Switzerland Country Report

Gunter Siddiqi Katharina Link

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Gunter Siddiqi[1], Katharina Link[2], Switzerland Country Report, IEA Geothermal, 2015.

[1] Swiss Federal Office of Energy, Postfach, CH 3003 Bern, Switzerland. Email: gunter.siddiqi@bfe.admin.ch

[2] Geo-Future GmbH, Rebstrasse 3, CH-8500 Frauenfeld. Email: info@geo-future.expert

1. Introduction and Overview

Switzerland's uptake of shallow geothermal continues unabated and unconstrained by natural potential. The theoretical potential for direct use geothermal and geothermal for power generation is considered very large. Yet arguably, realistic estimates of the technical and economic potential (with support mechanisms) is limited to between 1 and 20 TWh along with associated co-produced heat.

In the wake of the major incident at the Fukushima Daiichi Nuclear Power Plant due to the 11 March 2011 earthquake and tsunami, the cost reduction in renewables and political instabilities in North Africa and the Middle East, Switzerland is in the process of developing and implementing Energy Strategy 2050. Geothermal legislation has continued to work its way through parliament. The final votes in both chambers of parliament are expected in 2016 with a possibility of a referendum.

Table 1 Status of geothermal energy use in Switzerland for 2015.

Electricity		Direct Use	
Total Installed Capacity (MW_e)	0	Total Installed Capacity (MW_{th})	26.7
New Installed Capacity (MW_e)	0	New Installed Capacity (MW_{th})	-3.9
Contribution to National Capacity (%)	0	Total Heat Used (PJ/yr or GWh/yr)	0.78 [215.9]
Total Generation (GWh)	0	Total Installed Capacity Heat Pumps (MW_{th})	1925.5
Contribution to National Generation (%)	0	Total Net Heat Pump Use [GWh/yr]	2320.2
Target (MW_e, % national generation, etc.)	0	Target (PJ/yr,)	Na
Estimated Country Potential (MW_e or GWh)	4400	Estimated Country Potential (MW_{th} /PJ/yr/GWh/yr)	Na

The produced heat (Figure 1) is actual operating data and the data for any given year depends on the heating degree days for that year. 2015 and especially 2014 were characterised by a very warm winter.

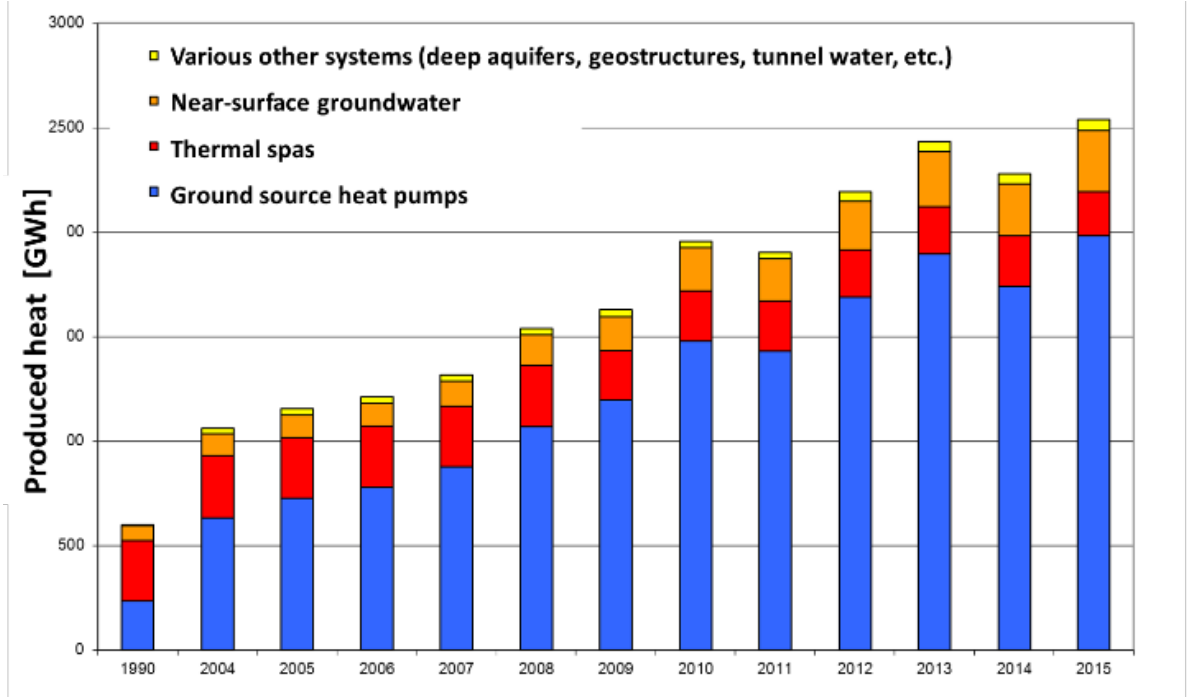

Figure 1 Geothermal energy utilization in Switzerland (Actual operating data).

