

# Geothermal Power Production in Switzerland

## GEOELEC Workshop

Jörg Uhde | Axpo AG  
Offenburg, 29.02.2012

# Overview

## Content

- Axpo AG
- Political Framework for Geothermal Energy
- Deep Geothermal Energy in Switzerland

## Axpo AG

### What is our mission?

- Axpo is the largest electricity company in Switzerland and delivers electricity to around three million people each day.
- Axpo is committed to sustainability - our goal is to guarantee a safe and reliable supply of electricity produced in an environmentally responsible manner at competitive prices.



# Axpo AG

## Switzerland's Leading Energy Utility Company

Axpo's aim is to guarantee a reliable supply of electricity produced from environmentally friendly sources at competitive prices.

The Axpo mix of nuclear power, hydropower and new energies not only makes economic sense, but also is practically carbon-neutral and therefore climate-friendly.

### Axpo's goals in geothermal energy are:

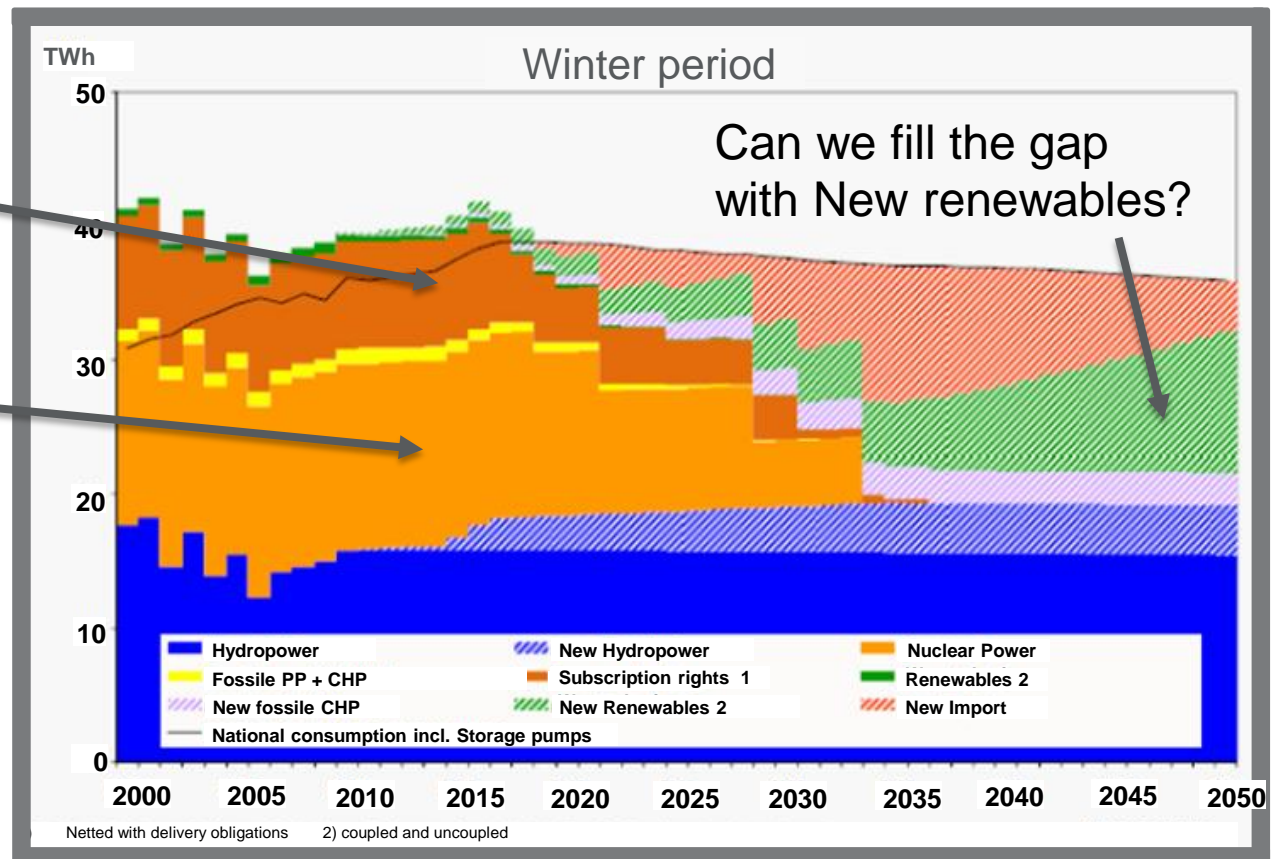
- Establishing of a centre of competence for geothermal energy in Switzerland
- **Construction and operation of geothermal power plants in Switzerland**



