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Energy transition & environment · Geothermal energy

# GEOTHERMAL ENERGY IN GERMANY'S BIG CITIES

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First published: January 24th, 2014, Volume 4

Digital Object Identifier (DOI): https://doi.org/10.48440/eskp.061

## Teaser

Germany heats its buildings almost exclusively with fossil fuels. But far below the Earth's surface, a large and untapped potential may one day turn the tide. An interview with Prof. Dr. Ernst Huenges.

## Keywords

Geothermal, deep geothermal, heat, electricity, power supply, drilling, Berlin, New Zealand, heat supply, fossil, $CO_2$ reduction, energy transition, energy, decarbonisation

It may very well be that our only option for supplying heat in future without emitting climate-damaging carbon dioxide lies dormant underground. What we urgently need is an awareness of our existing domestic potentials and an acceptance that geothermal is an environmentally friendly option for ensuring our future energy supplies. In this interview, Prof. Dr. Ernst Huenges discusses these potentials. He is head of the International Centre for Geothermal Research (ICGR) and leads the Section for Geothermal Energy Systems at the German Research Centre for Geosciences. For over 30 years, this internationally distinguished expert has been interested in reservoir characterization, transport processes in the Earth, and the engineering of underground reservoirs. The ultimate aim of his work is to harness these systems in order to efficiently produce heat and power supplies.

**Prof. Dr. Huenges, how does the potential for harnessing geothermal energy differ between Germany and a country like New Zealand, where completely different natural conditions prevail?**

**Prof. Dr. Ernst Huenges:** In several areas of New Zealand we find temperatures of over 100°C at depths of less than one kilometre; in Germany you would have to go down about four kilometres. This is due to the geological situation in New Zealand, where there is more heat flowing through the ground than in Germany, which has no active volcanoes. Besides temperature, a further characteristic of geothermal deposits is the availability of water. New Zealand has reservoirs with steam-water mixtures. In Germany we find water-bearing formations at various depths underground, and these can supply suitable heat sources provided that pathways exist. It is difficult to estimate the potential, but we believe that it is technically possible to cover about 10% of our energy needs sustainably by geothermal regenerative means.

**How do you currently view the situation in Germany with respect to geothermal energy use?**

**Ernst Huenges:** The huge potential offered by geothermal energy is hardly being used at all. We have in particular yet to take advantage of the base-load capability (the ability to generate a constant supply of power – editor) offered by geothermal. Near-surface heat sources are currently generating several gigawatts of power, while deep geothermal systems are still well away from the one gigawatt mark. Germany's Renewable Energies Act (EEG) has allowed geothermal to enter the electricity market on a moderate scale of several tens of megawatts. Nonetheless, more research in the field of deep geothermal is still needed because the required technologies do not as yet allow for reliable and plannable deployment.

**In Berlin, 99 percent of heating is done using fossil fuels. At least in the major population centres, Germany is still far from using forms of heating that do not harm the climate. What specific ideas and studies need to be pursued first in a metropolis like Berlin?**

**Ernst Huenges:** A major city like Berlin first needs to focus on the heat sources that are available locally. This especially includes deep geothermal sources, since tapping them requires only a point source – a borehole – so the amount of surface area required is very small. Since the source is local, all you need to do is hook it up to the existing heat distribution network. There is no need for other forms of transport through the city.

The first task is to initiate a development concept, which requires exploratory drilling and geophysical substrate studies. Then we need to develop pre-competitive demonstration projects, which are high risk affairs given the difficulty of predicting drilling success.

