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# Economic Situation and Political Support for Geothermal Energy in Germany

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## ABSTRACT

In April 2000, the Renewable Energy Act (*Erneuerbare Energien Gesetz*, EEG) was set into force. The EEG is consistent with the directive on electricity production from renewable energy source of the European Union. It has triggered a great step forward in the development of geothermal power production under the German geological conditions. In future, a fast spreading of geothermal power production inside Germany can be expected. The paper describes the mechanism of EEG and will give details on the recent amendments.

Large geothermal heating plants with deep wells still suffer economic problems within Germany. Linked to the success of EEG, a revival can be expected in combined heat and power production. Another new trend is highlighted by some projects for deep borehole heat exchangers, to get rid of the need for deep, permeable layers and the resulting site limitations.

For shallow geothermal energy, and in particular ground source heat pumps, no specific support projects are necessary anymore. The technology has a firm place on the market, and the task for the foreseeable future is a continuos optimisation and, most important, to develop and implement measures to ensure high quality and consumer satisfaction

## INTRODUCTION

In the European context, Germany currently is seen as a geothermal "boom" country. This perception is mainly based on the efforts to produce electric power from geothermal energy, and these efforts in turn are based on the Renewable Energy Act (*Erneuerbare Energien Gesetz*, EEG). Because the EEG is going alongside with a European Directive to foster Renewable Electricity, colleagues in other EU countries see god chances for themselves once the German example will have proven successful.

However, since many years other applications of geothermal energy have spread throughout Germany beside electricity, which as the "epitome" of energy has received more public and political awareness. These other applications comprise geothermal district heating, for which some new plants have been built or are under construction, and in particular the steadily increasing number of shallow geothermal systems.

Economic and legal boundary conditions, which are responsible for the status achieved and the future development, can be influenced by politics. Only if these boundary conditions are favourable, the efforts made in research and development can be transferred into application, and a group like GtV can fulfil its tasks in information, quality certification, etc.

## STATUS OF GEOTHERMAL ENERGY USE IN GERMANY

In Germany, currently about 2900 TJ of heat are provided by geothermal energy, and in addition 230 kW of installed electric power from the first geothermal power plant exist (Tab. 1 and 2, s.a. Schellschmidt et al., 2005).. There are no numbers available for the increasing use of shallow geothermal plants for space cooling. A comparison of the numbers by Schellschmidt et al (2005) and BMU (2004) in Tab. 1 and 2 shows also, how different assumptions for the annual exploitation and different views on how to draw the limits of the geothermal part result in differences in the calculated annual generation. The development of geothermal energy utilisation in Germany in the WGC country update reports is shown in fig. 1.

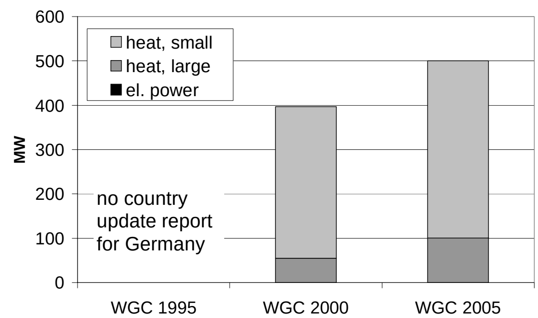


**Figure 1: Development of geothermal energy utilisation in Germany according to WGC country update reports**

## POLITICAL BOUNDARY CONDITIONS

In a purely micro-economic view, and without consideration of external cost, renewable energies cannot compete with most of the conventional energy sources, thus their success is strongly dependent on the political support available. Only in the long term this can result in a self-sustaining market, through a changing energy price structure, or through cost reductions due to increasing market penetration. The options for political support are many, including fiscal and regulatory measures (usually with the goal to internalise external cost into the competition), as well as direct financial support of investment or of R&D.

In order for an association like GtV to be able to improve the boundary conditions for geothermal energy utilisation, several conditions have to be fulfilled:

- A government recognising the need for climate protection and for renewable energy use (and not simply declaring the climate change for not existing)

- Information and lobbying with a considerable amount of time, effort and money
- Building confidence with decision makers in politics, administration and industry
- Public relations work to bring the advantages of geothermal energy across to the public, not just with technical facts, but also with appealing images and public highlighting (e.g. the stamp showing renewable energies issued in January 2004, s. fig. 2; a comprehensive review of geothermal stamps see in Lund, 2003)

A relevant result of the trustful co-operation with politicians is the inclusion of power from geothermal energy into the Renewable Energy Act (EEG) and the support of innovative geothermal projects through R&D-grants.