Axpo Geothermal Team

# Political Framework for Geothermal Energy

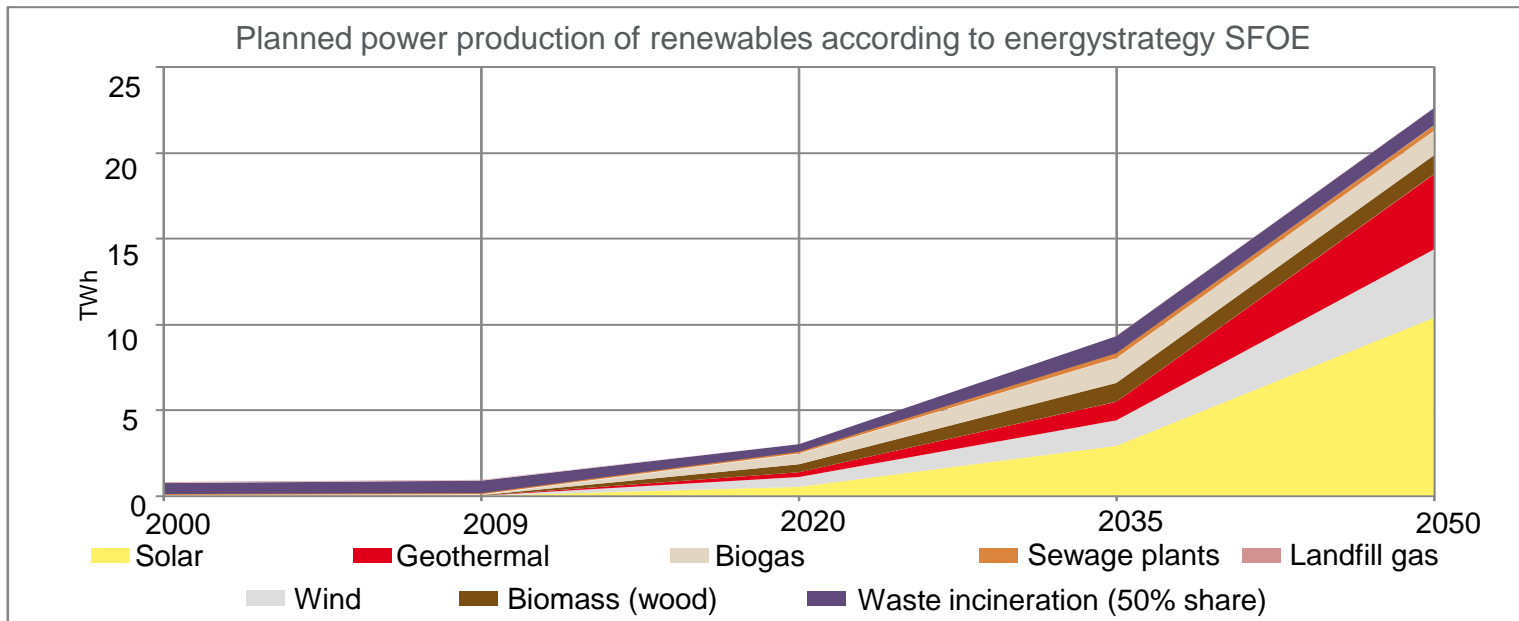
## Planning Swiss Federal Council after Fukushima



Source: Prognos 2011

# Political Framework for Geothermal Energy














No long term security of supply @ 83% of increased capacity



- 46% Solar → Where does power come from in January?
- 19% Geothermal → Geothermal Energy is not yet available in Switzerland
- 18% Wind → What happens if winds are low?

# Renewables in Switzerland

## Which options are realistic?

	Acceptance	costs	Important contribution to close the gap	Energy quality
Energy efficiency				
Hydro Power				
Wind				
Solar				
Biomass				
<b>Geothermal</b>				
Gas-fired combined cycle PP				
CHP				
Imports				

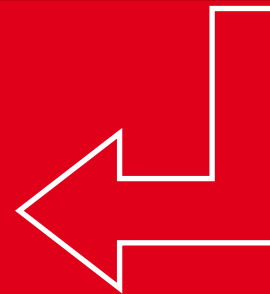
# Political Framework for Geothermal Energy

## Axpo Production strategy 2030

### Axpo intends to implement the following capacities

- Renewal of concessions for hydropower: 385 MW (CH)
- Small hydropower: 30 MW (CH)
- Hydropower abroad: 1 TWh
- Biogas, Biomass: 50 MW (CH)
- **Geothermal: 24 MW (CH)**

**Roughly equals 8 Plants at 3 MW<sub>el</sub>/Plant**





# Political Framework for Geothermal Energy

## Government Aid for Geothermal Power Production

### Government Aid: Fixed Electricity Feed in Tariff for 20 years

- Germany: EEG (Erneuerbares Energiegesetz → German Renewable Energy Act)
  - New, simplified system since 2012-01-01
  - Fixed Tariff: 25 ct/kWh<sub>el</sub>
  - Based on **gross electricity production**
  
- Switzerland: KEV (Kostendeckende Einspeisevergütung → Cost covering feed in tariff)
  - Fixed Tariff: 40 Rp./kWh<sub>el</sub> (~33.3 ct/kWh<sub>el</sub> @ 1€ = 1.2 CHF)
  - Based on **net electricity production**
  - No additional using of heat required
  - Risk insurance: Up to 50% of drilling costs will be refunded by the government in case of low productivity
  
