IEA GEOTHERMAL

Germany
Country Report
2013

IEA Geothermal
Implementing Agreement

National Activities

Chapter 11 of the 2013 IEA-GIA Annual Report

Germany

Figure 1. Geothermal drill rig in Insheim.

1 Introduction and Overview

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.

In Germany, the Molasse Basin in the South, the Upper Rhine Graben in the Southwest and the North German Basin are most suited for geothermal use (Figure 2). According to the German Geothermal Association in 2013, 25 geothermal heating plants with an installed capacity of 222.95 megawatts (thermal) were in operation throughout Germany, providing households, businesses and public buildings with thermal energy via district heating grids.

The four locations, Insheim and Landau (both in Rhineland-Palatinate, 2007), Unterhaching (Bavaria, 2008/2009) and Bruchsal (Baden-Wurttemberg, 2009) have so far been developed to the power generation stage and together provide an installed electrical capacity of 12.31 megawatts. In 2013, five other power stations were under construction: Dürrnhaar, Kirchstockach, Kirchweidach, Sauerlach and Traunreut (all in Bavaria).

Figure 2 Geothermal regions in Germany.

Although previous scientific-technological progress was taken further in 2013, geothermal energy has still not reached the status of an extensive renewable energy technology with the possibility for reliable use on an economic scale. Deep geothermal energy in Germany is still a young market under development in the renewable energy sector.

Table 1 Geothermal energy use in Germany.

Electricity	
Total Installed Capacity [MWe]	24
New Installed Capacity [MWe]	6
Contribution to National Capacity [%]	< 0,1
Total Generation [GWh]	80
Contribution to National Generation (%)	0,01
Direct Use	
Total Installed Capacity [MW_{th}]	n.d.
Heat Use (deep geoth. sources) [GWh/yr]	870
Total Heat Used (deep + GSHP) [GWh/yr]	n.n.
Number of geoth. heat pumps	250,000
Commercial indications	
Employment [jobs]	17,300
Investment [M. €]	900
Revenues [M. €]	900

2 National Programme

Germany has set itself ambitious climate protection targets and resolved to phase out the use of nuclear energy by 2022. By the middle of this century, the German Government aims for an energy supply based predominantly on renewables, meeting 80 % of electricity consumption and 60 % of final energy consumption by 2050. To support the development of renewable energy sources, the government has set aside some 3.5 billion euros (US$ 5 billion) for research and development of future energy technologies between 2011 and 2014 under the 6th Energy Research Program.

The basic concept of the energy transition is the expansion of renewable energies as an alternative to nuclear power. This is as important as the improvement of energy efficiency, primarily concerning heating flats and houses as well as mobility. Germany intends to develop into one of the most environmentally friendly and energy-efficient economies in the world - at competitive energy prices and with a high standard of living. In its coalition agreement, the government has therefore determined to proceed with purposeful and systematic developments towards an energy supply system without nuclear power and with a steadily increasing renewables ratio. Energy research will continue to direct its efforts towards the mentioned targets. As the expansion of renewable energies continues, cost-efficiency and economic viability of the overall system will be of particular importance.

At the beginning of the legislative term of the Federal Government, ministerial portfolios were redefined. All of the relevant funding measures for energy transition have been amalgamated into the Federal Economics Ministry, now entitled the Federal Ministry of Economic Affairs and Energy. These measures also affect the Energy Research Programme; previously under the authority of the Federal Environment Ministry, responsibility for project funding in renewable energy research and development has now been assigned to the Federal Economics Ministry and will remain there in future. The future development of the Energy Research Programme is the subject of the next government report on energy research to be submitted by mid-year.

Future renewable energy research and development funding will continue to aim at expanding renewables, reducing costs and optimising energy supply systems to increase the share of renewable energies in total supply. Other objectives include raising the competitiveness of German enterprises – also to create viable future jobs in Germany – and ensure the best possible use of renewable energies for the benefit of the environment and nature, as set out in the current Sixth Energy Research Programme.