**Figure 2: Special stamp of the German post service depicting renewable energies (issued January 2004), with the hot earth as a symbol for geothermal energy in the lower left-hand corner**

## RELEVANCE OF THE RENEWABLE ENERGY ACT (EEG) FOR GEOTHERMAL ENERGY

In the old Renewable Power Feed-in Act (*Stromein-speisegesetz*, StrEG), geothermal energy was non-existent. The continuing efforts of GtV to include geothermal energy at the occasion of amendments of StrEG have been rejected by the government with the reasoning that no geothermal power plant existed in Germany, hence no feed-in price had to be paid.. Notwithstanding this hen-and-egg problem, GtV advanced the topic further into the discussion on the new Renewable Energy Act (EEG). In 2000 the EEG was passed, and for the first time a sound basis for economic calculation was given for geothermal power plants (fig. 3), details see in Sanner & Bussmann (2002). The visible sign for success was the inauguration of the first geothermal power plant in Germany in November 2003.

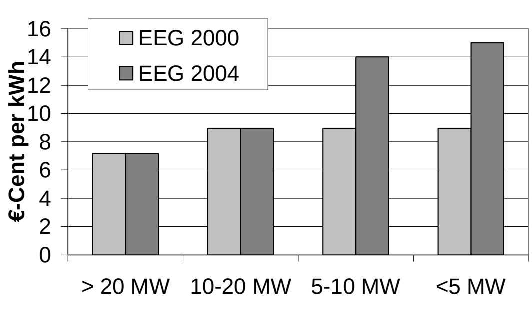


**Figure 3: Comparison of feed-in tariffs for geothermal electricity according to EEG 2000 and to EEG 2004**

The experiences with EEG 2000 have shown that the feed-in tariffs for geothermal energy had been set too low in the early phase of geothermal power production in Germany. Only with additional support, mainly through the ZIP-programme of the Federal Ministry of Environment, the barrier of geological, technical and economical risk could by overcome for the first plant. The problem of too low tariffs is in particular given for small plants, which on the other hand mainly have to be expected in the early phase. Hence in the amendment of 2004, higher tariffs have been fixed for plants below 10 MW electrical output (fig. 3).

The principle of EEG is that utilities operating the grid have to buy electric power from renewable energy at fixed (minimum) tariffs. Any supplier of such power can be sure his offer can not be rejected by the grid operator. On the other hand, the utilities are reimbursed from every single customer by a central fund into which all utilities pay and those having to buy renewable power can withdraw sums accordingly. The actual price increase for the end customer will be ca. 0.2 €-cent per kWh (Krzikalla, 2001).

Through the inclusion of geothermal power into the EEG, and through the support by the ZIP-programme, a number of new projects and innovative technological threads could develop. They now allow quite new perspectives for the geothermal power production not only in Germany, but also in the neighbour countries and elsewhere. Thus Germany can gain a good position on the export market for geothermal technology, which until today is mainly dominated by the USA, with Japan and Iceland as smaller players, and with up to now essentially Italy and France being the only EU-countries active on that market.

Geothermal projects require a relatively long preparation and construction period. Hence the success in form of electricity supplied to customers just now begins to materialise. The power plant in Neustadt-Glewe is in operation; however, in the statistics in BMU (2004) there are still 0 GWh listed for geothermal power, however, with the footnote saying: Power production from geothermal energy in pilot phase. The projects under way currently will change this in the years to come, as news like that about the excellent results in water temperature and yield in the the project Unterhaching (near Munich) make very probable.

## DEVELOPMENT OF SHALLOW GEOTHERMAL ENERGY

Ground-Source Heat Pumps (GSHP) are no longer exotic, they are, in fact, meanwhile a standard alternative to other heating systems in Germany. The immediately accessible potential for GHSP in Germany has been estimated to ca. 960 PJ/a by Kaltschmitt et al. (2003). This equals to about 10 % of the total end energy use in Germany in 2000. Following an estimation of GtV (table 2), ca. 2400 TJ/a of geothermal heat are used through GSHP; thus only 0.25 % of the potential currently is used.