- **Similar Financial Framework of the German and the Swiss Model**
  - If own consumption of the power plant and production pump is about 25%

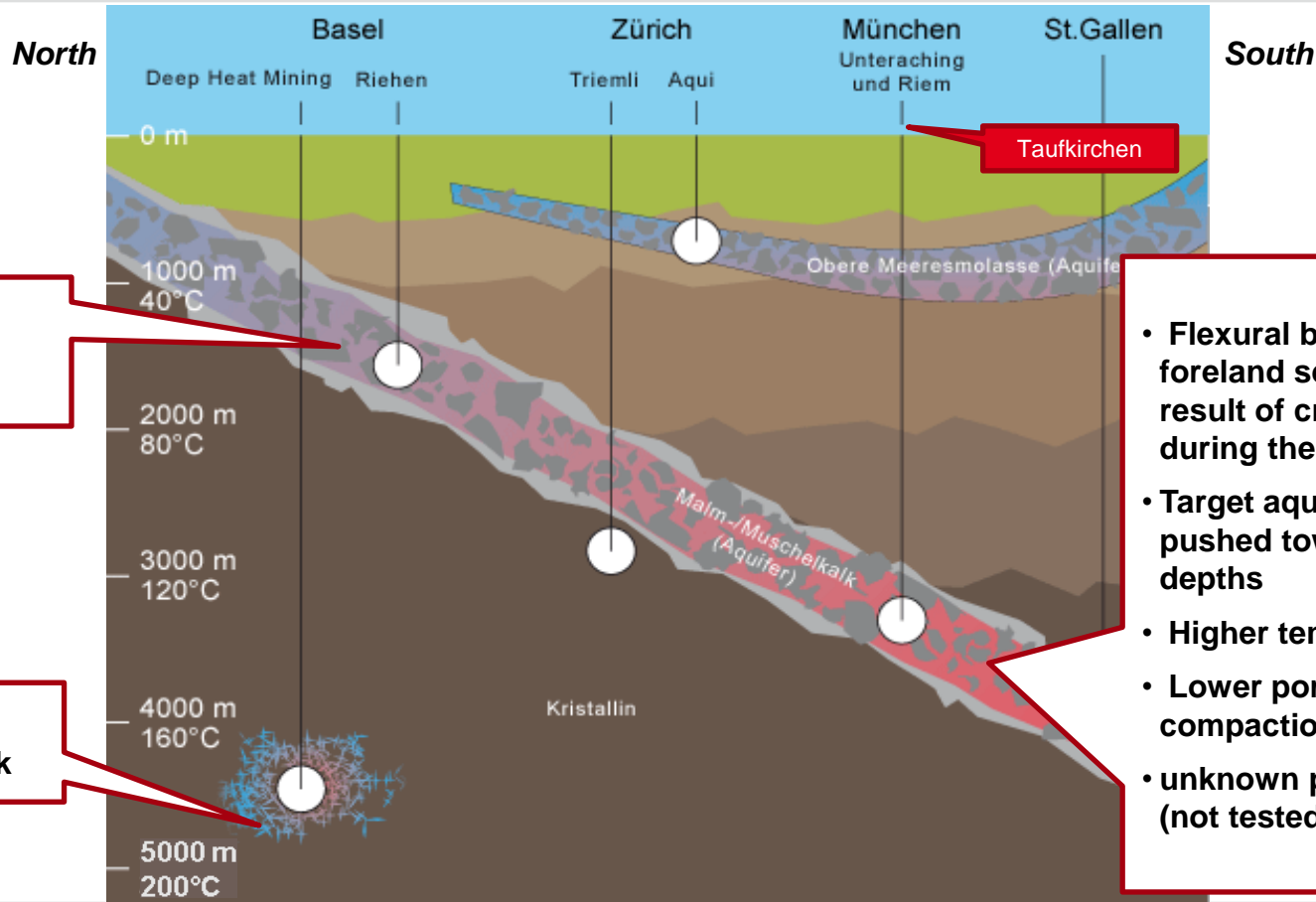
# Deep Geothermal Energy in Switzerland

## Challenges

- Only a few oil- and gas-drillings → Very limited knowledge of underground
- In the eastern part of Switzerland: No drillings deeper than 3000m
- No successful electricity production with geothermal energy yet
- No experience with project-management in such projects
- Only limited experience with new power plant technology (ORC, Kalina)
- No partners available with know-how and experience
- No insurances available for such projects (Axa, SwissRe)
- No sufficient legal base (mining law,...)