In 2013, the Federal Environment Ministry supported research and development projects in renewables with a total of about EUR 186 million from the federal budget and from the Energy and Climate Fund (ECF). This amounts to an increase of EUR 31.5 million compared to 2012, EUR 66 million compared to 2010 and more than threefold in comparison with 2004. 260 new projects with a total funding volume of about EUR

160 million were approved. The funding volume for new projects in 2013 thus exceeded that for 2010 by about EUR 19 million, but fell well short of total funding for new approved projects in 2011 and 2012. In these years, substantially more projects could be approved than previously due to the larger funds available in the federal budget and in the ECF. The funding volume for new approved projects in 2013 was, however, three times larger than in 2004.

Project funding in deep geothermal energy plays a decisive role and is necessary to advance the technology.

3 Industry Status and Market 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. Since the amendment to the EEG was adopted by the Bundestag (Lower House of Parliament) in late June 2011, the framework conditions for promoting geothermal energy have been improved. In order to mitigate the current high risks for investors, the subsidy for geothermal electricity was fixed at 25 Euro-cents per KWh. The use of enhanced geothermal system (EGS) techniques will also attract an additional subsidy of 5 Euro-cents per KWh as of 2012. With these new rates, the Government is hoping to encourage further advancement of geothermal energy, since construction of new capacity has fallen short of expectations to date. In order to set a realistic time frame for the commissioning of projects, while at the same time pushing for fast implementation, the reduction of subsidy rates has been postponed until 2018.

The market incentive program (MAP) of the German Government promotes renewable energy systems that provide space heating, hot water, cooling and process heat. 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 subsidises the installation of efficient heat pump systems in residential buildings with a maximum of 12,300 € (US$ 17,500)/ heat pump. For large heat pump systems over 100 kWt, a repayment bonus of 80 € (US$ 115) per kW heat capacity is granted with a maximum of 50,000 € (US$ 72,000) for a single system.

For heat and power plants using deep geothermal energy, a repayment bonus up to a maximum of 2,000,000 € (US$ 2.9 M)/ plant is granted. Well drilling accounts for a large amount of the total project costs. The repayment bonus for drill costs (only wells over 400 m) amounts to US$ 540 up to US$ 1,000/ m TVD depending on the depth of the well. The maximum bonus per well is US$ 36 million. 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. Although the market is still emerging, German specialist expertise is already in demand abroad, in Korea and East Africa, for example, which will afford interesting export opportunities in future.

4 Research, Development and Demonstration/Deployment

The research projects currently funded encompass all stages of the geothermal value-added chain. Their primary aim is to further reduce the costs for technology development in all project phases to make geothermal energy economically viable. Besides the reduction of drilling costs, which are still the bulk of investment costs, the major central issues of future research projects will be the development of efficient discharge pumps specifically for geothermal energy and the minimisation of induced seismicity. This will ensure the efficient, low-maintenance and reliable operation of installed facilities in the future. Besides technical developments in geothermal energy, the generation of public acceptance for geothermal energy has to be part of every successful project. Beyond that, the development of geothermal energy in currently less suitable regions has to be promoted.

In geothermal energy research, the Federal Environment Ministry approved a total of 29 new projects in 2013 with a volume of about EUR 20.6 million (Figure 3; 2012: 37 new projects for EUR 21.4 million). At the same time, about EUR 17.1 million was allocated for ongoing research projects (2012: EUR 20.8 million). Following the described funding strategy, about half of the newly approved projects are concerning topics of the drilling/exploitation/construction phase and technological developments. To minimise the prospecting risk for the economic use of geothermal energy, almost a third of the projects focus on the planning and exploration phase of geothermal plants.

