Geothermal Energy in the Alps
Switzerland: Status and development trends in 2006

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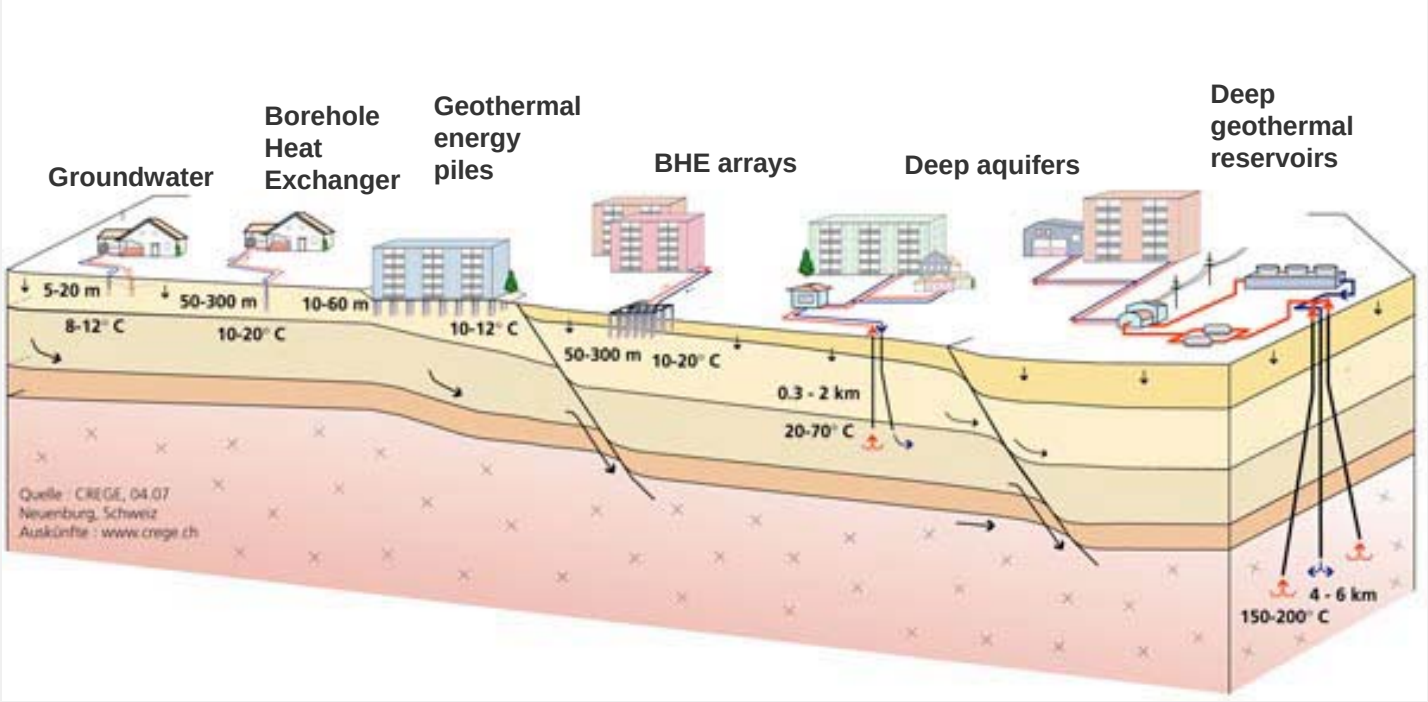
Introduction

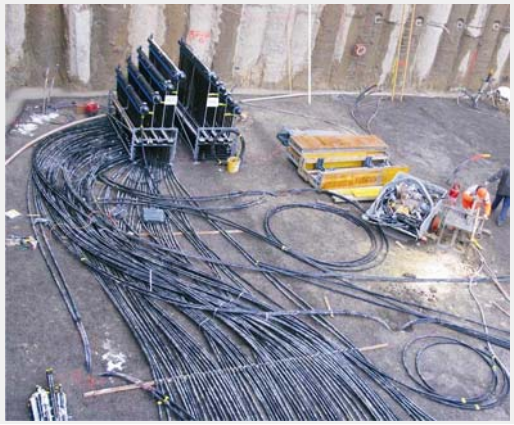
Different types of geothermal energy use
Geothermal installations are largely invisible