# Deep Geothermal Energy in Switzerland

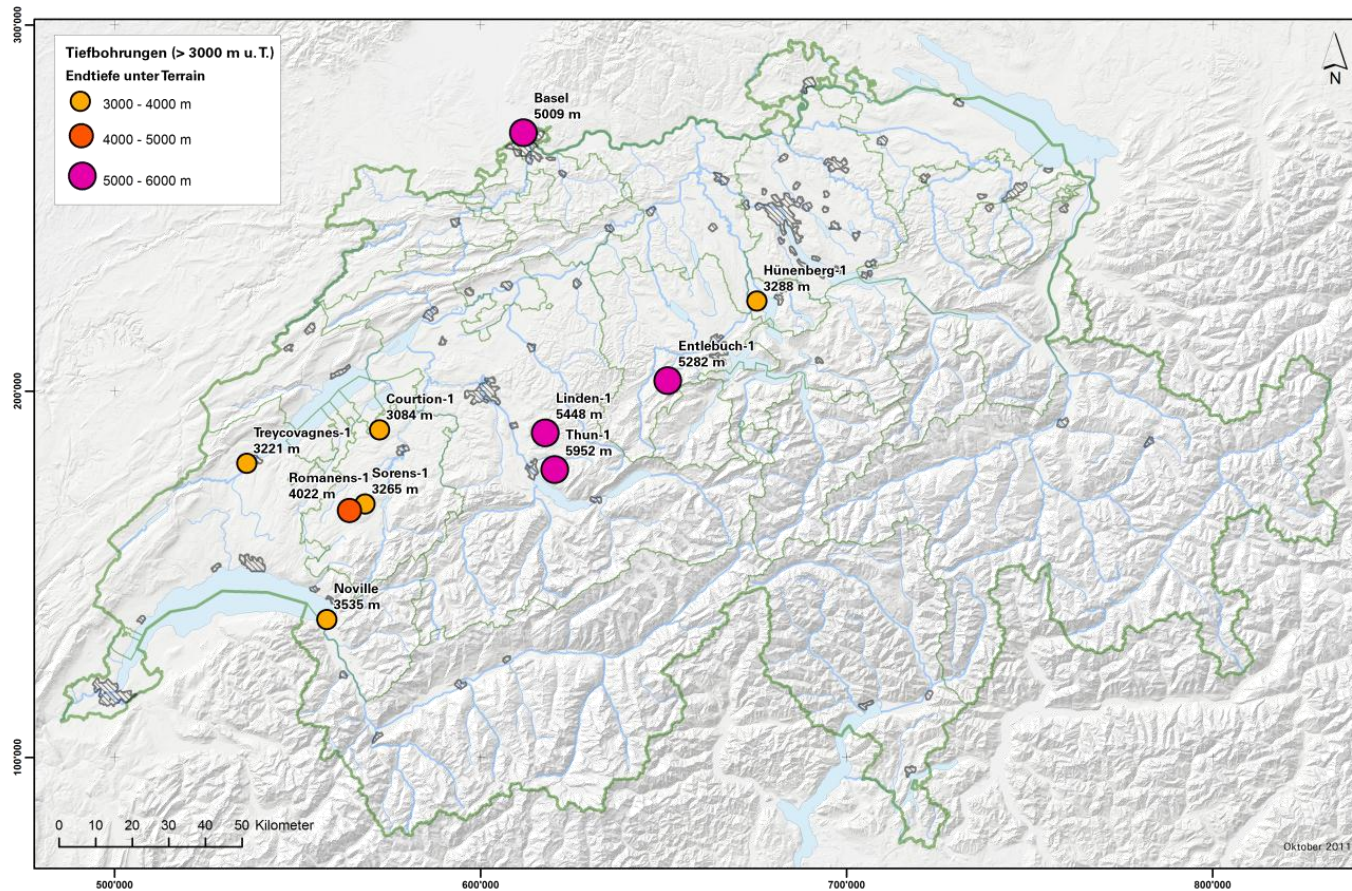
## Simplified geological setting in the Axpo prospection area



- Flexural bending of foreland sediments as a result of crustal thickening during the Alpine orogen
- Target aquifers were pushed towards increased depths
- Higher temperatures, but ..
- Lower porosity due to compaction expected
- unknown permeability (not tested)

# Deep Geothermal Energy in Switzerland

Only 5 drillings > 4000 m



# Deep Geothermal Energy in Switzerland

## ... available and desired data

- **Atlas of Geothermal Resources of Switzerland** (Baujard, Signorelli, Kohl, available at Swiss Geophysical Commission: [www.sgpk.ethz.ch](http://www.sgpk.ethz.ch))
- **Seismic Atlas of the Swiss Molasse Basin** (SGPK, Swisstopo, UniL)
- **Gravimetric Atlas of Switzerland** (SGPK)
- **Geophysical Maps of Switzerland** (SGPK)
- **Geothermal Map of Switzerland** (Bodmer, 1982)
- **Seismic and Borehole data from oil and gas exploration** (SEAG)
- **Technical reports on scientific and technical work** (National Cooperative for the Disposal of Radioactive Waste, Nagra)
- **Swiss Borehole Record to be implemented** (swisstopo)
- **Geological 3 D modelling of Switzerland to be implemented** (swisstopo)