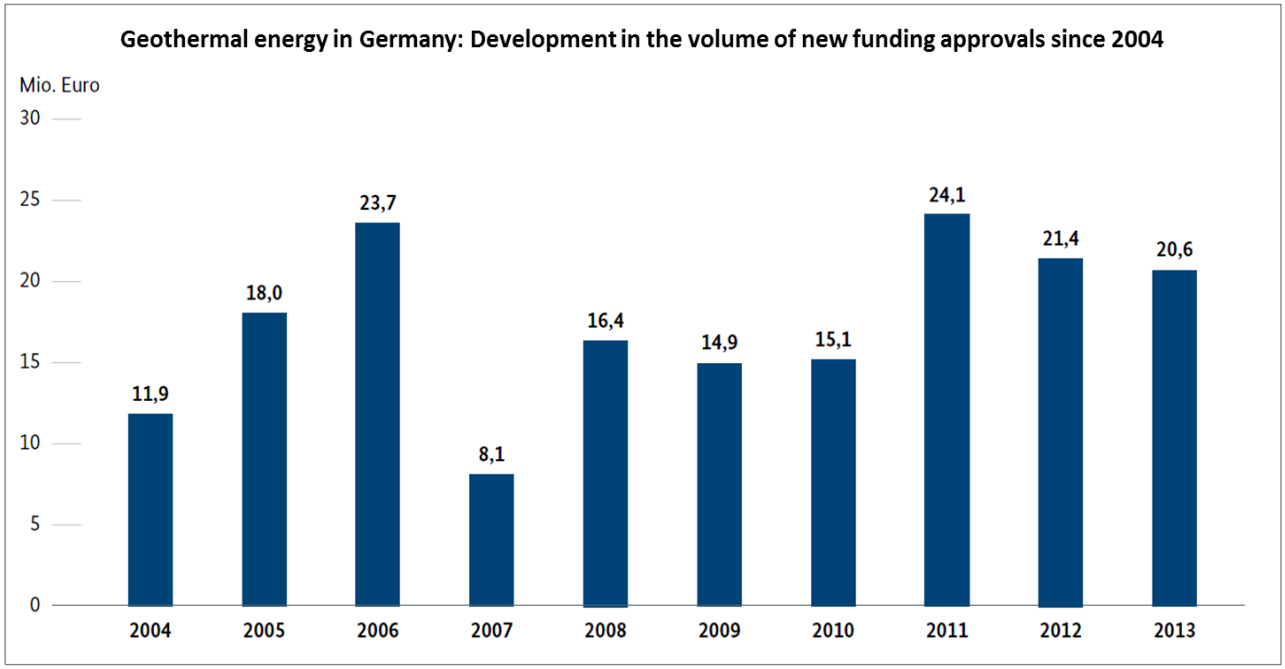

Figure 3 Geothermal energy funding for new projects since 2004.

Besides projects to reduce the prospecting risk for new geothermal reservoirs, several funded projects were aimed at the upgrading of drilling rigs, the installation of the casing in geothermal wells, and the upgrading of thermal water pumps. The behaviour of geothermal reservoirs has been investigated in detail in simulation projects and the monitoring of existing geothermal facilities supports the understanding of the whole process. The objective is to gain operational experience to optimize the operation of future plants. Other funded projects deal with questions of corrosion in the geothermal cycle or the behaviour of components in the geothermal plant.

4.1 Research Highlights

4.1.1 Accessing heat from crystalline bedrock

Pfalzwerke geofuture GmbH, the operator of the Insheim Geothermal Project, commissioned BESTEC GmbH to investigate the generation of geothermal energy by accessing a fault system in the crystalline bedrock and for the seismic monitoring of the operation process.

The study and the corresponding results are very important not only for the operation of the Insheim power station but also for developing other geothermal facilities for the industrial use of heat from the crystalline basement in the Upper Rhine Graben. The conditions in Insheim are particularly favourable for generating geothermal energy. For the geothermal power plant, two deep wells were first drilled to a depth of 3,800 metres (Figure 4). Detailed circulation

Figure 4 Geothermal drilling rig at Insheim.

tests were carried out over several months. As the drilling revealed no adequate permeability, a sidearm was drilled from the lower segment of the injection borehole at a depth of about 2,500 metres to distribute the bedrock water more extensively, further reduce the microseismic risk and improve the permeability of the bore-hole. This was successful; the injection in Insheim is now operated simultaneously via two bore-hole arms.

