Whenever legislation and natural conditions have permitted it, energy in the Czech lands has been drawn from the sun and wind, from biomass and geothermal sources, and from the use of heat pumps. It is the costliest from a financial point of view, but singularly the best in terms of efficiency and ensuring a steady supply of heat energy. Heat pumps are still the most popular source of heat in this country. Even though the discovery of this method goes back more than 150 years and has been in normal use for heating homes in Europe for at least 50 years, the past five years has seen interest rise markedly in the CR.

The idea for the heat pump was formulated by Lord Kelvin in 1852. One of the first such heat pumps was built in Switzerland in 1936, because there was no major source of energy in that country with the exception of water power. It was used to heat the magistrate building in Zurich. It was at that time that the idea took shape to use this source of heat on a mass scale. However, widespread use of heat pumps for heating did not occur until energy prices rose at the start of the 1970s [1].

In the Czech Republic several heat pumps were built by the firm ČKD some years ago or else constructed privately by enthusiasts, handymen and environmental activists. In 2004 there were a total of 1,597 heat pumps of different varieties installed throughout the CR according to the Association for the Use of Heat Pumps. By 2005/06 this number had grown to 2,500 heat pumps.

2. THE PRINCIPLE FUNCTION OF THE HEAT PUMP

There is a significant quantity of heat present in the earth, water and air. Its low thermal level, however, does not make it a direct source of energy. Heat pumps form the basis for
equipment that enables us to extract heat from the surrounding environment (so-called low-potential thermal energy), raise it to a higher thermal level and subsequently use it for heating and maintaining hot water taps for service water.

Heat pumps produce no solid, liquid or gaseous waste, unlike solid fuel (coal, biomass) or gas-fired (natural gas, LPG) furnaces, which are used the most in the Czech Republic. We can classify the operation of heat pumps as practically waste-free technology, and so far as operating and servicing them are concerned, they are very easy to control and virtually maintenance-free [2].

3. HEAT SOURCES FOR HEAT PUMPS

The primary sources of heat from the environment and geothermal energy are:
- “Dry” heat from rocky soil (“dry” drilling).
- Underground water (drilling, wells, irrigation shafts of old mines).
- Soil layers (aquifers).
- Outdoor air.
- Indoor air (air drawn from indoor ventilation systems).

4. OPERATIONAL COSTS FOR HEATING HOMES AND BUILDINGS

Owners of heat pumps have the advantage that every increase in energy costs means greater savings for them and a quicker return on their investment in the heat pump. Since 1991 the average family home has seen major increases in energy costs both for electric heating and natural gas, with costs for the latter going up a bit faster. Moreover, the price for natural gas depends on oil prices and can change drastically given the situation in the world. In the last year and a half alone natural gas prices have risen by 40%, requiring the average family home to pay more than 700 crowns more per month. 700 crowns are 25 EUR (Fig. 1).

![Fig. 1. The costs for heating per individual type of fuel](image-url)
5. HEAT PUMPS IN THE CR

Heat pumps are gaining wide acceptance in countries where people take a responsible approach towards the use of natural resources. In Sweden, for example, more than 90% of newly built houses come equipped with heat pumps. This country is also home to the largest European manufacturer of heat pumps, IVT INDUSRTY AB, which is part of the BOSH Buderus Thermotechnik concern. It has been successfully involved in the development of energy-savings equipment since 1975 and currently makes approximately 25% of all heat pumps sold in Europe. The Mining and Technical University of Ostrava cooperates with the IVT branch in Ostrava. The new lecture hall + information technology center are equipped with heat pumps made by this firm. In the Czech Republic, 1,880 homes are now equipped with heat pumps. This number continues to grow thanks to rising energy costs. Just for comparison: The country with the most heat pumps installed is the USA. In 2000, 140,000 of them were renovated, in 2004 that number had grown by another 150,000, and as of this year there were almost 1,000,000 heat pumps in the USA. First place on the European continent goes to Sweden. There were 24,000 of them installed there in 2000 and four years later the total was 60,000 units. Last year alone 300,000 pumps were installed in Sweden. A similar trend is underway in the Czech Republic, but the number of installations is still lower. In 2000 there were 400 heat pumps installed, 1,597 in 2004, and 2,500 units in 2006. Several examples of heat pumps being installed in the Czech Republic that draw energy by drilling into rocky soil are given below. Wells equipped with piping polyethylene collectors filled with an anti-freeze solution that carries the energy from the earth to the heat pump have been drilled by the company OKD, DPB a.s. Paskov, which has also been involved with this issue for a long period of time [3,4].

The largest projects carried out so far:
1) Bystřice pod Hostýnem – 4,166 m well for the metropolitan multipurpose sports hall.
2) Opava – 8,300 m well for a multipurpose sports hall.
3) Spojice – 3,192 m well for a multipurpose sports hall.
4) Spojice – 1,200 m well for a retirement home.
5) Horní Jelení – 1,620 m well for a nursing home.
6) Rusava – 1,000 m well for a daycare center and elementary school [4].