# Deep Geothermal Energy in Switzerland

## National Actors



Schweizer Kompetenzzentrum für Tiefengeothermie zur Strom- und Wärmeproduktion  
ein Unternehmen von



Wir bringen Energie



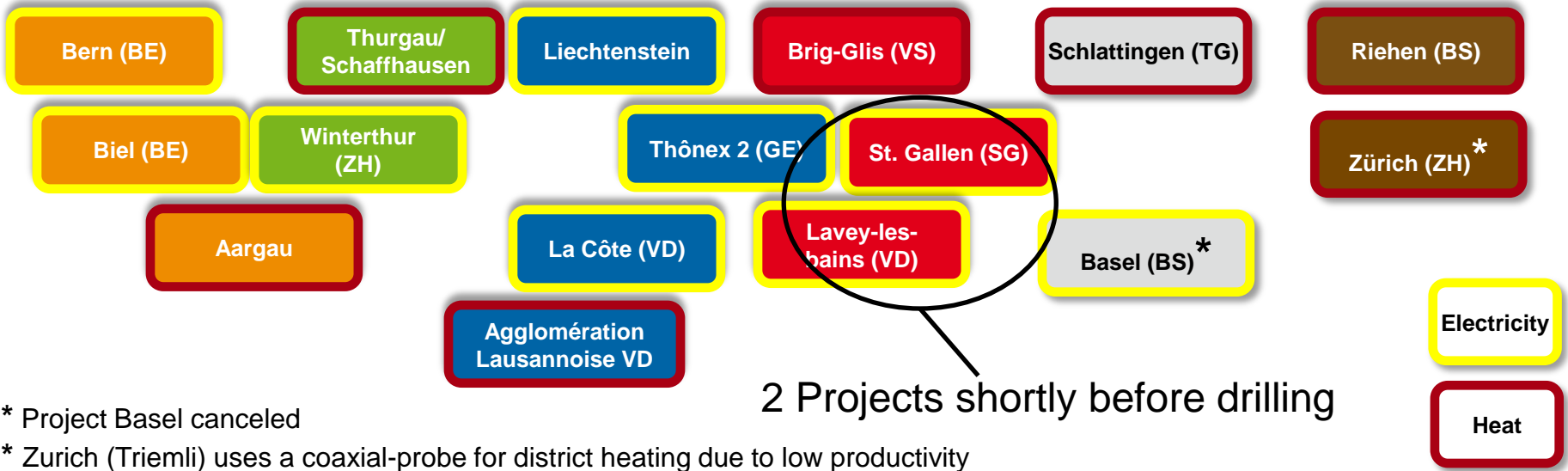
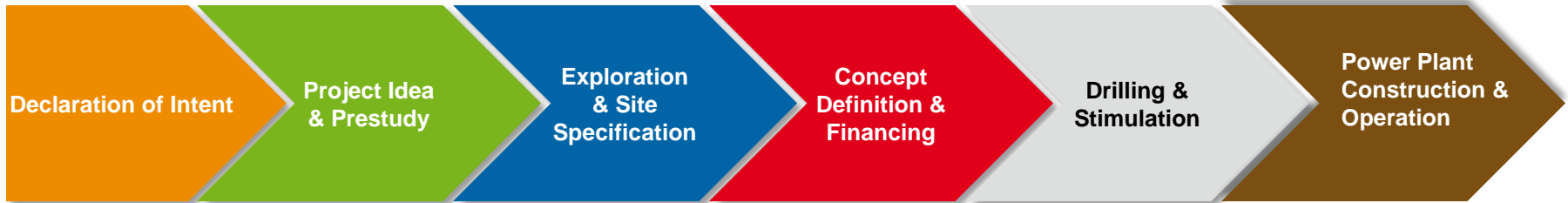
# Deep Geothermal Energy in Switzerland

## Joint Action Plan

- Exploration (Phase 1, 2013–2018):** Exploration of 10 «typical sites» suitable for Geothermal Power Production. Detailed research (e. g. seismic campaigns), 15 exploration wells incl. pilot experiments.  
500 Millionen CHF.
- Power plant construction (Phase 2, 2016–2020):** Construction of 5 pilot power plants with an electrical output of at least 5 MW<sub>el</sub> (→ 200 GWh<sub>el</sub> power p.a.).  
200 Millionen CHF.
- Upscaling and expansion (Phasen 3 and 4, 2020 to 2035/50):** Expansion large-scale power stations. Exploration- and construction activities in additional regions.