In November of last year, an organic Rankine cycle (ORC) power plant with an electric capacity of about 4.8 megawatts started operation. During the installation and the commissioning of the ORC plant in Insheim, great importance was attached to keeping noise emission to a low level. After the first test phase, the power station in Insheim has now reached about 75 per cent of its nominal capacity. The ORC plant has also proven its very good partial-load capability.

4.1.2 Microseismic activity in geothermal systems

Small but tangible earthquakes have occurred near the geothermal power stations in Landau, Insheim and Unterhaching in Germany. For public acceptance of deep geothermal energy, it is crucial to determine whether the seismicity near geothermal sites will remain confined to the level of microseismicity or whether the induced seismic events could pose a risk to people and buildings. With a consortium of scientists from the Federal Institute for Geosciences and Natural Resources (BGR), the Karlsruhe Institute for Technology (KIT), the Ludwig-Maximilians University Munich, the Free University Berlin, the Energy Research Centre at the Clausthal University of Technology and the Technical University Bergakademie Freiberg, the collaborative research project MAGS has worked on this question. With the aim of ensuring secure power generation from deep geothermal energy, the project cooperated closely with operators and licensing authorities.

The work was divided into two main areas: monitoring and modelling. Seismicity was measured and evaluated at locations of deep geothermal energy in the Palatinate, the Munich area, the North German Basin and in crystalline rock in Saxony. These results were used for seismic risk assessment and the modelling of fluid-induced seismicity. The researchers developed methods to calculate the seismic risk from induced micro earthquakes and compare these with the risk posed by natural earthquakes. The seismic modelling made a large contribution to understanding processes that cause fluid-induced earthquakes.

4.1.3 Geothermal ERA-NET

ERA-NET began its engagement in geothermal energy in May 2012 with nine participant states. On behalf of the Federal Environment/Economics Ministry, Programme Management Jülich took part as a member of these activities and headed the working group, Development of Joint Activities. The aim of the project is to step up cooperation between European authorities and ministries for effective research and development work. ERA-NET comprises both technical and non-technical issues to do with geothermal power generation.

During the four-year term, cooperation is also planned with the European Energy Research Alliance's Joint Programme on Geothermal Energy, which supports expansion targets for renewable energies by 2020, and also with EU member and associated states for research and development. One of the objectives of Geothermal ERA-NET is to make preparations for setting up a European geothermal database to facilitate the exchange of information on legal and regulatory aspects, policy goals, measures, institutions and research projects.

5 Future Outlook

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 finally use the extracted heat for power generation or heating purposes.

According to the Working Group for Renewable Energy Statistics (AGEE-Stat), the contribution of deep geothermal energy to primary energy demand in Germany amounted in 2013 to some 0.01 per cent only. The potential of deep geothermal energy indicates, however, that this ratio can be considerably increased if the market can develop.

6 Publications and Websites

Erneuerbare Energien: Innovation durch Forschung, Jahresbericht 2013 zur Forschungsförderung:

http://www.bmwi.de/DE/Mediathek/publikationen,did=651742.html

("Innovation Through Research 2013: Annual Report on Research Funding in the Renewable Energies Sector", English version expected in early 2014)

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

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety:
www.bmub.bund.de

Federal Ministry of Education and Research:
www.bmbf.de

Energy Research at the Federal Economics Ministry:
www.bmwi.de/go/energieforschung

Energy Business Area of Project Management Jülich:
www.ptj.de/erneuerbare_energien

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:
http://www.bmwi.de/EN/Service/publications,did=477502.html

EEG – Renewable Energy Sources Act:
http://www.erneuerbare-energien.de/EE/Navigation/DE/Gesetze/Das_EEG/das_eeg.html

Bundesverband Geothermie GtV:
http://www.geothermie.de/

Informationsportal Tiefe Geothermie:
http://www.tiefegeothermie.de

Geothermal Information System for Germany (GEOTIS):http://www.geotis.de

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