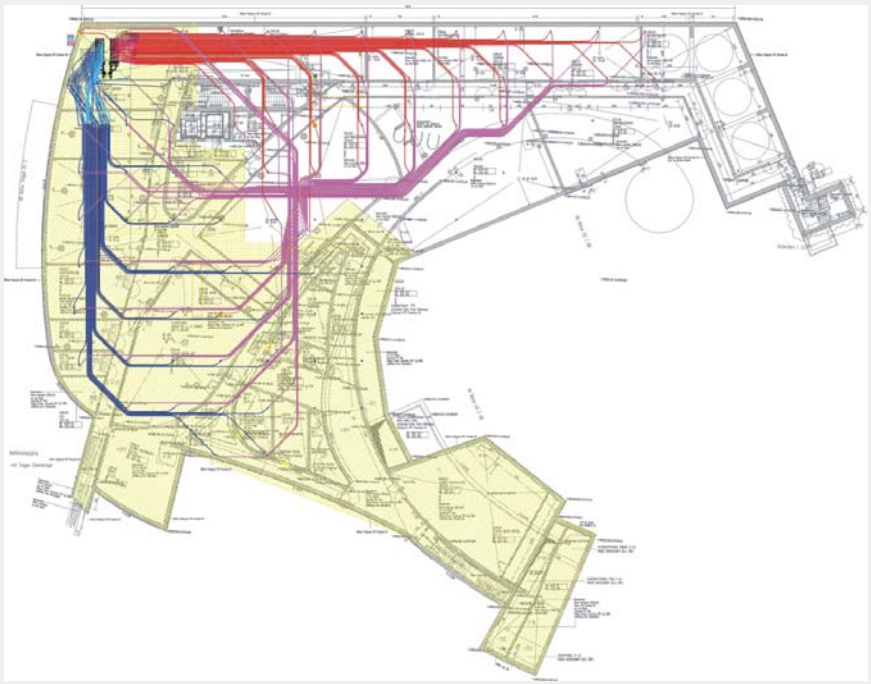


[www.geothermie.ch]

