2016 Germany Country Report

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1. Introduction

The use of geothermal energy offers significant potential and could theoretically meet Germany's energy demands several times over. Considerable efforts have already been made to tap into this potential, from exploration and development of particularly suitable regions and development of drilling technologies, through to systems for converting extracted geothermal heat into electricity.

The regions of Germany in which suitable conditions exist include the Molasse Basin in Southern Germany (mainly in Bavaria), the Upper Rhine Graben in South West Germany and the North German Basin. Hydrothermal geothermal energy is already being exploited in these parts of the country to a large extent. There is an especially high natural increase in temperature at increasing depths in these regions.

According to information from the German Geothermal Association (BVG), there were 33 geothermal power plants in operation across Germany in February 2016. Most of these plants exclusively generate heat, with the related installed capacity of 303 megawatts (thermal). Nine of the geothermal plants generate electricity – either exclusively or supplementary to heat. They have an installed electrical capacity of around 37 MW megawatts. Due to technical failures and restricted operating permissions the running capacity is estimated to be 35 MWel.

In Germany, deep geothermal energy is being increasingly used to generate heat. In terms of the prevailing geological conditions in Germany and the existing structure of demand, projects involving heating, such as supplying local and district heating systems, have higher prospects for being economically successful than projects for the generation of electricity only.

2. Changes to Policy Supporting Geothermal Development

Apart from funding carefully selected research projects, the Federal Government is also creating incentives for new projects by remunerating geothermal electricity under the Renewable Energy Sources Act (EEG) and by offering subsidies towards drilling costs. The last amendment to the EEG was adopted by the Bundestag (Lower House of Parliament) in December 2015. Since then the feed-in-tariff was fixed at 25.2 Euro-cents per KWh.

The market incentive programme (MAP) of the German Government promotes renewable energy systems that provide space heating, hot water, cooling and process heat. It was revised in March 2015. It has a section for smaller buildings administered by the Federal Office of Economics and Export Control (BAFA), and one for large buildings and commercial uses, the latter being a premium component of the KfW Banking Group renewable energies program. Several geothermal technologies can be supported by the MAP; it subsidizes the installation of efficient heat pump systems in residential buildings with a repayment bonus, depending of the installation size.

For heat and power plants using deep geothermal energy, a repayment bonus for the plant can be granted and the drilling cost can be supported depending on drilling depths. Furthermore, part of the exploration risk can be covered within a KfW-program.

The geothermal market predominantly comprises small and medium-sized enterprises from mechanical engineering, as well as some large-scale enterprises, whose portfolios belong more to the classical energy sector, such as the hydrocarbon industry.

3. Geothermal Project Development

Table 1 Electricity producing geothermal power plants in Germany as of February 2017.

Region	Location	MWel	MWth	Power Plant
Upper Rhine Graben	Landau	(3.6)	(0.1)	ORC
	Bruchsal	0.44	5.5	Kalina
	Insheim	4.3		ORC
South German Molasse Basin	Unterhaching	3.4	38	Kalina
	Dürrnhaar	7.0		ORC
	Kirchstockach	7.0		ORC
	Sauerlach	4.0	5	ORC
	Oberhaching	4.3	40	ORC
	Traunreut	5.5	12	Kalina

4. Research Highlights

In 2011, the 6th Energy Research Programme “Research for an environmentally friendly, reliable and affordable energy supply” was started. The goals of this programme are to accelerate the modernization process for the German energy supply system, to strengthening German business in international competition and to secure and expand technological options. The Federal Ministry for Economic Affairs and Energy (BMWi) is responsible for leading the 6th Energy Research Programme and for funding applied research and technological developments in all energy technologies (except for bioenergy). The basic principles for research funding are described in the 6th Energy Research Programme.

The potential offered by deep geothermal energy as a continuously available source of renewable energy needs to be further exploited. A lot of research and development work has already been carried out towards this goal that has also been recognised internationally. Advances have been made in all areas. There have been continuous improvements in the areas of drilling technology and plant construction and it has been possible to significantly extend the service intervals of thermal water pumps. New methods have also been developed to determine appropriate target areas for drilling. In the field of drilling technology, directional drilling can be carried out with a lot more precision than was possible a few years ago.

Due to the major influence of the local conditions in each region, such as the composition of the thermal water or the geological structures, each geothermal heat or power plant is unique. A more individual approach is necessary in the planning phase, compared to other technologies. In view of the significant potential and expected contribution of geothermal energy to a future energy system based on renewable energy, the Federal Ministry for Economic Affairs and Energy (BMWi) is continuing to support relevant research projects. Further research is still required in order to economically utilise deep geothermal energy and thus fully exploit the existing potential

of the heat. The BMWi primarily provides funding to projects that are dedicated to complete systems – such as pumps.

The research projects currently being funded encompass all stages along the value chain for geothermal energy. The primary goal is to further reduce the cost of projects in order to make geothermal energy economically viable nationwide. Contributions towards the achievement of this goal are made by technological developments in all project phases: in the planning of the project, the exploration of the target region, the drilling/ construction phase and the testing and operation of the completed plants. In particular, deep boreholes must be completed more quickly and less expensively as they account for the main part of the investment costs. The operation of completed heat or power plants needs to be more efficient and reliable with low maintenance needs. Alongside further technical developments in geothermal energy, concepts for improved public relations work are now a fundamental component of successful research projects. And, last but not least, the conditions must be created to allow geothermal energy to be utilized in those areas that have not yet been explored or which are less suited.