Sales numbers of GSHP increase steadily (fig. 4). In order to sustain this trend, the target has to be the satisfaction of the customer with a reliable, economic heating system and that of the contractor with a safe and competitive product on the market. To achieve this goal, concepts to ensure quality, for education and training, and for public information are required. Political support of the market development as e.g. during the first market introduction programme for renewables 1995-98 could help in addition.

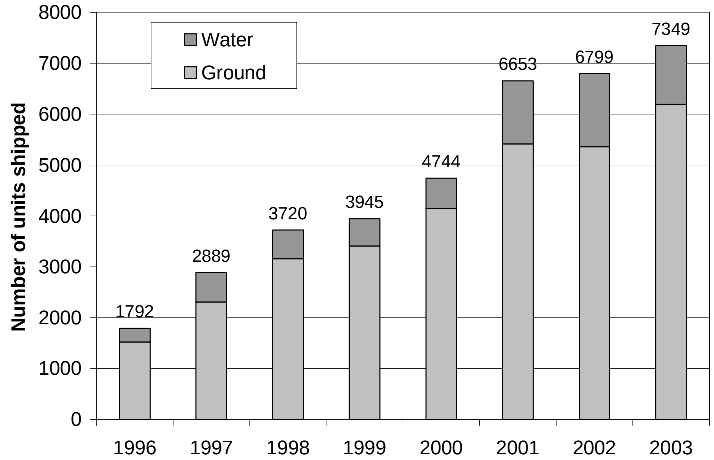


**Figure 4: Development of sales numbers for GSHP in Germany (after data from BWP and IZW)**

## BOUNDARY CONDITIONS FOR ECONOMIC USE OF GEOTHERMAL ENERGY

The following boundary conditions have to be fulfilled for a successful use of geothermal energy:

- A secure legal position concerning the right to exploit the geothermal resource (in Germany given by the Mining Law, see below)
- Practicable and sufficient environmental regulations (for large shallow geothermal plants using borehole heat exchangers or groundwater currently difficult in some areas of Germany)
- Sound, long-term basis for economic calculation providing acceptable return of invest (for electric power production, in Germany provided by EEG)
- Support of R&D to overcome barriers that still exist in certain areas
- Covering of the geological risk of success, e.g. through an insurance scheme

As can be seen from the listing above, there is still a lot to do. Also with the points looking favourable at first sight, like the legal situation in Germany, adaptations in details are required.

## LEGAL BOUNDARY CONDITIONS FOR GEOTHERMAL ENERGY IN GERMANY

As might be expected in a federal country, laws exist both on the federal level (*Bund*) and on the state level (*Länder*). Geothermal energy in Germany is governed by the Federal Mining Act (*Bundesberggesetz*, or BBergG for short).

According to § 3 BBergG, geothermal energy is not a property of the land owner, but belongs to the federal administration (*bergfreier Rohstoff*). Exploration and exploitation of this kind of resources, like coal, various types of ore, oil, or natural gas, is regulated by the authorities and is granted to an applicant, usually with a certain regular payment to be made according to the amount of the resource exploited (*Förderzins*). However, for geothermal energy, because of the still poor economics and the wish to foster environmentally benign energy, such payment has not yet been asked for.

A license for exploration and, if the resource has been proven, for exploitation gives a rather strong legal position to its holder. If necessary, even the (temporary) right for land use against the will of the owner can be obtained through court order, of course with fair financial compensation. The extension of a mining field according to such license is delineated on the earth surface and shown in a map, and in the vertical dimension it always starts at the ground surface and extends downward (theoretically down to the center of the earth). When a mining license is given, other aspects like water protection and environmental issues are dealt with by the mining authorities in collaboration with the relevant offices, and the necessary approvals are included in the mining license.

An exception is stated in the mining act for the use of a *bergfreie* resource, if it is used on the same lot where it is exploited, and is used only for the construction and operation of buildings on that lot, belonging to the owner of the lot (§ 4 BBergG). In this case no license is required. However, even here the mining authorities might come into the game again, if § 127 BBergG is fulfilled, asking for a specific approval for boreholes which penetrate into the underground more than 100 m. Use of this exception is made for most of the ground source heat pump plants in the residential sector, and this fact is the explanation why so many borehole heat exchangers for heat pumps in Germany have a depth of 99-100 m.