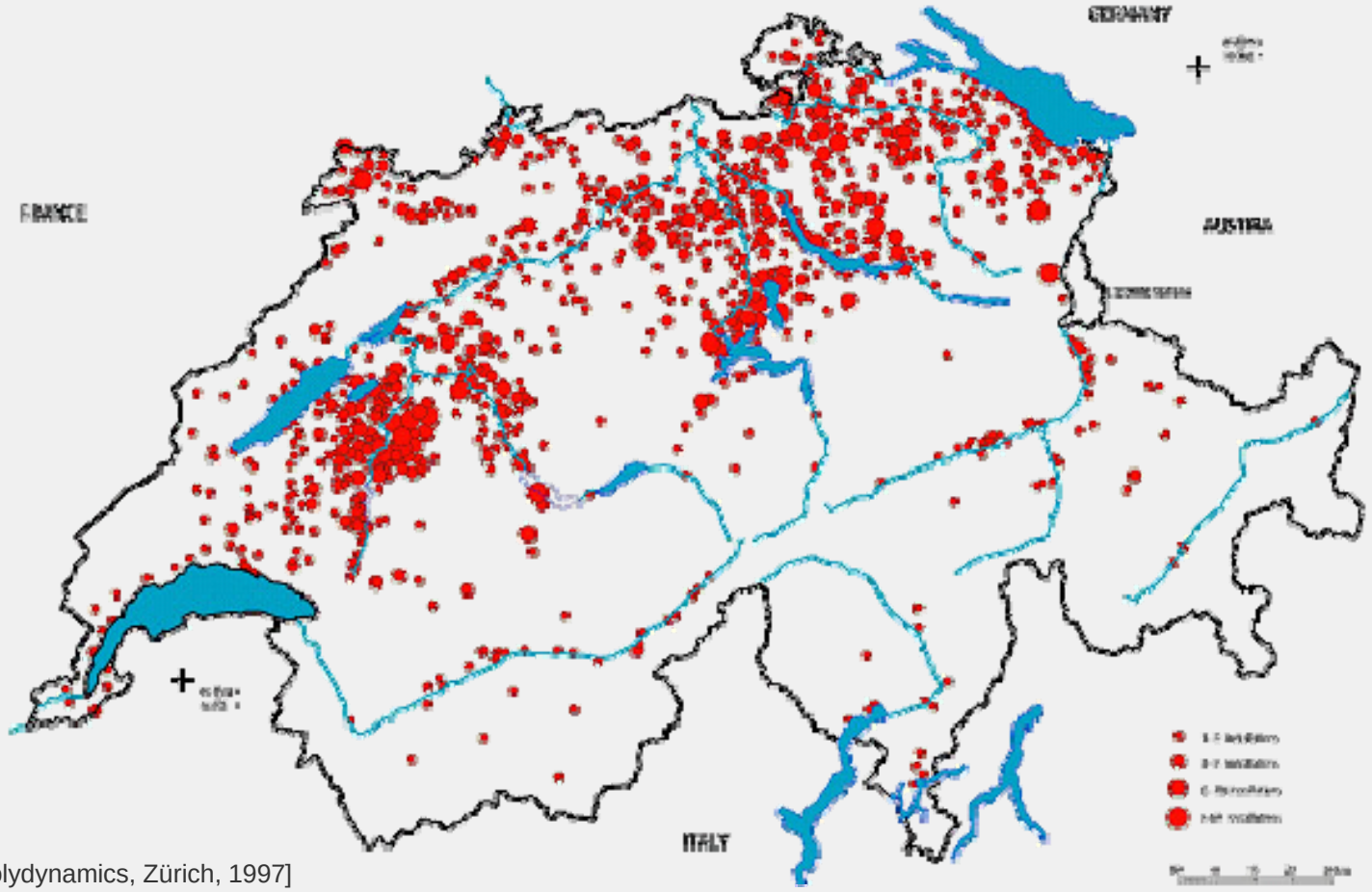
1. Direct Use: The Dolder Grand*****

- 1 GWh/a heating energy demand 1 GWh/a cooling energy demand
- 72 BHE, total 11‘000 m length
- Heated area: 45’000 m²





1. Direct Use. Swiss BHE Map 1997

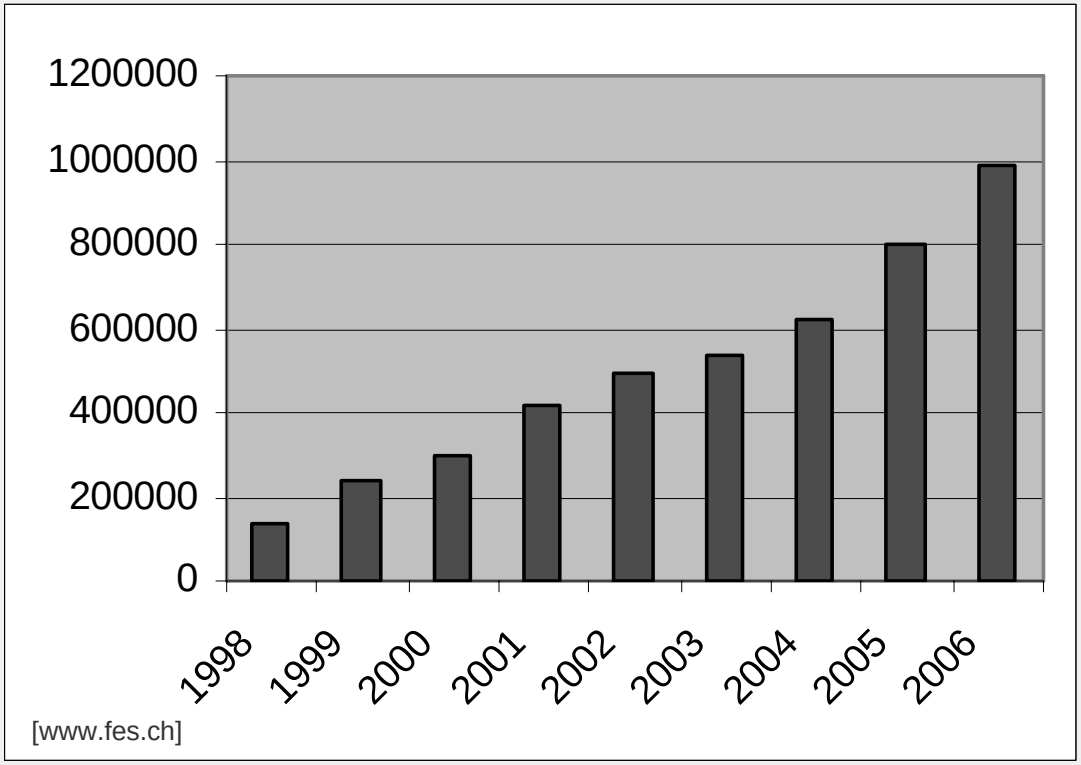


[After Polydynamics, Zürich, 1997]

1. Direct Use: Swiss Drilling Activities

Drilling meters for Borehole Heat Exchangers in Switzerland.

