Swiss Country Report

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\section*{ABSTRACT}
Geothermal direct use, estimated for 2006 on the basis of previous and growth rate data, reached about 650 MWt installed capacity and 5500 TJ/yr heat production, mostly from geothermal heat pumps (GHP). This corresponds to the saving of 130’000 toe fossil fuel. Geothermal energy in Switzerland thus reduces the emission of CO\textsubscript{2} by about 400’000 tons per year. GHP installation prices decrease whereas drilling for GHPs increases. The largest Swiss geothermal project, DEEP HEAT MINING in Basel, has been suspended in December 2006 due to earthquake activity triggered by water injection for stimulation. National research activities as well international cooperation are accompanied by increasing educational efforts.

\section*{1. INTRODUCTION}
In the following, the status and development trends in the year 2006 are summarized.

The reorganization of the key Swiss player and coordinator in geothermal energy development and utilization, the Swiss Geothermal Association SVG, has been completed. The SVG, an Affiliated Member of IGA, acts now as the Swiss Geothermal Competence Center under the label GEOTHERMIE.CH. Its bi-lingual (G/F) Newsletter also carries the name GEOTHERMIE.CH.

Geothermal heat pumps contribute still the largest share to direct use, which grows steadily by about 10 \% per year. Quality labels and engineering norms guarantee operation reliability and efficiency.

As a negative highlight it must be reported that the largest Swiss geothermal project, DEEP HEAT MINING in Basel, has been suspended in December 2006 due to earthquake activity triggered by water injection for stimulation.

\section*{2. NATIONAL POLICY}
On the political scene the main change is that a CO\textsubscript{2} tax is being introduced. The Energy Law already passed both chambers of the Parliament; it shall include promotion measures like a Risk Guarantee for deep geothermal drilling for electricity production.

Increasing participation in international R&D efforts, besides in the IEA Geothermal Implementing Agreement (GIA), can be reported: Switzerland cooperated in 2006 in several EU projects; details see below.

Expenditure of industry provided significant contributions to the DEEP HEAT MINING project in Basel (> 10 Mio. US$).

\section*{3. CURRENT STATUS OF GEOTHERMAL ENERGY USE IN 2006}

\subsection*{3.1 Electricity Generation}
So far there is no electricity generation in Switzerland. The EGS project DEEP HEAT MINING BASEL aiming at CO\textsubscript{2}-free co-generation, financially the most focused geothermal endeavour in Switzerland, is organized and managed by the shareholder company Geopower Basel AG. The project is financed from public and private sources; expenditure until end of 2006 was 55 MCHF (~45 MUS$). The project has been suspended by the local authorities; now a risk study (including seismic risk) shall provide the decision basis for definite project end or continuation (with restrictions).

\subsection*{3.2 Direct Use}
In 2004 a statistical survey was carried out about geothermal energy use in Switzerland; the numbers about installed capacities, energy produced, fossil fuel and CO\textsubscript{2} emission savings etc. are published in the Swiss Country Update Report 2005 (available also at the IEA GIA website under \url{http://www.iea-gia.org/publications}). So far there are no new statistical data; the numbers reported below have been estimated on the basis of the experienced trends in the last few years.

The key achievement of Switzerland is still in the use of shallow geothermal resources by ground-coupled heat pumps. An evaluation of available global data reveals that Switzerland occupies a prominent world-wide rank in installing and running geothermal heat pump systems (Rybach, 2005). Figure 1 shows the clear growth in installing borehole heat exchangers for GHPs over the years 1998-2006; in 2006 close to 1000 kilometers have been drilled for borehole heat exchangers. Geothermal heat pumps are now increasingly and soon routinely used for heating as well as for cooling.
Table 1: Estimated numbers in direct use in 2006 (usage category, installed capacity, and thermal energy used). The total numbers are about 10% higher than in 2005.