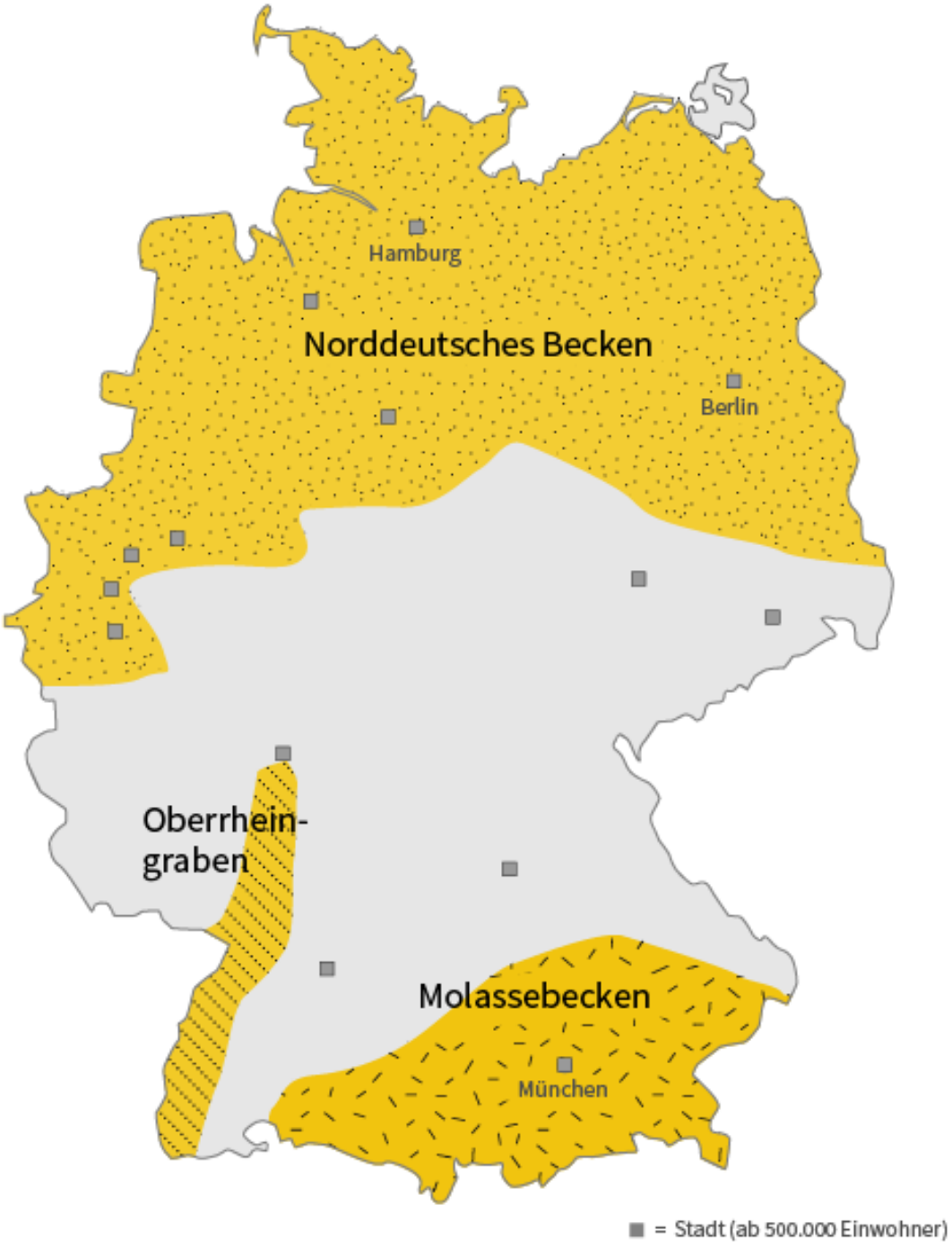


**Fig. 1: Regions in Germany with a large potential for geothermal energy use and the location of the country's 14 largest cities (population over 500,000). (Map: Wissensplattform Erde und Umwelt, Licence: CC BY 4.0)**

**Are there special considerations that need to be taken into account when exploring near or in large cities? What hurdles need to be overcome?**

**Ernst Huenges:** Performing exploration in inner-city areas on the one hand requires measurement instruments that can be set up on a small area between existing structures. Then you need to deal with the noise and interference of the city. Magnetoelectric soundings are therefore largely unsuitable and seismic methods can only be done at great cost and effort. The next step is to get the population on board. Experience shows that resistance develops very rapidly, even though most apprehensions, such as the risk of damaging buildings, are unfounded.

**What are the most important possible impacts on the environment?**

**Ernst Huenges:** In most cases boreholes need to be drilled, and in so doing we of course alter the environment. If done properly, environmentally safe drilling is possible. When drilling to depths of 100 metres or more, the procedures and regulations of the mining industry apply, including closely scrutinised operation plans to ensure compliance.

*Shallow/intermediate geothermics (heat supply):*

There was one case of massive damage to the Earth's surface when boreholes of varying depths of less than 100 metres were, in violation of good practice, not sufficiently separated by properly cemented casings. This case, however, was one of inexcusably poor execution that can be ruled out if the quality criteria are adhered to. Other environmental effects occur when the subsurface cools down too far due to overexploitation of the site. Particularly in large cities, however, we find that urban conditions are causing an increase in subsurface temperatures, something that can be mitigated by the exploitation of shallow geothermal resources.

*Deep geothermics:*

The use of underground resources has aroused concerns relating to seismic tremors and the safety and reliability of drinking water production. Exacting analysis is therefore required to help make sure that exploitation can be done in an environmentally safe manner. Soft stimulation techniques, for example, can at most locations ensure the safety of development activities. Scientifically monitored demonstration projects can serve to bring greater objectivity to the public debate and to clear up legitimate concerns.