Increase of drilling activities for borehole heat exchanger-coupled geothermal heat pumps 1998-2006.

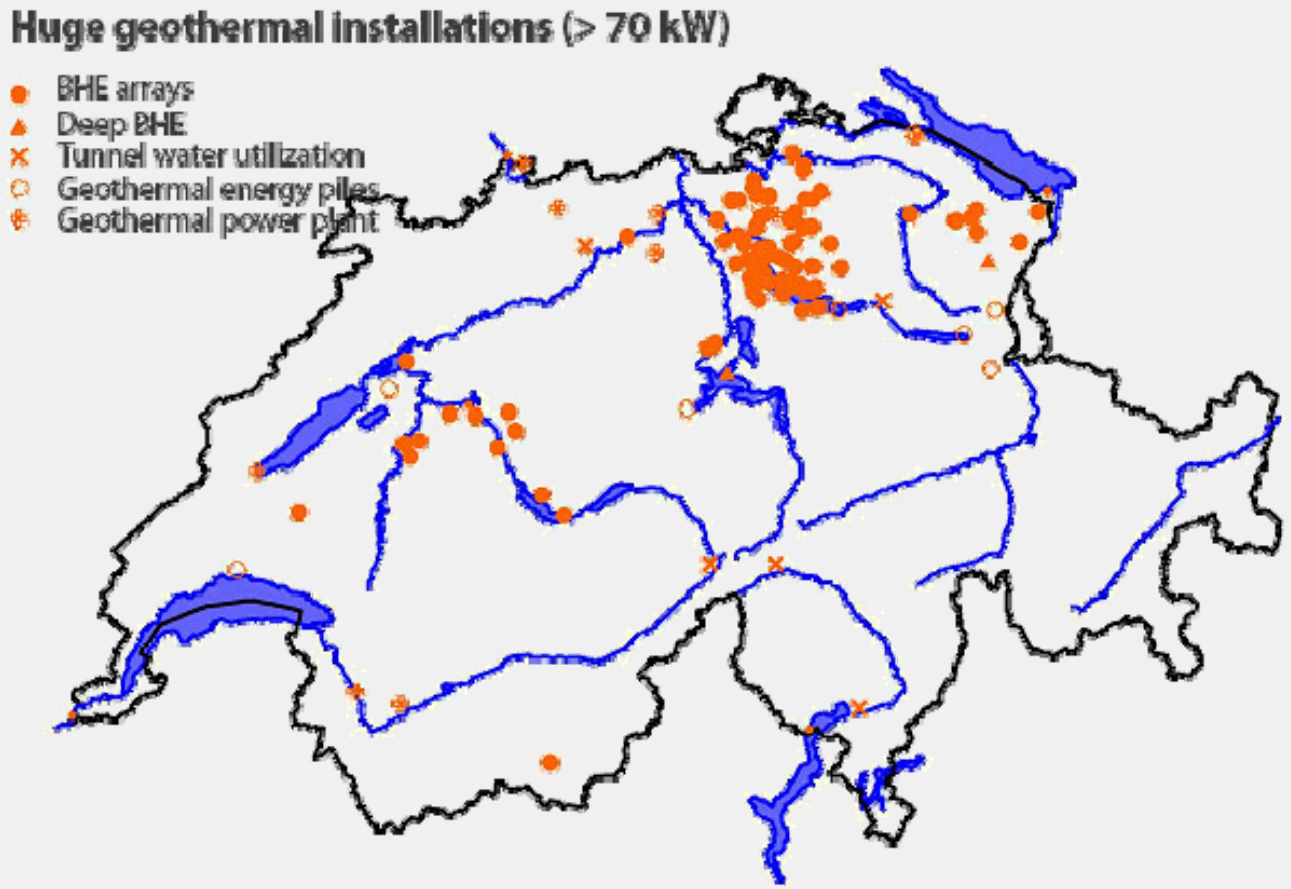


[www.fes.ch]