# Deep Geothermal Energy in Switzerland

## Overview Projects

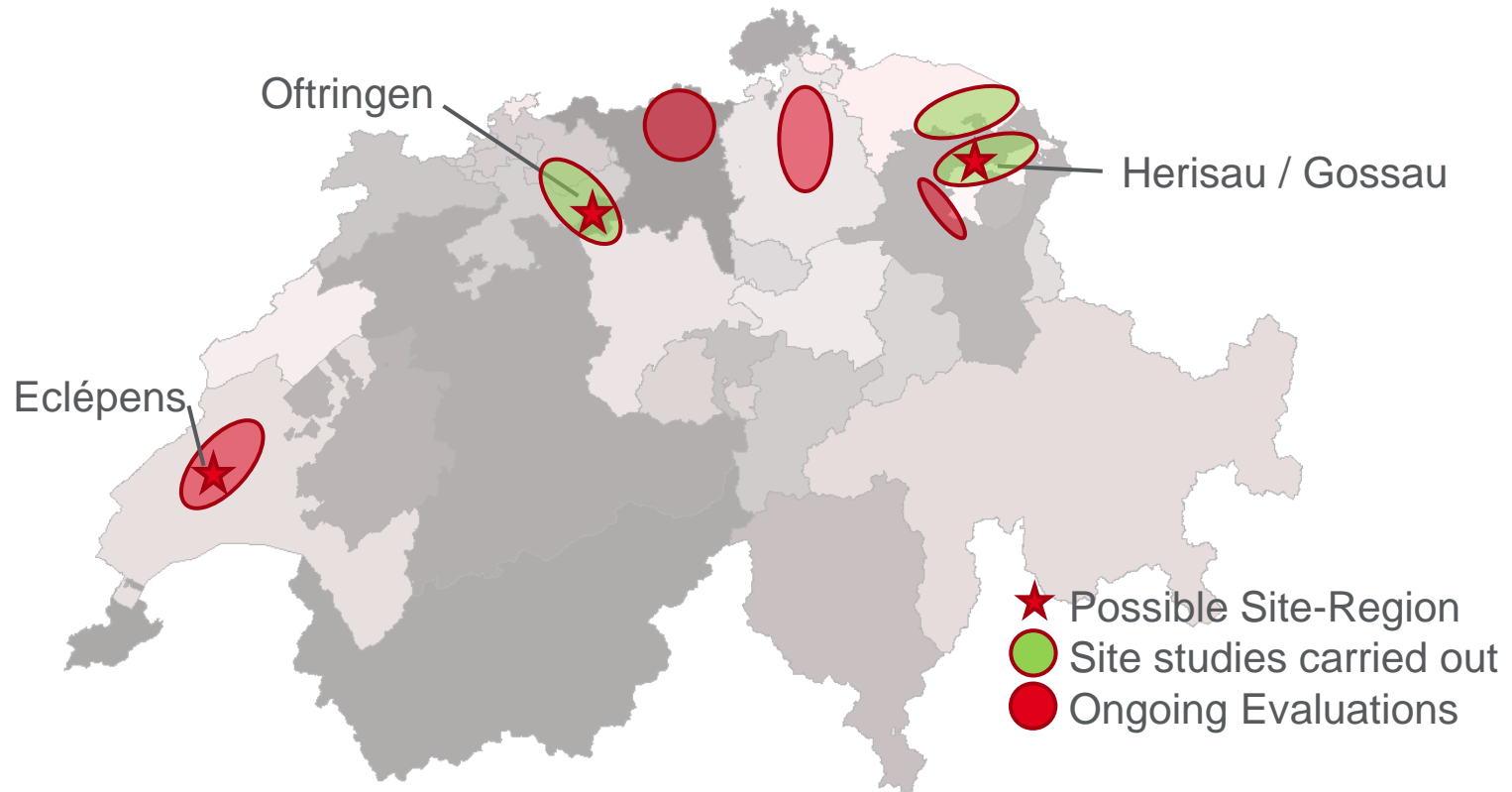


\* Project Basel canceled  
 \* Zurich (Triemli) uses a coaxial-probe for district heating due to low productivity



# Deep Geothermal Energy in Switzerland

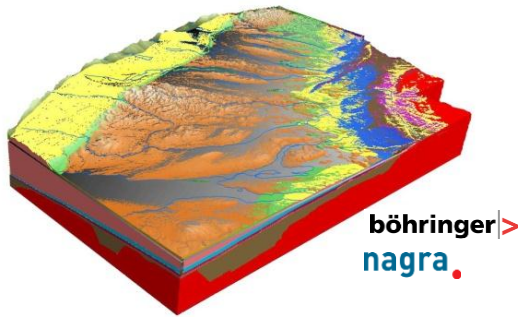
## Potential Regions for Axpo Projects



# Deep Geothermal Energy in Switzerland

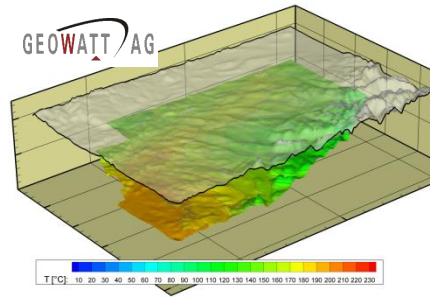
## Site evaluation based on Geothermal - GIS

