Deep Geothermal Projects in Germany
Status and Future Development

Dr.-Ing. Horst Kreuter
GeoThermal Engineering GmbH

Paris
04.05.2011
I. The Energy World after Fukushima

II. Opportunities
   ▪ Projects
     ▪ Electricity
     ▪ Heat
   ▪ Research and Development
   ▪ Industry
   ▪ Opportunities Worldwide

III. Risk and Risk Mitigation
   ▪ Exploration Risk
   ▪ Drilling Risks
   ▪ Environmental Risks (Seismicity, …)
Impact

- Nuclear on the downswing?
  - Germany stops 7 old power plants
  - Moratorium for 3 months
  - Technical check up
  - Exit from nuclear power until 2017, 2020, 20??
  - “Bridge” for Renewable Energies
- Opportunity for Renewables and Geothermal
  - Geothermal: Base Load
  - Better support of Geothermal Energy
    - Electricity: Raise in FiT and other support schemes
    - Focus on Heating and cooling projects
    - R&D
    - Not just electricity
    - More Funds
Geothermal Power Production

**POWER PLANTS**

- NEUSTADT-GLEWE
  250 KW
- LANDAU
  2,5 – 3 MW
- UNTERHACHING
  3 MW
- BRUCHSAL
  500 KW
- Simbach-Braunau
  150 KW
Regions of Activity
Project Development

- Berlin
- Hannover
- Groß-Gerau
- Frankfurt
- Brühl
- Rülzheim
- Karlsruhe
- All of the Molasse Region (>20 Projects)
- Krefeld
- Munster-Bispingen
- ...
Power Plant Landau
Power Plant Unterhaching
District Heating Unterhaching
Drilling
Geothermal Heating Riehen

Wärmeverbund Riehen AG
R&D Challenges

GOALS
- EFFICIENCY
- RISK REDUCTION

TOPICS
- EGS
- PUMPS
- DRILLING TECHNOLOGY
- BINARY POWER PLANTS
- SEISMICITY
Geothermal Industry

**History (1999 – 2004)**

- **Communities**
  - Unterhaching, Neuried,…
- **Private Initiatives**
  - HotRock
  - GeoEnergy,…

**Today**

- **Local Utility Companies**
  - Munich, Mainz, Heidelberg,…
- **Industry**
  - Manufacturers (Siemens, Hochtief, Evonik, Linde,…)
  - Big utilities (RWE, EnBW,…)

Geothermal Industry
Geothermal Consultants

**History (1999 – 2004)**
- Small (3 – 10 employees)
- Highly specialized (deep geothermal applications)
- GTN, GeoT, GeoTec,…
- Only in Germany

**Today**
- Big Consulting Companies
  - Lack of Know-How ?
- Going International
  - Europe, Africa, South America, Asia,…
Future Potential

Glitnir Bank, 2008
Risk of Energy Generation

- **Nuclear:** Tschernobyl, Fukushima
- Nuclear waste storage?

- Fossil fuels: global risks, greenhouse gas, climate change
- **CO₂-**goals?

- Risks of geothermal and other renewable energies: different risks on a much smaller scale
Risk of Renewable Energy Generation

- **Wind**: Environmental risk fauna / shadow / view
- **Hydro**: Environmental risk massive interference with nature, seismic risk, dam failure
- **Solar**: Land requirements, environmental risk during disposal
- **Biomass**: Concurring uses: competition with food production & land requirements
Risk in Geothermal Applications

- Relatively risk free technology
- Clean, renewable, low CO$_2$ footprint, base load
- Nevertheless there is some risk
  - Exploration risk
  - Drilling risks
  - Environmental risks
  - Seismic risk
Environmental Risks

- Sustainable resource management
  - Inexhaustible on the human time scale
  - Continuous heat flow from the earth’s core
  - Sufficient distance between production- and injection well
  - Sustainable production rate
- German Environmental Agency (Umweltbundesamt 2008): Environmental Risks and effects are very small in comparison to other energy generation systems
  - Almost no negative ecological impact from the operation of a geothermal power plant
  - Especially heat projects (efficiency)
Risk in Geothermal Projects

- **Drilling Risk**
  - Lost in hole
  - Blocked string
  - ...

- **Exploration Risk**
  - Temperature
  - Flow Rate
  - Chemistry ?
  - Long Term ?

- **Technology**
  - Hydrothermal Yes
  - EGS (HDR,…) No !
- High financial risk

- Success = defined temperature & production with fixed drawdown of water level
- Definition on commercial basis
Who needs an Insurance?