1. Direct Use: Swiss Applications

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

1. Direct Use: Huge Projects



1. Direct Use 2005: Alpine Countries

Austria	2‘200	GWh a^{-1}
Germany	1‘400	GWh a^{-1}
France	1‘400	GWh a^{-1}
Italy	1‘100	GWh a^{-1}
Switzerland	1‘100	GWh a^{-1}
China	12‘600	GWh a^{-1}
Iceland	6‘600	GWh a^{-1}
Sweden	10‘000	GWh a^{-1}
Turkey	5‘500	GWh a^{-1}
USA	8‘700	GWh a^{-1}

[Clauser, C., 2006. Geothermal Energy, In: K. Heinloth (ed), *Landolt-Börnstein, Group VIII: Advanced Materials and Technologies, Vol. 3: Energy Technologies, Subvol. C: Renewable Energies,* Springer Verlag, Heidelberg-Berlin, 493-604.

J. Lund u.a.: *World wide direct use of geothermal energy 2005*. World Geothermal Congress, Antalya 2005]

1. Heat Pump Olympic Games

Disziplines:

1. Installed capacity (MW_t)
2. Energy use (TJ/yr)
3. Capacity per area (MW_t/km^2)
4. Capacity per capita (W_t/capita)
5. Energy per area (GJ/yr per km^2)
6. Energy per capita (GJ/yr per capita)
7. Units per area (12 kW equivalent units per km^2)

Gold: Sweden 3x, Switzerland 2x, Denmark 1x, USA 1x

Silver: Sweden 4x, Denmark 1x, Norway 1x, USA 1x

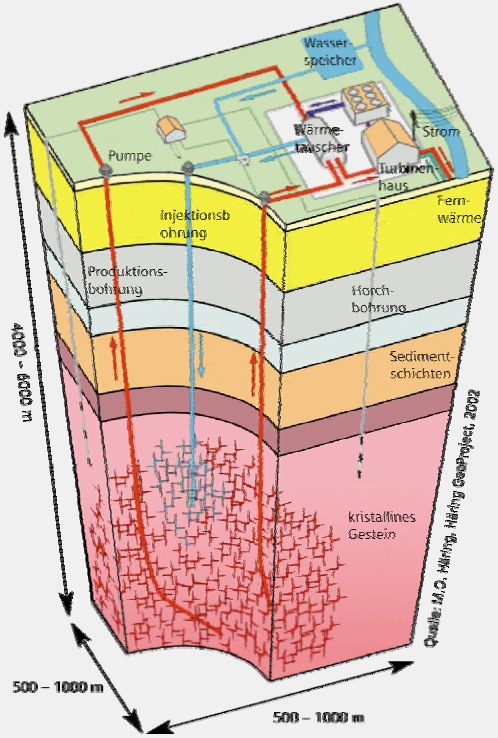
Bronce: China 2x, Denmark 2x, Switzerland 2x, Norway 1x

[Rybach (2005), IEA Heat Pump Centre Newsletter Vol. 23 Nr. 4]

2. Electricity Generation in Switzerland

So far there is no geothermal electricity generation in Switzerland.

The EGS project DEEP HEAT MINING BASEL has been suspended by the local authorities due to earthquake activity triggered by water injection for stimulation.