### Underground site criteria



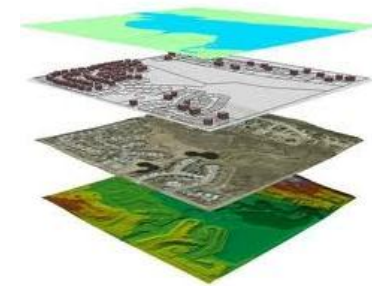
- Geology
- Structures / Tectonics
- Properties of potential deep aquifers: Porosity, hydraulic conductivity, thickness

### Temperature data

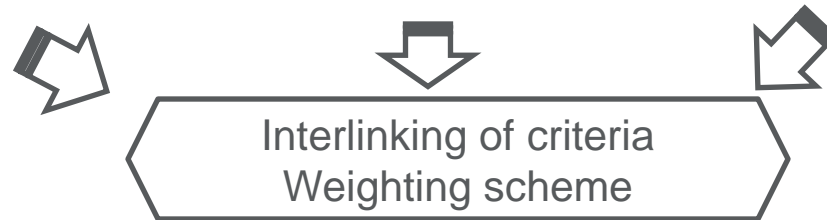


- Aus 3D-temperature model
- T-values are projected on layers and potential aquifers in the Geothermal-GIS

### Surface site criteria

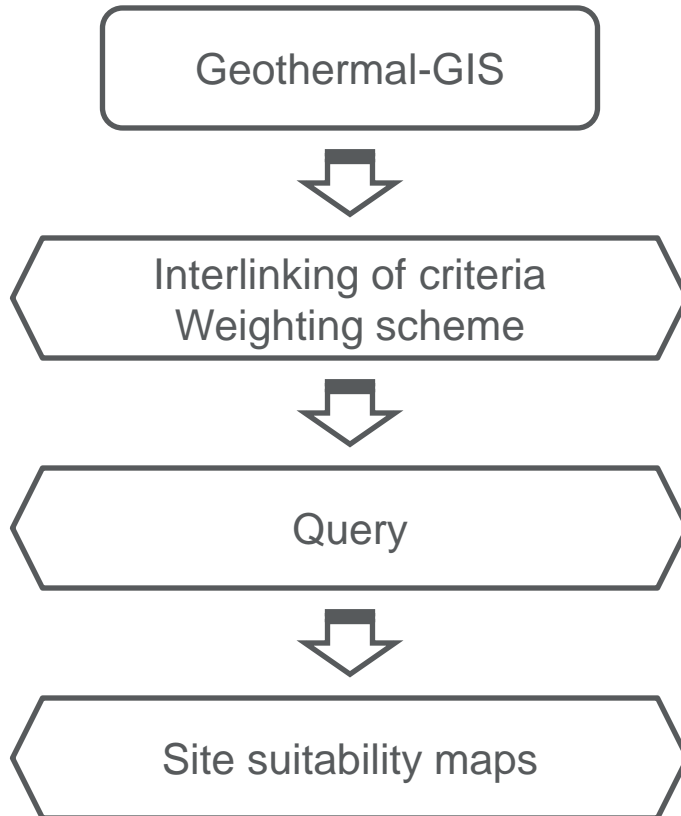


- Topography
- Heat sinks
- Competing utilizations
- Risks (seismicity)



# Deep Geothermal Energy in Switzerland

## Site evaluation based on Geothermal - GIS



### Advantages:

- Versatile, extendible tool for Geothermal exploration
- Quick and flexible queries
- Mapping
- Data gaps become evident

### Disadvantages:

- Heterogeneous data
- Few data of target horizons
- Results have to be checked

### Outlook:

- Improvement of significance of results by additional drilling and seismic data

# Deep Geothermal Energy in Switzerland

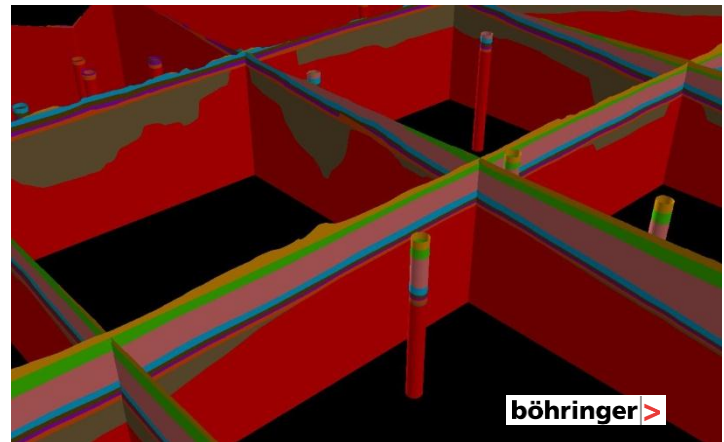
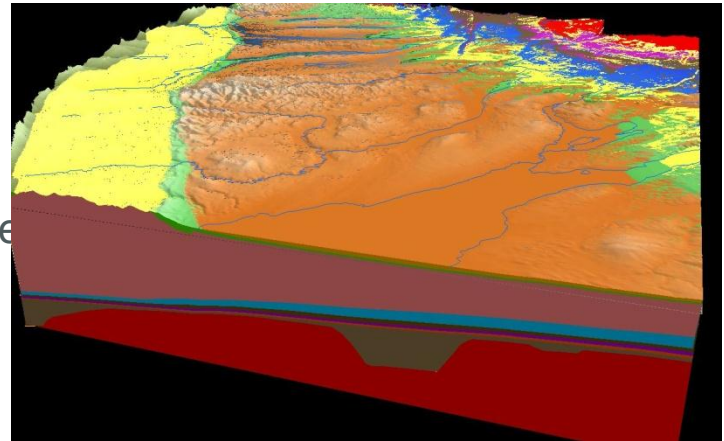
## Geological model of Geothermal - GIS