2. Highlights and Achievements

The 2015 year was characterised by several highlights and achievements.

2.1 Deep geothermal energy sector:

3 deep geothermal projects developed further in 2015:

- 2015 saw the continued execution of the hydrothermal direct heat geothermal project in Schlattingen (Canton Thurgau, in the north of the country, for an agricultural business). The two wells have been connected to heat plant, and the long term fluid flow has been evaluated in a production test.

- The EGS project in Haute Sorne received the building permit in June 2015. This is an important milestone towards the realisation of a new reservoir creation concept. In contrast to massive stimulation in a borehole, Geo-Energie Suisse AG will use multi-stage hydraulic stimulation in horizontal wells in combination with open-hole packer technology. The pilot project in the Canton Jura aims at proving the technical feasibility of the concept and producing up to 5 MWe by 2020.

- A further highlight was a comprehensive study and seismic exploration campaign in the Canton of Geneva (GE) to investigate the potential for cascaded use of geothermal energy. The next milestone of this project “GEothermie 2020” will comprise drilling exploration wells commencing in 2016/2017.

In 2015, several cantons passed laws regulating the exploration and exploitation of the deep underground. In the past, the lack of a legal framework was one of the main non-technical barriers for the development of deep geothermal projects in Switzerland.

A number of R&D activities are well under way through the Swiss Competence Center for Energy Research on "Supply of Electricity" (SCCER SoE - http://www.sccer-soe.ch/) whose remit includes geothermal energy. Geothermal highlights are the experiments at the Grimsel underground test site (http://www.grimsel.com/).

2.2 Near-surface geothermal (heat pump) sector:

The near-surface geothermal heat pump sector is very well established and enjoyed an annual compound growth rate of about 7% in 2015. By the end of 2015, a total of some 90,000 ground source heat pumps systems have been installed in Switzerland (reference 1).

Quality assurance is one of the main aspects for further improvement. The following four achievements and highlights focus on that aspect:

- A technical norm for groundwater utilisations has been published (SIA 384/7), similar to the existing one for ground source heat exchangers (SIA 384/6). It is available in German or French http://shop.sia.ch/normenwerk/architekt/384-7_2015_d/F/Product/

- A new quality label has been developed and published in 2015, “Waermepumpensystemmodul” (www.wp-systemmodul.ch). This quality label not only considers the heat pump and the underground heat exchanger separately, but considers the whole system including connections between the different components.

- In 2015 tools that measure temperature and temperature deviations of boreholes (for GSHP systems) have been investigated and compared. Results have been published in German on the website of the Swiss Federal Office of Energy http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_27874 3707.pdf.

- On behalf of the Swiss Federal Office of Energy, Geothermie Suisse, the Swiss geothermal association (http://geothermie-schweiz.ch/?lang=fr) ran a series of 5 workshops across Switzerland. The workshops are a continuing education scheme for ground source heat pump experts and were designed to improve the flow of information and to share knowledge among the stakeholders (drilling companies, geologists, public authorities).

R&D activities focus on the development of smart thermal (low temperature) grids. Several grids (e.g. in the city of Zurich) are under construction in 2015. In addition, a project “thermal networking” has been launched by the Swiss Federal Office of Energy.

3. National Programme

In 2013, Switzerland’s government developed a completely revised Energy Act along with important modifications to other acts of parliament. They constitute the first set of measures to implement Switzerland’s Energy Strategy 2050. In 2015, the legislative commission of the Council of States (upper chamber of parliament) and the plenary Council of States have reviewed the proposed Energy Act. For geothermal power projects, the Energy Act will feature an expansion of Switzerland’s geothermal guarantee scheme both, in terms of scope and budgets. Also a new support mechanism for exploration activities has been put forward; here project developers can receive an investment grant covering up to 60% of the cost required to prove the existence of a geothermal reservoir. To promote direct use of geothermal energy, the Council of States has

followed the National Council and approved a modification of the CO_2 Act which would explicitly mandate the federal government to support direct use geothermal energy projects as long as they help to reduce CO_2 emissions from the use of fossil fuels in buildings. In 2016, both chambers of parliament will pass a final vote on the first set of measures in support of Switzerland's Energy Strategy 2050. Pending a national referendum in 2017, the revised Energy Act is likely to come into force in 2018.