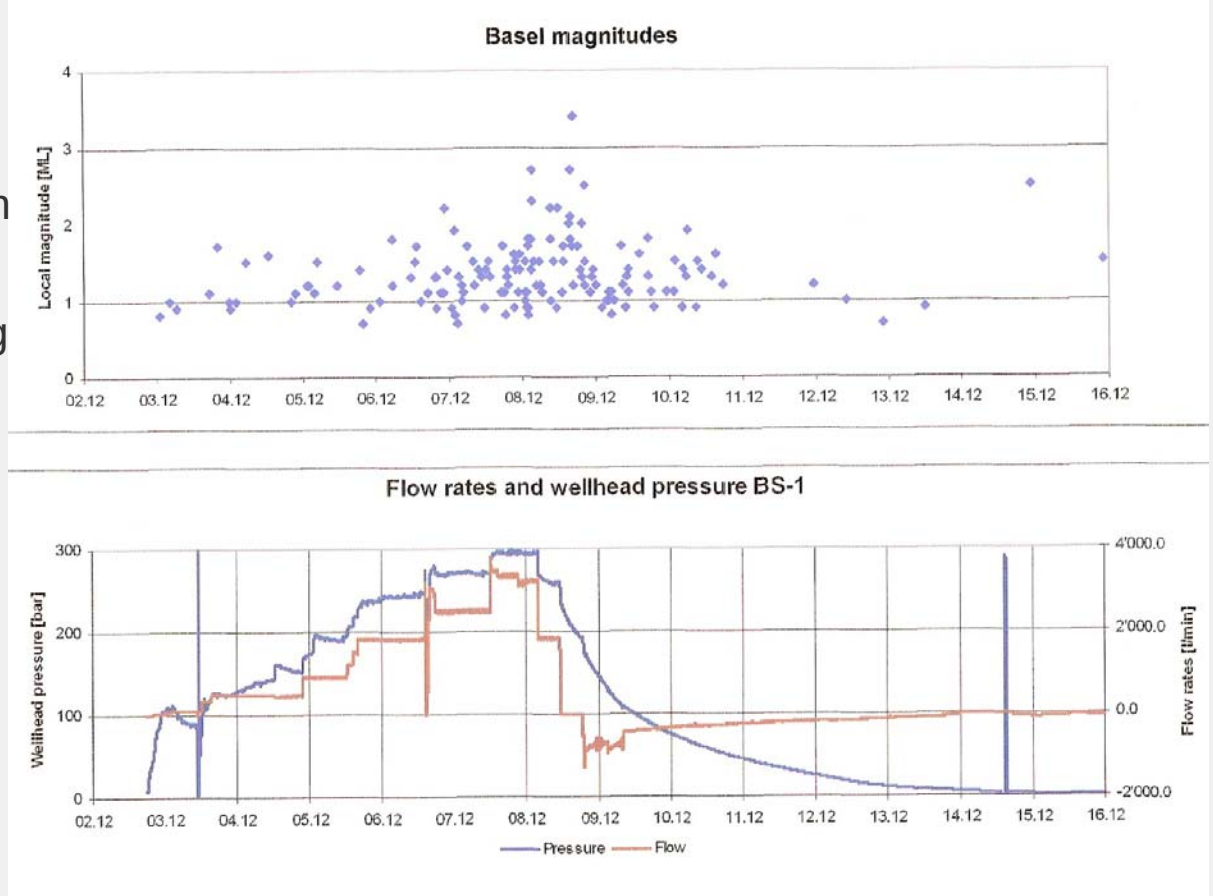


[Geopower AG Basel]

2. Electricity Generation: Risks

The project has been suspended due to earthquake activity triggered by water injection for stimulation.

Now a risk study (including seismic risk) shall provide the decision basis for definite project end or continuation.



[Geothermal Explorers Ltd.]

2. Electric Energy Production 2005: Alpine Countries

Austria (GHZ Altheim)	3	GWh a^{-1}
Germany (Neustadt-Glewe)	2	GWh a^{-1}
France (Guadeloupe Isl.)	102	GWh a^{-1}
Italy	5‘340	GWh a^{-1}
Switzerland	-	GWh a^{-1}
China	96	GWh a^{-1}
Iceland	1‘406	GWh a^{-1}
Turkey	105	GWh a^{-1}
USA	17‘840	GWh a^{-1}
Philippines	9‘419	GWh a^{-1}

[Clauser, C., 2006. Geothermal Energy, In: K. Heinloth (ed), *Landolt-Börnstein, Group VIII: Advanced Materials and Technologies, Vol. 3: Energy Technologies, Subvol. C: Renewable Energies,* Springer Verlag, Heidelberg-Berlin, 493-604.

3. Fossil Fuel Savings

The heat production from geothermal sources ("direct use") enables to save fossil fuels.

The annual heat production in 2006, 5'485 TJ, corresponds
to the saving of 130'000 toe.

Geothermal energy in Switzerland thus reduces the emission of CO_2 by about 400'000 tons per year.