### Profile

- Complemented on the basis of the Nagra-model
- Covers high-rhine to the northern fringe of the alps
- Up to 7000 m depth
- Permocarboniferous troughs (PKT)

### Important questions and To-Do's

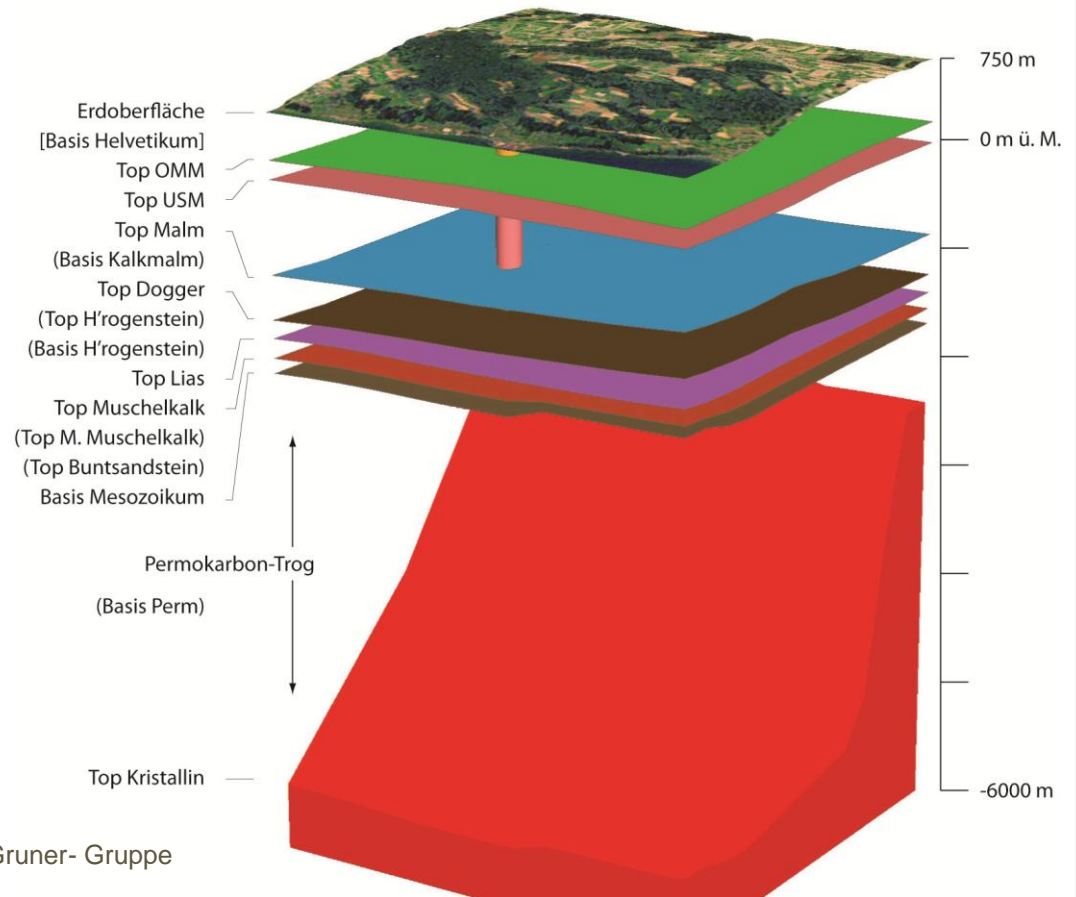
- Verlauf tief reichender Verwerfungen
- Permeability of fault zones
- Stresses
- Presence of Permocarboniferous troughs => „basement study“ to cover aspects



# Deep Geothermal Energy in Switzerland

## Structure of the Geological model

- 16 layers als GIS-grid
- 12 geological layers are modeled
- Permocarboneous troughs : Dissemination difficult to define



Source: P. Jordan (2012): Mailing, Kundenzeitschrift Gruner- Gruppe

**Thank you for your kind attention**



**Axpo AG | New Energies**

Flughofstrasse 54 | CH-8152 Glattbrugg

T +41 44 809 73 33 | F +41 44 809 74 00 | [www.axpo.ch](http://www.axpo.ch)