In those cases where the mining law is not applicable, other authorities make sure there is no harm done to the environment by a geothermal application. Thus shallow geothermal energy mainly is governed by the water law. The Federal Water Household Act (*Wasserhaushaltsgesetz*, or WHG for short) only gives a framework, and the relevant state laws handle the details. Water authorities are purely state authorities; on the federal level, there is only a regular co-ordination group of the states. According to WHG and the state water laws, the use of groundwater requires a license from the water authorities (in a mining license, the right to use groundwater is included, if it is part of the exploitation). Some of the states already have guidelines how the licensing procedure should be handled, in other states such guidelines are in preparation.

The basic technical requirements for sound design, save construction and trouble-free operation of shallow geothermal installations (down to about 400 m) are given in the guideline VDI 4640 of the Association of German Engineers (*Verein Deutscher Ingenieure*, VDI). VDI 4640 meanwhile has been made mandatory through the individual state guidelines mentioned above (VDI, 2000-2004).

To facilitate the site-specific design of smaller plants, the Geological Survey of Nordrhein-Westfalen has compiled a database of ground thermal parameters down to 100 m depth for the whole area of the state, available on CD-ROM. Similar work is under way in other states also.

A particular problem recently arose from the fact that geothermal energy does not have a certain boundary like a coal seam, ore body or oil deposit. With the number of applications for mining licenses on geothermal energy rising, the need for proper sizing of the mining fields became apparent. A group of experts from different branches of the administration suggested a guideline on how to delineate mining fields in geothermal energy.

Now the case may arise, that a larger ground source heat pump plant, serving more than one owner and thus not eligible for the exception according to § 4 BBergG, has a mining license, and the site is inside the area influenced by a planned HDR plant. Of course, in practice these two plants would not have any impact on each other, with several kilometres vertical distance between the HDR heat exchanger and the shallow plant. Legally, the right to use the geothermal heat resides with the owner of the mining license, no matter what the depth of that use will be. So in said case, the constructors of the HDR plant would need to negotiate with the owner of the license to be allowed to exploit geothermal energy, and they most probably will have to pay the owner. In the worst case, the owner of a mining license for a shallow borehole heat exchanger could prevent the construction of a deep geothermal plant, and vice versa. Now GtV is trying to convince administration and politics to discuss an amendment to the mining law, to allow for depth-specific mining fields for geothermal energy, in order to avoid the aforementioned problems.

## CONSEQUENCES OF THE CURRENT POLITICAL-ECONOMIC SITUATION

The positive atmosphere for renewable energy utilisation in Germany eventually becomes visible in increased energy production from these sources. Geothermal energy, however, still has to catch up, as the following statistics show. In total, the percentage of renewable sources meanwhile has reached about 3 % of the primary energy production in Germany. Looking only at electric power production, the 10-%-mark has been passed, according to extrapolation for the first half of 2004 (fig. 5).

In fig. 6 the development of heat production from geothermal and solar thermal energy is shown in comparison. While the heat production from solar thermal energy increased by a total of 565 % from 1995 to 2003, the number for geothermal heat for the same period was a meagre 7.5 %. In 1995, solar thermal energy supplied less than a third of the heat from geothermal sources, but in 2001 it already surpassed geothermal energy. This would not have been possible without massive political support for solar thermal energy. With geothermal, there is only a slight increase to be seen from 1997-99, when the results of the market introduction programme 1995-98 became visible. This programme included ground source heat pumps; no other support measures for market development where provided for geothermal energy on the federal level by now.

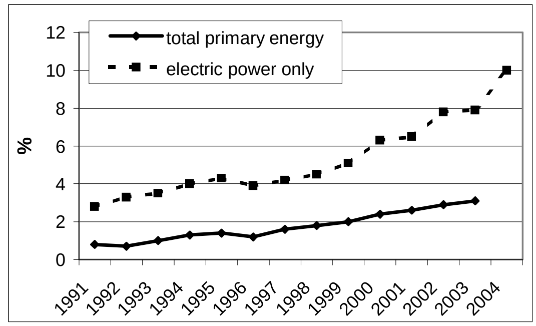


**Figure 5: Development of percentage of renewable energy sources in the energy production in Germany (after data from Bayer, 2004; the value for 2004 is for the first half only, according to preliminary extrapolation by BMU in August 2004)**