**Which regions in Germany have the greatest potential? Is there potential for both geothermal power and heat generation? If yes, why these regions?**

**Ernst Huenges:** Generally speaking, temperatures increase the deeper you go. In some areas, the geothermal potential is particularly high. These include the North German basin with its many aquifers, the Molasse Basin in Bavaria due to the widespread Malm karst found there, and the Upper Rhine Plain with its tectonic fracture systems. Electricity

generation only makes sense at temperatures well above 100°C and if the geothermal gradient is steep enough.

**If the potential of this technology were fully exploited, what contribution could geothermal make to the success of Germany's transition to renewable energy sources?**

**Ernst Huenges:** Geothermal heat sources and seasonal thermal energy storage are key solutions on the way to providing sustainable low-carbon heat supplies in the future.

**What does that mean for our CO2 reduction goals? What contribution could geothermal make to reducing CO2 emissions in Germany?**

**Ernst Huenges:** The German heat market is currently served nearly exclusively by fossil fuels. Heating accounts for half of our total energy needs, with the other half going to electricity and transport. The aim of decarbonizing the heat market can only be achieved by transitioning to renewable energy sources. This would not only result in a reduction of CO2 emissions to some 60%, as in the switch from coal to gas. Switching from coal to solar, biomass or geothermal heat could bring the level down to well under 10%. Reaching this goal, however, requires having heat sources that are located in inner-city areas in order to avoid the losses associated with transporting heat over long distances from outlying districts.

**How much is geothermal energy being used in Europe, for example in Italy or Iceland? How does Germany compare?**

**Ernst Huenges:** The amount of geothermal power generated in Italy and Iceland is currently several orders of magnitude greater than in Germany. Iceland incidentally gets nearly all of its heat from under the Earth's surface. 99% of the heat supplied to Reykjavik, for example, comes from geothermal sources.

**Could a country like Iceland cover nearly all of its power and heating needs with geothermal energy?**

**Ernst Huenges:** Iceland could do it, but for economic reasons it still relies for the most part on hydropower. But this energy source has apparently reached its limits, so that the chances for geothermal power in future look very bright.

**Let's look at some practical issues: Over what distances can thermal energy be transported? Where do the limits of transport lie?**

**Ernst Huenges:** Iceland has already built heated water pipelines up to 60 kilometres long. In Germany we should be looking at shorter distances, given the difficulty of routing lines through densely populated areas.

**What preconditions need to be met for power generation on the one hand and heat supplies on the other. How do these preconditions differ?**

**Ernst Huenges:** The ground source installations are basically the same for both power and heat. The only thing different for electricity is that we need to drill deeper to reach the higher temperatures required to generate power. The technology for exploiting deep geothermal energy typically involves at least one production well and one return well to extract energy as needed and at the required temperature from a deep geothermal deposit. The thermal water circuit is completed above ground, where the energy is passed on to the customer and the cooled water is returned to the deposit following use through the return well.

**What do you believe are the greatest obstacles to further enhancing the standing of geothermal energy in Germany? In what areas would you appreciate more support?**

**Ernst Huenges:** As a new technology, geothermal is subject to the scepticism that is often aimed at anything new. That is why the demonstration facilities at many locations need to be enlarged, so that people can get an accurate picture of the situation. At those sites where large-scale geothermal projects have been realised – near Munich for example – the facilities have proven themselves to the point where many in the general public are explicitly in favour of adopting geothermal technology, particularly for heating.

**Is the technology perceived correctly in Germany? Why is it that there may be problems with the acceptance of geothermal energy?**

**Ernst Huenges:** What we urgently need is a perception of the existing domestic potential and an acceptance that geothermal energy is an environmentally friendly option for future energy supply. This results in the need for a well-founded strategy of inner-city exploration and development for the given utilisation options. Unfortunately, officially created obstacles and unobjective public debates can lead to a development that deprives us of this important and perhaps only future option of a decarbonised heat supply.

**What issues are regularly brought up in the public discussion and how does the scientific community respond?**

**Ernst Huenges:** Besides the technical questions that arise, people also ask why we choose populated sites to carry out experiments and studies on the usability of geothermal energy. They want to know whether we can stay out of their backyards, because that would make the technology more acceptable. Since it is not possible to reliably transfer our knowledge of one direct-use reservoir to another, we of course cannot carry out exploration anywhere else. We also have to make clear that it is the backyard owners themselves who stand to gain from domestic production. And the only way to achieve this

is by sufficiently exploring and developing sources of energy at strictly defined locations. Of course we also need to discuss the possible risks involved and judge them in the context of all other conceivable hazards such as the road traffic situation.

The interview was conducted by Oliver Jorzik (ESKP) and Jana Kandarr (ESKP).

## Cite as

Huenges, E., Jorzik. O. & Kandarr, J. (2017, January 21st). Geothermal energy in Germany's big cities. *Earth System Knowledge Platform* [eskp.de], *4*. doi:10.48440/eskp.061