CO2-Emission of „dirty" power plants

Rank	Power Plant	Country	Fuel	Start of operation	Operator	Relative Emissions[1]	Absolute Emissions[2]
1	Agios Dimitrios	Greece	Lignite	1984-1986, 1997	DEH	1.350	12.4
2	Kardia	Greece	Lignite	1975, 1980-1981	DEH	1.250	8.8
3	Niederaußem	Germany	Lignite	1963-1974, 2002	RWE	1.200	27.4
4	Jänschwalde	Germany	Lignite	1976-1989	Vattenfall	1.200	23.7
5	Frimmersdorf	Germany	Lignite	1957-1970	RWE	1.187	19.3
6	Weisweiler	Germany	Lignite	1955-1975	RWE	1.180	18.8
7	Neurath	Germany	Lignite	1972-1976	RWE	1.150	17.9
8	Turow	Poland	Lignite	1965-1971, 1998-2004	BOT GiE S.A.	1.150	13.0
9	As Pontes	Spain	Lignite	1976-1979	ENDESA	1.150	9.1
10	Boxberg	Germany	Lignite	1979-1980, 2000	Vattenfall	1.100	15.5
11	Belchatow	Poland	Lignite	1982-1988	BOT GiE S.A.	1.090	30.1
12	Prunerov	Czech Republik	Lignite	1967 & 1968	CEZ	1.070	8.9
13	Sines	Portugal	Hard coal	1985-1989	EDP	1.050	8.7
14	Schwarze Pumpe	Germany	Lignite	1997 & 1998	Vattenfall	1.000	12.2
15	Longannet	UK	Hard coal	1972-1973	Scottish Power	970	10.1
16	Lippendorf	Germany	Lignite	1999	Vattenfall	950	12.4
17	Cottam	UK	Hard coal	1969-1970	EDF	940	10.0
18	Rybnik	Poland	Hard coal	1972-1978	EDF	930	8.6
19	Kozienice	Poland	Hard coal	1972-1975, 1978-1979	state owned	915	10.8
20	Scholven	Germany	Hard coal	1968-1979	E.ON	900	10.7

[1] Grams of CO_2 per Kilowatt hour (g CO_2/kWh). Where two plants have the same relative emissions, the plant with the higher absolute emissions (million tonnes CO_2 per year) ranks dirtier.
[2] Annual emissions for the year 2006 in million tonnes of CO_2 ($mtCO_2$)

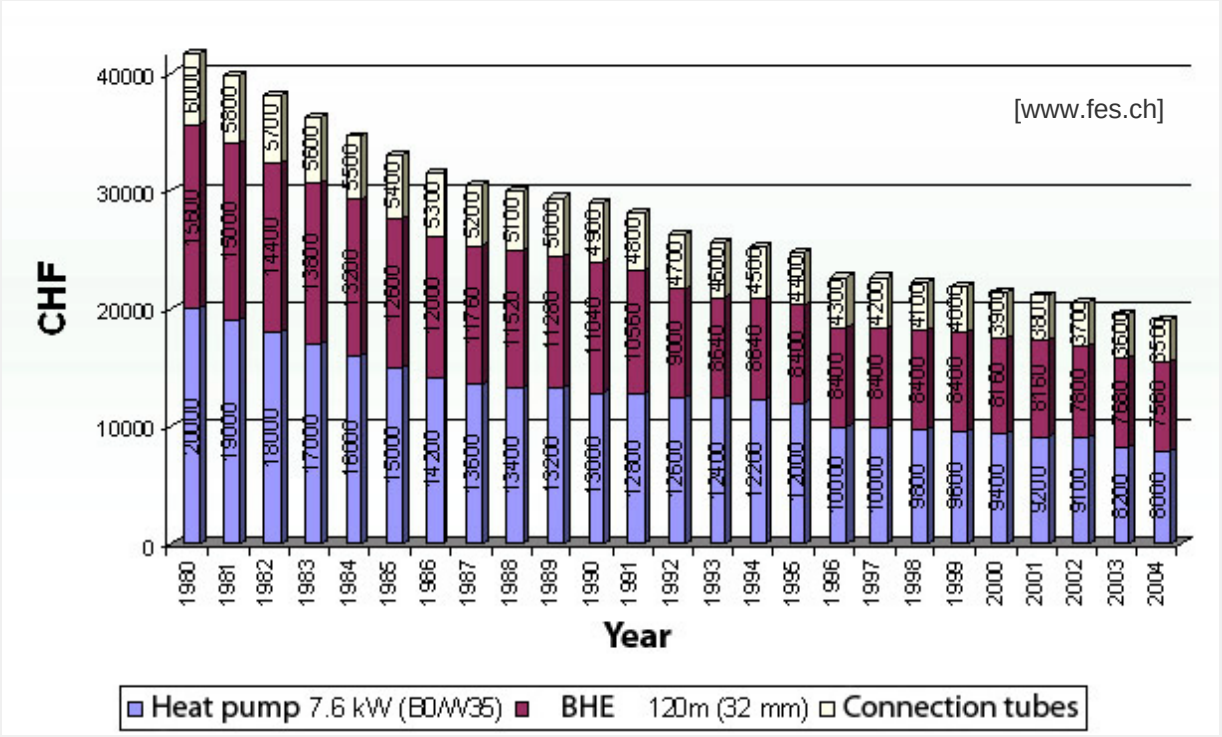
[WWF Dirty Thirty 2007: Ranking of the most polluting power stations in Europe]