Aula, the new lecture hall at the Mining and Technical University of Ostrava – the largest installed system of heat pumps in the Czech Republic.

In 2006, a building went up in the Czech Republic heated by a system of heat pumps, the size of which exceeded the project for the sports hall in Opava: Aula, the new multipurpose lecture hall for the Mining and Technical University of Ostrava + CIT (information technology center). The unique system is based on the source of heat and cold. Originally Aula should have been heated remotely from a central distribution system, but the investor decided to switch to heat pumps during the course of construction. The installed system of heat pumps is the largest ever carried out in the CR and Central Europe. It consists of 10 heat pumps made by the Swedish firm IVT, providing a total output of 700 kW from 110 wells drilled to a depth of 140 m (a total of 15,400 m of drill holes) in the space of the parking lot at the new lecture hall and a parking space next to the New Library of the Mining and Technical University of Ostrava (Fig. 2).
The installed heat pumps have significantly reduced heating and air conditioning costs for the building. The project was financed using grants from EU structuralization funds, from the state environment fund, and from university resources. In addition to heating and cooling the building, the wells operating within the temperature polygon are providing interesting scientific research and the background for developing technology within this field. Three types of specialized wells – operational wells within the temperature polygon, special measuring wells, and a monitoring hydro-geological well, were also drilled and outfitted precisely for this purpose and within the framework of orders for heating the lecture hall.

The operational wells of the temperature polygon consists of a group of 10 operational wells, constructed in two parallel lines within the framework of the field designated for heating. Both lines are placed roughly in the V-Z direction set at 10 m apart from each other. The wells are located the same distance from one other in both setups. Special measuring wells consists of a group of 5 wells in a curving pattern constructed from the middle of the temperature polygon and slanting in the direction of VJV-ZSZ. The wells are located in the line, see Figure 3.

A monitoring hydro-geological well was drilled for the purpose of long-term monitoring the movement of the surface of the underground water, furthermore for the purpose of control measuring temperatures, perhaps other types of measurement as well, like geophysical measuring for determining the nature of the rocky soil. Using the information provided by this temperature polygon, thermal changes in the rock massif can be monitored during
the operation of the heat pumps, both for managing the heat being drawn off (winter periods) and reverse “heating” the rocky massif (summer periods). By analyzing the values provided by the temperature sensors, the efficiency of the operation of the underground collectors can also be monitored. Monitoring the affect of the heat pumps on the rock-embedded collectors is a project unique in the Czech Republic and offers large space for carrying out plenty of scientific projects and research. Lots of information can therefore be acquired that will subsequently be applied when carrying out other projects, while at the same time the heat pumps will be used for heating homes and buildings, and providing air conditioning or hot water [5].

Ten borehole connected to the heat pumps – VO71, V073, V075, V079, V081, V082, V084, V086, V088 – are monitored. Two temperature sensors are located at the entry branch- es at a depth of 20 and 100 m, another four temperature sensors at depths of 20, 50, 100 and 140 m. In addition to these energy wells, the 5 measuring wells MV1, MV2, MV3, MV4 and MV5 are also monitored but are not connected to the heat pumps. The 4 temperature sensors are located at a depth of 20, 50, 100 and 140 m, see Figure 4. A total of 80 temperatures are monitored in the 15 wells. The temperatures are measured using temperature sensors PT1000 in a four-lead connection. The low-level signals of the sensors are run through a shaft and converted into a numerical signal with the help of 16-bit A/D convertor. The data is then transferred via Ethernet from the shaft to the utility room in the lecture hall, where a PC equipped with Promotice application software is located.

Fig. 3. Wells of the temperature polygon

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Only a minimum amount of information is available about heat pumps, which are relatively little used here in any case. Serious information is lacking among laypeople and professionals, particularly with regards to practical experience acquired from operating them. Unfortunately, this situation continues to persist today even though much has been done to popularize heat pumps. Increasing the number of heat pumps installed in the Czech Republic lags far behind countries where lowering energy demand and protecting the environment have been active issues for decades. HPs with wells are used abroad for heating and providing air conditioning for major complexes. They are also used in industry as part of various types of technology used for heating or cooling liquids or dry substances. In comparison with the rest of West Europe, the CR remains behind in the number of pumps installed. Still, it continues to record an annual growth rate of about 30% and positive growth in the Czech market for heat pumps can be expected. Major growth in the market is just now beginning. The eventual outcome will depend to a large degree on support provided by state programs and a rise in the number of offers. Uses should become more inclined toward HPs once startup costs begin to approach prices for conventional heating.

Solvect by support of the project. Research into the temperature fluctuation of a rock mass (refrigeration-warming) for application of heat pumps on the of VŠB-TU Ostrava, KÚ Ostrava.
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