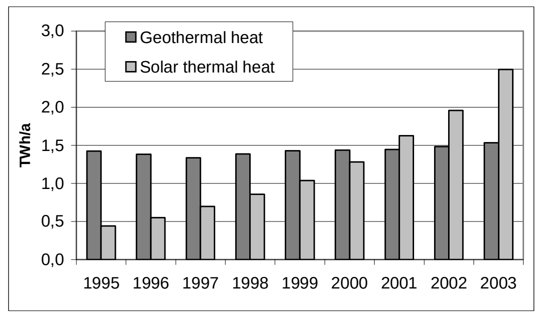


**Figure 6: Development of heat production from solar thermal and geothermal energy in Germany (after data from BMU, 2004)**

In 2003 a total annual turnover of about 120 million € has been achieved in supplying components, in planning, and in construction of geothermal systems, including ground source heat pumps (BMU, 2004). This value, which is quite substantial regarding the past development, is but only 1.2 % of the estimated total 10 billion € in turnover in renewable energies in Germany (fig. 7). Wind energy gets the largest piece of the cake. The immense need for support of geothermal energy to catch up with other renewable sources becomes obvious.

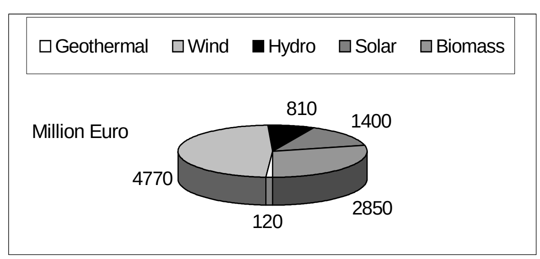


**Figure 7: Annual turnover in renewable energies in 2003 in Germany (after data from BMU, 2004)**

## GERMANY IN THE EUROPEAN PERSPECTIVE

Within the European Union (EU), geothermal energy utilisation has developed rather differently (fig. 8). One reason is, of course, the size and geological position of the member countries; but also the political boundary conditions and the role of renewable energies in the public perception have a substantial impact. This becomes apparent when looking at the two largest geothermal energy users in the EU (fig. 8; please be aware that Switzerland is not a member of EU): Italy is a classical geothermal country, with high-enthalpy resources and 100 years of tradition in geothermal power generation, while Sweden with its position on the Scandinavian shield is on first sight the contrary to a “geothermal country”. In Sweden, the vast majority of geothermal heat is produced by ground source heat pumps, and the hydrogeothermal potential in the very south of the country is small in comparison.

Political boundary conditions can be changed, to the better or to the worse. The remarkable amount of utilisation of hydrogeothermal heat for district heating in France was made possible by a programme for tax incentives in the late 80s, and since then not many new installations have been realised in spite of favourable operation cost. In Germany, the market introduction programme from 1995-98 had contributed much to the spreading of shallow geothermal plants (fig. 6), and a suitable new programme could continue this development.

In fig. 8 a problem with EU-wide statistics becomes apparent. The limitation of data to be considered, or the way how data are collected in the different countries, are not consistent. This is also valid between individual member countries and the central EU administration. The EU-statistics show a value for Germany in 2002 of 510 GWh/a, while the national statistics add up to 1483 GWh/a. This would make Germany to become the forth-largest geothermal energy producer within the EU.

The data in fig, 8 concern the “Europe of the 15”, as it existed until early 2004. The enlargement which took place meanwhile brought some important geothermal countries into the EU. Fig. 9 shows the situation in the new EU, with the data for the new member countries taken from the WGC 2000 country update reports. Among the new members in particular Hungary and the Slowak Republic have to be mentioned, which according to the status in 1999 fall into the category of the five largest geothermal energy producers within the EU.

## CONCLUSIONS

In the beginning of the 21st century, the situation for geothermal energy in Germany is quite favourable. The Renewable Energy Act (EEG) favours geothermal power production. However, compared to other renewable energy sources, the geothermal sector has still to go a long way.

The EEG is compatible to a EU directive on renewable power, which is intended to set similar conditions in other member countries. Since early 2004 discussion is going on concerning a similar directive to support renewable heat. A statement made by the relevant pressure groups for solar thermal, biomass and geothermal (the latter the European Geothermal Energy Council, EGEC) at a EU conference in Berlin in January 2004, and published thereafter, the “Bielefeld Declaration” voted at a workshop in the name-giving German city in May 2004, and a side-event to the large conference “renewables 2004” in Bonn in June 2004 paved the way to a substantial discussion on the European level. It is hoped that such a directive on renewable heat will spark national legislation in the member countries to support heat production from renewable sources. For geothermal energy, which within Europe has the most resources towards direct applications, such a directive could open up a new era.