In the area of geothermal research, the BMWi approved funding for a total of 22 new projects with a funding volume of around 19.6 million euros in 2016 (2015: 21 new projects with around 17.3 million euros). At the same time, around 12.5 million euros were invested in already ongoing research projects (2015: around 13.4million euros).

The main themes of R&D funding of geothermal energy addressed in 2016 were:

- Data collection (GeotIS.de)
- Corrosion and Scaling (for operating power plants)
- Advanced drilling technologies (laser, electro-impuls, plasma)
- Machinery (workover rig, submersible pump, valves)
- EGS related themes (rock stress models, EGS-project)
- District Heating (Munich, urban areas)

4.1 Geothermal heat for Munich

Munich is located in the region of the so-called Molasse Basin in Bavaria. The underlying geological formations here are particularly suited for the extraction of geothermal heat. The rocks are part of Malm, a geological formation that acts like an aquifer for hot thermal water due to its special structure. Stadtwerke München (SWM) intends to provide the entire district heating for Munich from renewable energies by 2040, with the majority being contributed by geothermal energy.

SWM, as the coordinator, aims to lay an important foundation for this vision with the GRAME project. But there is still no consistent concept for determining what locations would be best suited for extracting the heat and how it can then be integrated into the existing district heating network. The project partners SWM and the Leibniz Institute for Applied Geophysics (LIAG) completed a three dimensional image of the subsurface in 2016 and are using it to develop a suitable extraction strategy. In general, the results should contribute to the better exploitation of the geothermal resources within the Molasse Basin and the utilization of the potential that will be opened up for the generation of both electricity and heat. The goal is to generate electricity of around 50 megawatts or to extract heat in the range of 400 megawatts.

The project partners used 3D-seismic surveys to determine the structure of the reservoir and to decide about the most promising locations for future drillings. The measurements were taken over an area of 170 square kilometers. Investigations about the potential for geothermal use on this scale have never been carried out in the region. Conducting 3D-seismic measurements beneath an urban area was also breaking new ground: Amongst other things, traffic or construction work on the surface generate incessant vibrations that influence the measured values.

As well as the technological success of the 3D-seismic campaign, high public acceptance for the installation of the geothermal district heating system was promoted. Further drilling activities around Munich are planned. Also, foreign investors are involved to explore and use geothermal heat with new businesses in the Molasse Basin.

5. Other National Activities

5.1 Useful Websites

Federal Ministry of Economic Affairs and Energy: www.bmwi.de

BMWi publications in English: http://www.bmwi.de/EN/Service/publications.html

Project Management Jülich (Public Funding Agency): https://www.ptj.de/renewable-energy

Database of all projects sponsored by the Federal Economics Ministry in renewable energies: www.forschungsjahrbuch.erneuerbare-energien.de

6th Energy Research Programme of the Federal Government: https://www.bmwi.de/Redaktion/EN/Artikel/Energy/research-for-an-ecological-reliable-and-affordable-power-supply.html

2017 Renewable Energy Sources Act: http://www.bmwi.de/Redaktion/EN/Dossier/renewable-energy.html

German Geothermal Association (BVG): http://www.geothermie.de/

Geothermal Information System for Germany (GEOTIS): http://www.geotis.de/index.php?loc=en_us

Marktanreizprogramm (Market Incentive Program, MAP): http://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/Foerderbekanntmachungen/marktanreizprogramm-erneuerbare-energien.html

6. Future Activity

The energy concept developed by the German federal government in 2010 envisages the far-reaching restructuring of the energy supply system in Germany by 2050. Important goals in this concept are the reduction of primary energy consumption by 50 percent and increasing the proportion of renewable energies to cover 80 percent of the demand for electricity and 60 percent of the gross final energy consumption.

If the energy transition continues to run successfully, this concept will lead to an energy system in 2050 that is completely different to the current structure for the supply, distribution and demand for energy. The technologies that will be utilized in the realization of this concept are to a large extent currently either not technically available or are economically infeasible. Energy research thus forms a strategic element of energy policy in order to generate technical innovations in the medium to long term that will enable the successful realization of the energy transition.

German Government supports the development of renewable energies with a bundle of support mechanism, e.g. feed-in-tariffs and budgets for research. One of the results is that the renewable energy share of gross electrical consumption is 31.7 % and the renewable-based heating and cooling supply increased to 168 TWh - 0.6% by deep geothermal - in 2016.

Numerous efforts have already been made to develop the potential of geothermal energy as a continuously available renewable energy source. These include the exploration and exploitation of suitable reservoirs, the development of drilling technologies, and innovations in plant construction to eventually use the extracted heat for power generation or heating purposes.

The market for geothermal heat pumps has increased to 320,000 units but the growth rate has slowed down. The investments in geothermal energy remain on a constant level of about 1 bn € per year (heat pumps and deep geothermal power plants).

The development of geothermal district heating for the well-known municipality of Munich with the goal to supply up to 100% of house heating, attracts a lot of attention in Germany and worldwide. The 3D-seismic measurement campaign in an urban area with thousands of geophones and vibrating trucks over 6 month found a wide acceptance by the population. This acceptance gives an optimistic view for further geothermal developments in Germany. Beside the geothermal production of electricity, the direct use of heat in densely populated areas is moving into focus due to the commercial success of several district heating operators using geothermal heat as resource.

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