<table>
<thead>
<tr>
<th>System</th>
<th>Installed capacity (end of 2006)</th>
<th>Heat produced (in 2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat pumps with borehole heat exchangers</td>
<td>440 MWt</td>
<td>3000 TJ</td>
</tr>
<tr>
<td>Groundwater-based heat pumps</td>
<td>100 MWt</td>
<td>650 TJ</td>
</tr>
<tr>
<td>Geostructures, tunnel waters</td>
<td>20 MWt</td>
<td>500 TJ</td>
</tr>
<tr>
<td>Deep aquifers for district heating</td>
<td>15 MWt</td>
<td>135 TJ</td>
</tr>
<tr>
<td>Spas, wellness facilities</td>
<td>81 MWt</td>
<td>1200 TJ</td>
</tr>
<tr>
<td>Total</td>
<td>656 MWt</td>
<td>5485 TJ</td>
</tr>
</tbody>
</table>

3.3 Fossil Fuel Savings

The heat production from geothermal sources ("direct use") enables to save fossil fuels. The annual heat production in 2006, 5485 TJ, corresponds to the saving of 130,000 toe. Geothermal energy in Switzerland thus reduces the emission of CO₂ by about 400,000 tons per year.

4. MARKET DEVELOPMENT AND STIMULATION

4.1 Support Initiatives and Market Stimulation Incentives

Financial support or tax credits of different kind and size can be obtained when installing geothermal heat pumps, depending on the site location. Local electric utilities, communities, various entities provide support. This explains at least partly the rapid development of the Swiss geothermal heat pump market. Information about the various sources of support can be downloaded from the website of the Swiss Heat Pump Promotion Association FWS [http://www.fws.ch/](http://www.fws.ch/) under “Zahlen & Fakten” and “Förderbeiträge und Steuervergünstigungen” (= support finances and tax reductions).

4.2 Development Cost Trends

Technologic progress (e.g. measurable by heat pumps COP), better materials, increasing experience lead to progress on the learning curve; absolute prices are constantly decreasing, see Figure 2.

5. DEVELOPMENT CONSTRAINTS

For geothermal direct use in general and for geothermal heat pumps in particular there could be – irrespective of already impressive achievements- even more rapid development. Architects as well as engineers responsible for building energy supply are still not always familiar with geothermal heating and cooling. Therefore increased efforts in education and post-graduate training are undertaken (see below).

Quite recently a bottleneck becomes evident for new projects: the Swiss companies active in drilling for borehole heat exchangers (more than twenty) have so many orders that the waiting time to get borehole heat exchangers installed can be up to 5-6 months.

The stop of the DEEP HEAT MINING PROJECT in Basel ordered by authorities due to induced seismicity had also repercussions on plans and expectations about geothermal power generation and EGS projects in Switzerland in the future: the DEEP HEAT MINING PROJECT in Geneva has been suspended as well. The commercial realization of the EGS project in Basel and Geneva must wait now until basic questions about seismic risk and heat extraction efficiency are answered.
Table 2. Cost comparison of heating systems in Switzerland (reference system capacity 10 kW).

<table>
<thead>
<tr>
<th>Heating system</th>
<th>Efficiency (η/SPF*)</th>
<th>Investment (CHF)</th>
<th>Capital cost (Annuity, CHF)</th>
<th>Operating cost (CHF)</th>
<th>Total annual cost (CHF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil boiler</td>
<td>0.85</td>
<td>18'000</td>
<td>1'741</td>
<td>1'483</td>
<td>3'224</td>
</tr>
<tr>
<td>Gas boiler</td>
<td>0.95</td>
<td>14'500</td>
<td>989</td>
<td>1'882</td>
<td>2'871</td>
</tr>
<tr>
<td>Biomass (pellets)</td>
<td>0.90</td>
<td>33'500</td>
<td>2'692</td>
<td>1'814</td>
<td>4'506</td>
</tr>
<tr>
<td>Geothermal heat pump (with BHE)</td>
<td>3.4</td>
<td>30'500</td>
<td>2'055</td>
<td>872</td>
<td>2'929</td>
</tr>
<tr>
<td>Air-source heat pump</td>
<td>2.6</td>
<td>25'500</td>
<td>1'876</td>
<td>1'110</td>
<td>2'986</td>
</tr>
</tbody>
</table>

*) Seasonal performance factor

6. ECONOMICS

Concerning geothermal heat pumps their economy becomes, in view of generally rising fossil fuel prices and the CO₂ tax, increasingly competitive. The geothermal option for heating alone is already favourable; in summer it is the only system that can also provide space cooling.

A comparison with other heating systems has been performed (Table 2).

There is no official statistics about the number of people employed in the geothermal sector; from the number of drilling companies and institutions active in geothermal R&D a rough estimate yields about 100 – 120 people.