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**Table 1: Geothermal energy use in Germany in 2004 (after data from Schellschmidt et al., 2005)**

| Application | Installed power | Annual generation |
|---|---|---|
| Electric Power | 0.23 $MW_{el}$ | 1.5 $GWh_{el}$ |
| Heat, large plants | 100 $MW_{th}$ | 710 TJ / 197 $GWh_{th}$ |
| Heat, GSHP | 400 $MW_{th}$ | 2200 TJ / 611 $GWh_{th}$ |
| Total | 500.2 MW | 809.5 GWh |

**Table 2: Geothermal energy use in Germany in 2004 (after an estimation by GtV)**

| Application | Installed power | Annual generation |
|---|---|---|
| Electric Power | 0.23 $MW_{el}$ | 1.5 $GWh_{el}$ |
| Heat, deep geothermal | 58 $MW_{th}$ | 200 $GWh_{th}$ |
| Heat, shallow geothermal. | 460 $MW_{th}$ | 660 $GWh_{th}$ |
| Total | 518.2 MW | 861.5 GWh |
| After data from BMU (2004), for 2003: | | 1532 GWh |

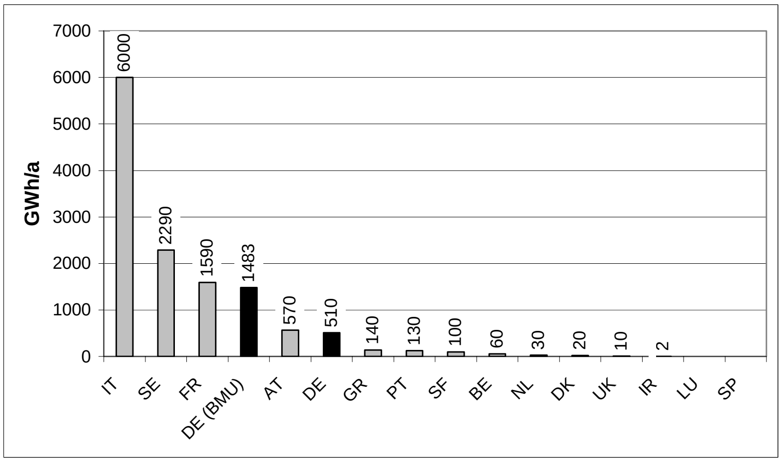


**Figure 8: Geothermal energy use in the EU 2002 (after data from BMU, 2004); the EU-wide numbers (BMU 2004, 27) have been complemented with data from the German national statistic (BMU 2004, 13), see text.**

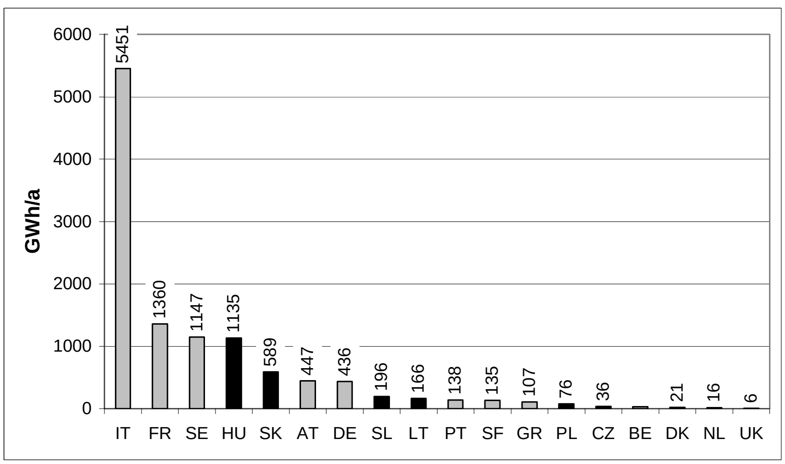


**Figure 9: Geothermal energy use in the enlarged EU 2004 (18 of 25 member countries, new members are shown in black). The values are mainly valid for 1999 and are taken from the country update reports of WGC 2000.**