One of the main features of Switzerland's Energy Strategy 2050 is the phasing out of nuclear energy over approximately the next 20-30 years, which today supplies around 40% (25 TWh) of the country's electricity demand. One of the consequences is an ambitious drive to increase the share of power from new renewables from today's 2.8 TWh to some 4.4 TWh and then 14.5 TWh by 2020 and 2035 respectively. The Government is currently developing a legal and support framework that paves the way for geothermal power to provide about 1 TWh by 2035 from zero today. Further aggressive targets for end-users in terms of energy efficiency and reduced greenhouse gas emissions are expected to fuel growth for indirect and direct heat supply from geothermal energy. While targets are discussed in terms of consumption, no targets are given for individual sources on the supply side.

While near-surface geothermal utilization is a market driven application, Switzerland encounters severe challenges in developing geothermal resources suitable for direct use and combined heat and power use.

4. Industry Status and Market Development

Market conditions for industry players in the ground source heat pump sector are increasingly challenging (reference 3). Due to the success of ground source heat pump deployment, many players have entered a market which based on anecdotal evidence suggests early signs of consolidation. Most shallow geothermal drilling companies compete on price, yet quality assurance has been maintained at a high level because of quality labelling schemes for heat pumps and drilling companies, and norms and guidelines (SIA 384/6 for ground source heat pumps and SIA 384/7 for groundwater applications) provided by the Swiss Federal Office of the Environment for geothermal heat pump applications. A number of gaps have been identified for ground source heat pump schemes; checks and controls are not widely implemented, completion (installation, backfilling and testing) of ground source heat pumps pose the biggest risks. In addition, the lack of spatial planning regulations in Switzerland suggests a poorly regulated legal framework for the deployment of deep ground source heat pumps. In general, ground source heat pumps are problem-free to depths of about 150 m. At depths greater than 250 m, risks are higher and problems are observed. In general, the Swiss Molasse Basin is well suited for the wide-spread uptake of ground source heat pumps; the Molasse Basin straddles about 50% of the country by area and serves as the deep underground for more than 75% of its population (see reference 3).

Currently, the Swiss Federal Government does not have any direct incentive schemes for utilizing geothermal energy for heating purposes. A number of Switzerland's 26 cantons have support schemes that are in effect investment subsidies for geothermal heat pumps.

Switzerland's industry is less advanced in developing deep geothermal resources. This covers the entire value chain from exploration, drilling, facilities and operation of geothermal heat and power plants. There are only a very few players in a practically non-existent market. Besides,

development is constrained by lack of financial resources, lack of skilled human resources and deficits in the legal and regulatory framework. It should be noted, however, that most of the core competencies for overcoming those barriers exist, and notably cantonal administrations and legislators are willing to work with developers in designing and implementing business friendly legal and regulatory frameworks.

Complimentary to these efforts, the Swiss Federal Government continues to implement feed-in tariffs and a geothermal guarantee scheme for geothermal power plants. The requisite funds for financing the feed-in tariffs and other related measures such as the geothermal guarantee derives from a surcharge that end customers pay for power transmitted via the high voltage grid.

Since the revenues resulting from the surcharge are determined by the power transmitted via the high voltage grid, there is a cap on the annual subsidies available which in effect results in a wait-list for projects. The wait-list has a substantial turn-over because many announced projects (mostly photovoltaic or wind energy) do not materialize. Feed-in tariffs remain in effect for 20 years.

Since feed-in tariffs are governed by the Energy Ordinance there is one unusual side effect on the feed-in tariff for geothermal power: the power required for artificial lift is not subtracted from the power supplied to the grid subject to the feed-in tariff. This feature stems from an analogy to power from biomass. The energy required to mobilize bio-feedstock to the factory gate is not subtracted from the power supplied to the grid. Hence artificial lift, the energy necessary to deliver hot water/steam to the power plant is also discounted.

Table 2 Feed-in tariffs for electricity from geothermal energy resources (Reference 4).

Installed capacity	Feed-in Tariff (Rp./kWh)
≤5 MW	40.0
≤10 MW	36.0
≤20 MW	28.0
>20 MW	22.7

US$ 1.05 = CHF 1 or 100 Rappen (Rp.)