7. RESEARCH ACTIVITIES IN 2006

The national activities financed by the Swiss Federal Office of Energy (SFOE) comprised:

- feasibility study AGEP (Alpine geothermal power production)
- software development “Groundwater Energy Designer”
- innovative improvements of Thermal Response Tests
- establishment of a hydrochemical data base for deep aquifers
- documentation and evaluation of failures with geothermal heat pumps
- economic feasibility study for an EGS installation at Geneva
- energy conversion processes for the use of geothermal heat.

All research projects have to deliver their final reports; these can be downloaded from the SFOE database: http://www.bfe.admin.ch/dokumentation/energieforschung/.

8. GEOTHERMAL EDUCATION

Also in 2006, significant efforts were undertaken for education and information dissemination. Besides regular courses at universities and technical schools there have been numerous special geothermal courses, workshops and excursions: Special training for students (7 courses; 165 participants), Postgraduate training (18 courses, 6 technical excursions, 800 participants). The activities are planned and implemented by Geowatt AG Zurich for GEOTHERMIE.CH and financed by the Swiss Federal Office of Energy (SFOE). Since the establishment of the educational activities in 2001, totally 88 events have been organized with over 3'000 participants. Figure 3 shows the development over the years; the events are taking place in all parts of Switzerland: the French speaking Romandie, the Italian speaking Tessin, and the German speaking Deutschschweiz.

![Figure 3: Geothermal educational events in Switzerland 2001 – 2006 (Geowatt AG Zurich)](http://www.bfe.admin.ch/dokumentation/energieforschung/)

9. INTERNATIONAL COOPERATIVE ACTIVITIES

First of all the participation of Switzerland in the IEA Geothermal Implementing Agreement must be mentioned. The Enhanced Geothermal System Project Management Decision Assistant (EGS PMDA), completed under Annex III, Subtask C (Leader: Th. Mégel, GEOWATT AG, Zurich), received international attention in 2006. The EGS PMDA can still be ordered through http://www.iea-gia.org/publications.asp.

The paper Geothermal Sustainability - the View of the International Energy Agency Geothermal Implementing Agreement (IEA-GIA) has been prepared by L. Rybach and M. Mongillo and presented at the GRC 2006 Annual Meeting in San Diego/USA where it received a Best Paper Award.
Switzerland is also active within R&D programs of the European Union. Cooperation is ongoing in the following geothermal projects:

- EGS Scientific Pilot Plant Soultz/F
- ENGINE
- I-GET
- GROUNDHIT.

Strong involvement is to be reported especially in the project ENGINE (“ENhanced Geothermal Innovative Network for Europe”): ENGINE Workshop no. 3 “Stimulation of reservoir and induced microseismicity” was organized by Geowatt AG Zurich and held 26 June – 1 July 2006 in Ittingen/TG. L. Rybach is member of the ENGINE Executive Group, the governing board of the project.

10. GEOTHERMAL WEBSITES IN SWITZERLAND

<table>
<thead>
<tr>
<th>Organization</th>
<th>Website</th>
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<tbody>
<tr>
<td>SVG/GEOTHERMIE.CH</td>
<td><a href="http://www.geothermal-energy.ch">www.geothermal-energy.ch</a></td>
</tr>
<tr>
<td>BFE (SFOE)</td>
<td><a href="http://www.bfe.admin.ch">www.bfe.admin.ch</a></td>
</tr>
<tr>
<td>CREGE</td>
<td><a href="http://www.crege.ch">www.crege.ch</a></td>
</tr>
<tr>
<td>FWS/Heat Pump Promotion Association</td>
<td><a href="http://www.fws.ch">www.fws.ch</a></td>
</tr>
<tr>
<td>Swiss Deep Heat Mining Project</td>
<td><a href="http://www.dhm.ch">www.dhm.ch</a></td>
</tr>
<tr>
<td>Geopower Basel AG</td>
<td><a href="http://www.geopower-basel.ch">www.geopower-basel.ch</a></td>
</tr>
<tr>
<td>Geothermal Explorers Ltd.</td>
<td><a href="http://www.geothermal.ch">www.geothermal.ch</a></td>
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<tr>
<td>Geowatt AG Zurich</td>
<td><a href="http://www.geowatt.ch">www.geowatt.ch</a></td>
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REFERENCES