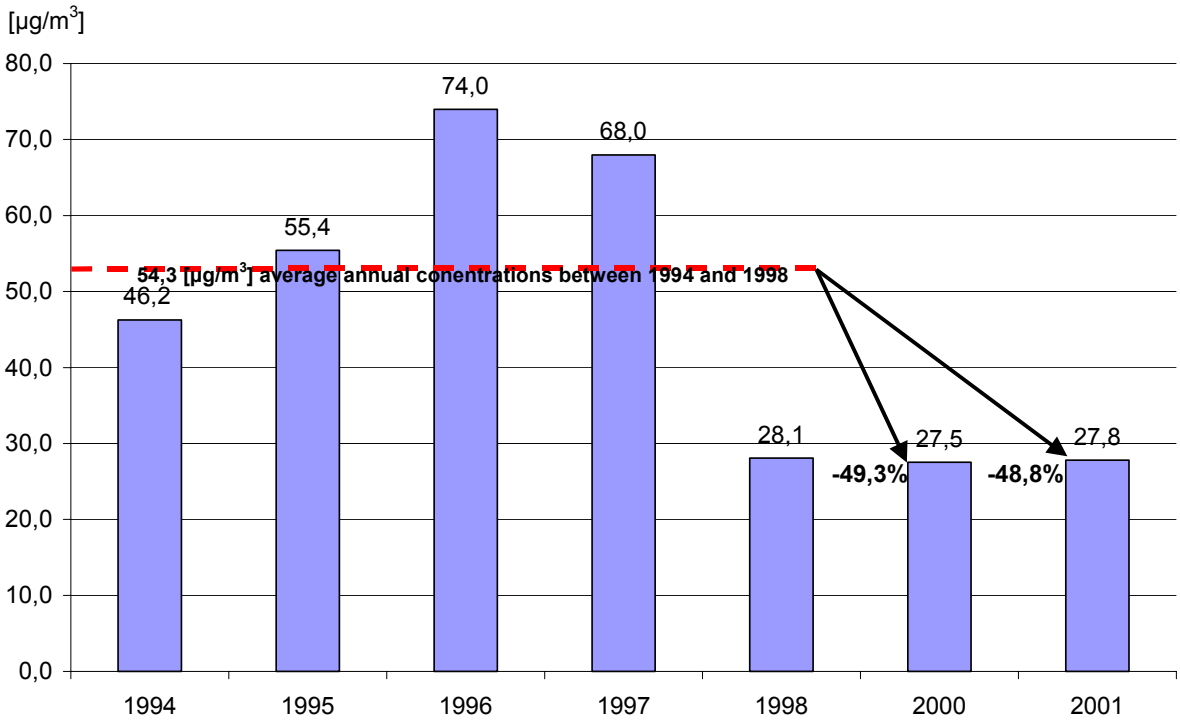

Figure 3: Annual average concentrations of PM_{10}

References

1. KWI Consultants @ Engineers – EC BREC- Podhale Geothermal District Heating and Environment Project – Monitoring of CO2 Abatement- 2002