4. Swiss Market Developement

Financial support can be obtained when installing geothermal heat pumps, depending on the site location.

This explains at least partly the rapid development of the Swiss geothermal heat pump market.

Absolute prices are constantly decreasing.



5. Economics

Concerning geothermal heat pumps their economy becomes, in view of generally rising fossil fuel prices and the CO 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 (reference capacity 10 kW) has been performed

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

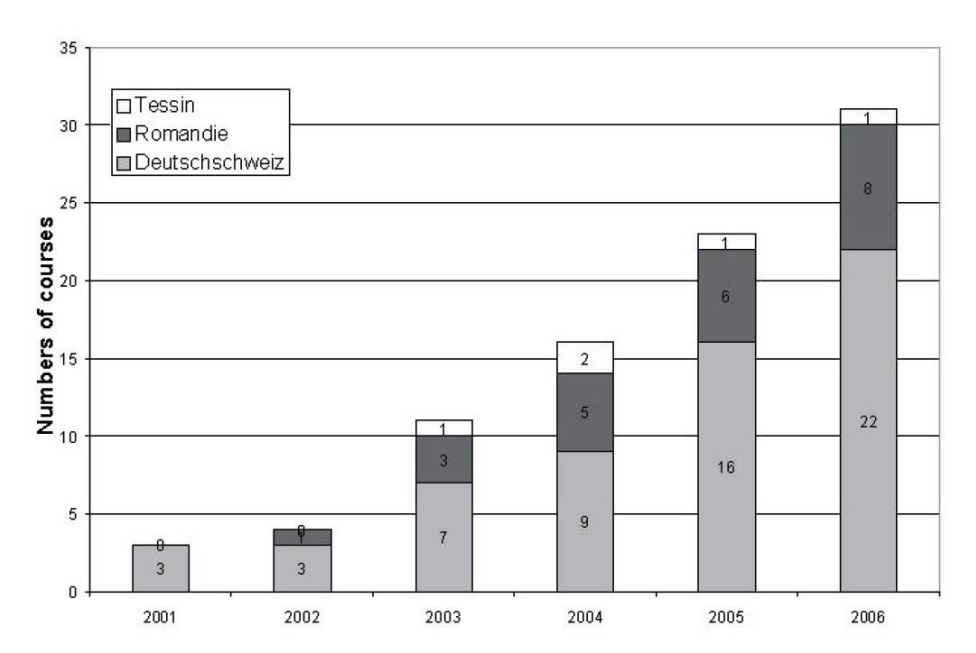
*) Seasonal performance factor

6. Geothermal Education in Switzerland

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, Postgraduate training.

The activities are planned and implemented by Geowatt AG Zurich for GEOTHERMIE.CH and financed by the Swiss Federal Office of Energy.

Since the establishment of the educational activities in 2001, totally 88 events have been organized with over 3'000 participants.



7. International Cooperative Activities

Switzerland is a participating country in the IEA Geothermal Implementing Agreement (GIA).

Switzerland is also active within geothermal 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.

8. Developements

Switzerland has a high and by far not yet exploited geothermal energy potential

Direct Use (e.g. BHE): fast-selling item
Reasons: increasing fossil energy costs, incresing competition, established and reliable technique

Electricity generation: Not market-ready
Reasons: very high exploration risk, small research budgets,...
Activities in Switzerland: Master plan for future geothermal research activities (planning state....)