- Only one project
  - Small Developers
  - City and Villages
  - Small utility companies

- Project Portfolio
  - Frame Contract

Soultz, Alsace
 Unterhaching (2003)
- First risk mitigation for geothermal exploration risk in Germany
- Munich Re
- One timer
- Features: Bavarian support and „non claim bonus“

 Contract Offer
- Molasse basin and Upper Rhine Valley
- North German Basin - not yet

 Technology
- Hydrothermal :Yes
- EGS (HDR,…): No
Quality

- Quality of developer
  - Financial strength
  - Technical ability (know-how, references,…)
- Quality of development
- Project description
  - Geology
  - Drilling concept
  - Stimulation program and test program
  - Power plant concept (permissions, contracts,…??)
  - Permissions for drilling, etc.
  - Contractors and key personal
  - Business plan and insurance
- Third party opinion (exploration risk)
Private Insurance Market

Definition of success or failure

- Exploration risk = risk, not to be able to exploit a resource in sufficient quantity or quality
- Quantity = Thermal output $P$ which can be extracted from the brine

$$P = \rho_F c_F Q (T_i - T_o)$$

- The amount of $P$ is important. The combination of the parameters is less important.
- Covering $P$ instead of fixed pairs of parameters gives the insurance company a higher flexibility and a lower premium
Private Insurance Market

Insurable?

Feasibility study

Stimulation and test concept

Well design

Drilling concept

Seismic exploration

Exploitation concept

Intensive dialog
Private Insurance Market

Precondition: High Probability of Success

Premium Basis: Insurance Parameters, Own Risk Share

Total insured investment costs:
- drilling, stimulation, test program
- (seismic, drilling pad, ...)

Integral Part of Policy:
Stimulation Concept, Hydraulic Test Layout

Insurance contract
Drilling Risks

- Technical problems while drilling
- Unexpected geological conditions
- Lost in hole
- Time overruns (fishing)
- Can be insured
  - In a conventional builder’s risk insurance as an additional coverage
  - In Government risk coverage programs (MAP Germany)
Seismic Risk

- Induced seismic events in Basel (2006) and Landau (2009) – a topic to be taken seriously
- EGS-projects (Basel, injection well in Landau)
  - stimulated geothermal systems
  - Hydraulic stimulation to build an artificial underground reservoir
  - Change of natural stress conditions
Seismic Risk

- Risk management
  - Seismic risk analyses
  - Well controlled reservoir development and management
  - Seismic monitoring
  - Action plan
  - Liability insurance
Seismic Risk

- Risk communication
  - Fear of earthquakes – Danger of overestimating the risk
  - Relatively low magnitudes – relative low damage potential
  - Risk = probability x damage

- Mining vs. EGS-projects

<table>
<thead>
<tr>
<th>Year / Time</th>
<th>Project</th>
<th>Maximal magnitude (M&lt;sub&gt;L&lt;/sub&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003-2007</td>
<td>GeneSys (Horstberg), Deutschland</td>
<td>No measured events</td>
</tr>
<tr>
<td>1980-1993</td>
<td>Fenton Hill (Los Alamos), USA</td>
<td>~ 1</td>
</tr>
<tr>
<td>2003</td>
<td>Bad Urach, Deutschland</td>
<td>1,8</td>
</tr>
<tr>
<td>1980-1993</td>
<td>Rosemanowes, England</td>
<td>1,9*</td>
</tr>
<tr>
<td>1985-2003</td>
<td>Hijiori, Japan</td>
<td>2,4*</td>
</tr>
<tr>
<td>2003</td>
<td>Soultz-sous-Forêts, Frankreich</td>
<td>2,9</td>
</tr>
<tr>
<td>2006</td>
<td>Basel, Schweiz</td>
<td>3,4</td>
</tr>
<tr>
<td>2003</td>
<td>Cooper Basin, Australien</td>
<td>3,7</td>
</tr>
</tbody>
</table>
Environmental Risk

- Mining authorities protects the interests of residents and the environment
- Drilling
  - Oil standards
  - Well established technology
  - Blow-out-preventer avoids oil spills
  - Restrictions in water and nature protection areas
- Operation
  - Safety precautions prevent environmental hazards
  - Closed cycles
- Radioactivity
  - Radioactive elements dissolved in the geothermal brine
  - Avoid scaling in filters and pipes – overpressure
  - Health and safety protection: Measurements and controls
  - Special radioactive waste disposal path
Communication

- Project Communication: early, continuous and transparent
- Local acceptance is important for project success!
  - Public relations
  - Addressee: public, local and regional authorities, political decision makers
  - Supporters: keep positive attitude, get their support
  - Opponents: Take them serious and reduce their fears
  - Successful communication especially when these conditions are met:
    - Heat projects with a direct benefit for local residents
    - City or city utility as project developer
    - Decentralized power and heat production in a 100% renewable concept
THANK YOU FOR YOUR ATTENTION!

Dr. Horst Kreuter
04.05.2011 Paris