Owing to the large gaps in the knowledge of Switzerland's deep subsurface (only 11 wells have been drilled in the country to depths greater than 3000 m), the Federal Government has instituted a geothermal guarantee scheme for geothermal power projects (reference 5). The scheme is underwritten by a CHF 150 million fund that has been financed by the grid surcharge. Geothermal power projects can apply for a geothermal guarantee and once qualified may be reimbursed for up to 50% of the total subsurface development cost of a project if it fails.

5. Research, Development and Demonstration/Deployment

Research and innovation is funded by the Swiss National Science Foundation (fundamental research), the Swiss Federal Office of Energy (applied research) and the Commission for Technology and Innovation (market-driven research). Some of the federally funded Swiss Federal

Institutes of Technology have allocated funds to be used for geothermal energy research and innovation. Of the five institutes, ETH Zurich, EPF Lausanne and the Paul Scherrer Institute have some geothermal research work underway.

Eight new Swiss Competence Centers for Energy Research (SCCER) officially launched in 2014 have been established to initiate research and innovation in fields deemed critical for Switzerland's Energy Strategy 2050. One of the SCCERs, SCCER – Supply of Electricity or SCCER-SoE, has a focus on geothermal energy and particularly on technologies required to unlock Engineered Geothermal Systems. The SCCER's are set up along the lines of a public-private partnership with industry players encouraged to participate.

Since 2015, R&D activities have been established in the new institutions. R&D funds for 2015 are at a level of US$ 10 million (including funds for deployment activities).

Despite ongoing political discussions in 2015 between Switzerland (as a non-EU member) and the EU regarding the free movement of labour, Switzerland continues to participate on a self-funding basis in R&D programs organised by the European Commission. Similarly, the dedicated funding agency for geothermal energy (located in the Swiss Federal Office of Energy) cooperates with European funding agents in the European Commission enabled Geothermal ERA-NET, as well as the International Partnership for Geothermal Technology (with the USA, Iceland, Australia and New Zealand). Naturally, Switzerland participates in the IEA's Geothermal Technology Collaboration Program.

Industry classifies a large part of their geothermal development activities in the areas of hydrothermal project development and EGS as research and innovation. Financial information is not available.

6. Geothermal Education

The University of Neuchâtel is running a successful, oversubscribed Certificate for Advance Studies or CAS DEEGEOSYS - Exploration & Development of Deep Geothermal Systems. At ETH Zurich one full professorship related to geothermal energy and other subsurface energy applications has been filled in the Earth Science Department. One other professorship in the field of Mechanical Engineering continues to be advertised. With the establishment of the SCCER SoE, a number of tenure-track professorships at the EPF Lausanne, at the Universities of Geneva and Neuchâtel have been filled with incumbents who took up posts in 2015.

7. Future Outlook

Beyond 2015 a number of policy changes will be progressed; most notably the revised Energy Act will be discussed in the upper chamber of parliament in 2016.

For the last 6 years Switzerland's utility industry has been in dire straits. In 2015, some of the larger Swiss power supply companies (e.g. Axpo, BKW) stopped work and engagement in deep geothermal energy. The distortion in neighbouring European energy markets due to highly subsidized renewable energy has caused havoc in established long-running and profitable Swiss businesses. Margins have eroded, asset write-downs are the norm and industry players have not been able to adapt to or compete well in the new world.

8. Publications and Websites

1 Statistik der geothermischen Nutzung in der Schweiz Ausgabe 2015 (2016). Published by the Swiss Geothermal Association geothermie-schweiz http://geothermie-schweiz.ch/wp_live/wp-content/uploads/2016/07/Geothermiestatistik-Schweiz-Ausgabe-2015_20160728.pdf [Document only available in German]

2 Energiestrategie 2050 – Erstes Massnahmenpaket Zusammenstellung der Massnahmenbeschriebe (2012) http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_691836301.pdf [Document only available in German; deep geothermal enery support program pp. 116-140]

3 Qualitätssicherung Erdwärmesonden by Dr. Walter Eugster, dipl. Natw. ETH http://www.fws.ch/tl_files/download_d/Downloads/Eugster-QS-EWS_Eugster.pdf [Document only available in German; presentation on Quality Assurance in Ground Source Heat Pumps]

4 Energy Ordinance (730.01) Appendix 1.4 http://www.admin.ch/opc/de/classified-compilation/19983391/201210010000/730.01.pdf [Document available in German and French]

5 Energy Ordinance (730.01) - Appendix 1.6 http://www.admin.ch/opc/de/classified-compilation/19983391/201210010000/730.01.pdf [Document available in German and French]

IEA Geothermal

Executive Secretary
IEA Geothermal
C/ - GNS Science
Wairakei Research Centre
Ph: +64 7 374 8211
E: iea-giasec@gns.cri.nz