



# Towards a European Geothermal Deep Drilling Program

*Ernst HUENGES, David BRUHN,  
Bernhard PREVEDEL, Thomas SCHULTE*  
GeoForschungsZentrum Potsdam  
and the ENGINE group

Vilnius, 14.02.2008



## Outline



- introduction
- EU regional peculiarities
- technological challenges
- road map towards the European Geothermal Drilling Program
- conclusions



## Outline



- **introduction**
  - **EU goals**
  - **advantages of an expanded geothermal industry**
  - **specific geothermal requirements**
  - **existing activities**
- EU regional peculiarities
- technological challenges
- road map towards the European Geothermal Drilling Program
- conclusions



## EU goals



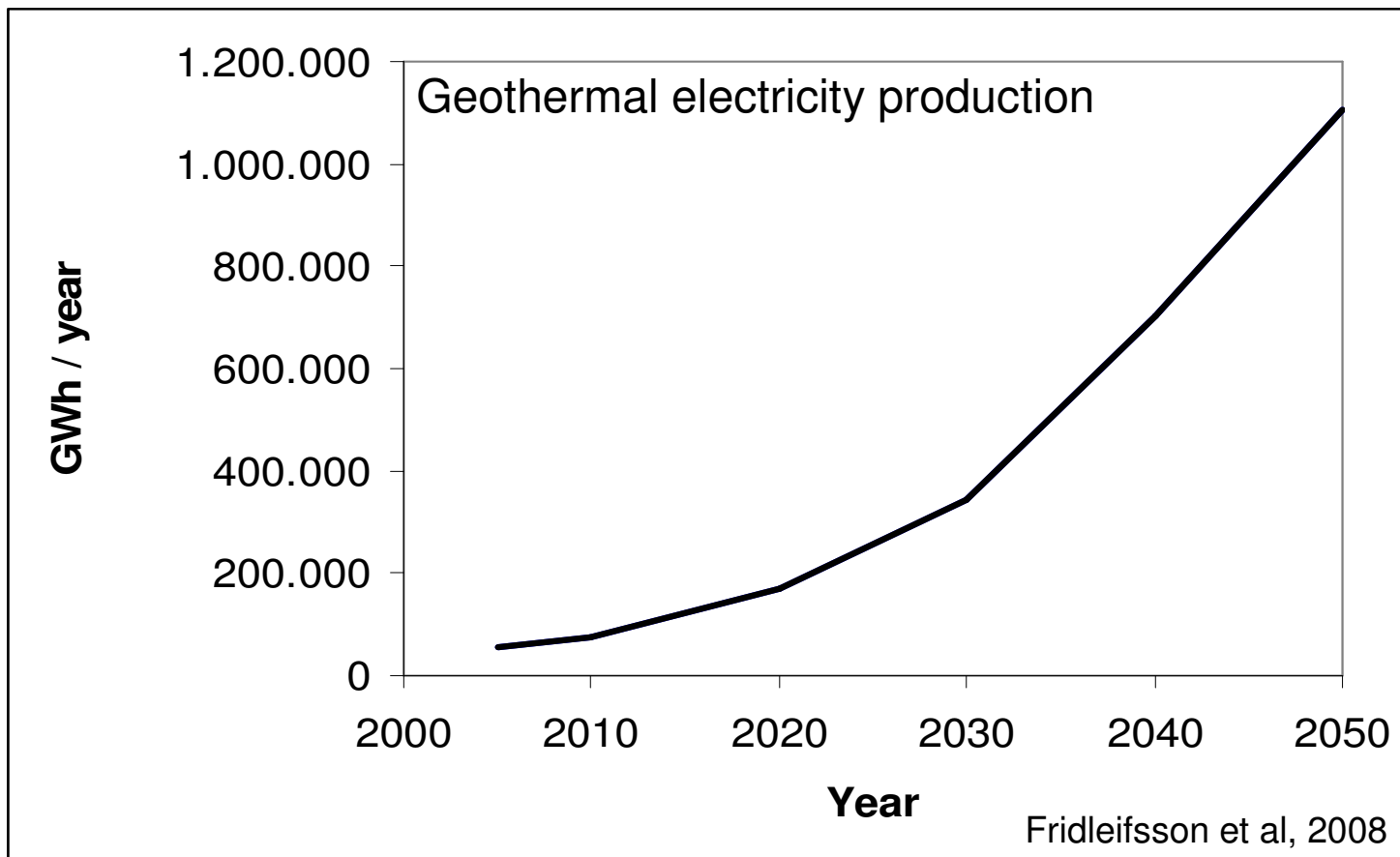
- Deployment of renewable energy
  - end of other resources
  - demand of mitigation of CO<sub>2</sub>-emissions
- Geothermal Energy because of
  - huge potential to address a significant proportion to future energy provision especially as base load
  - Industry politics (Lissabon) to keep the technological leadership
    - Italy, Iceland
    - EGS research



# advantages for an expanded geothermal industry



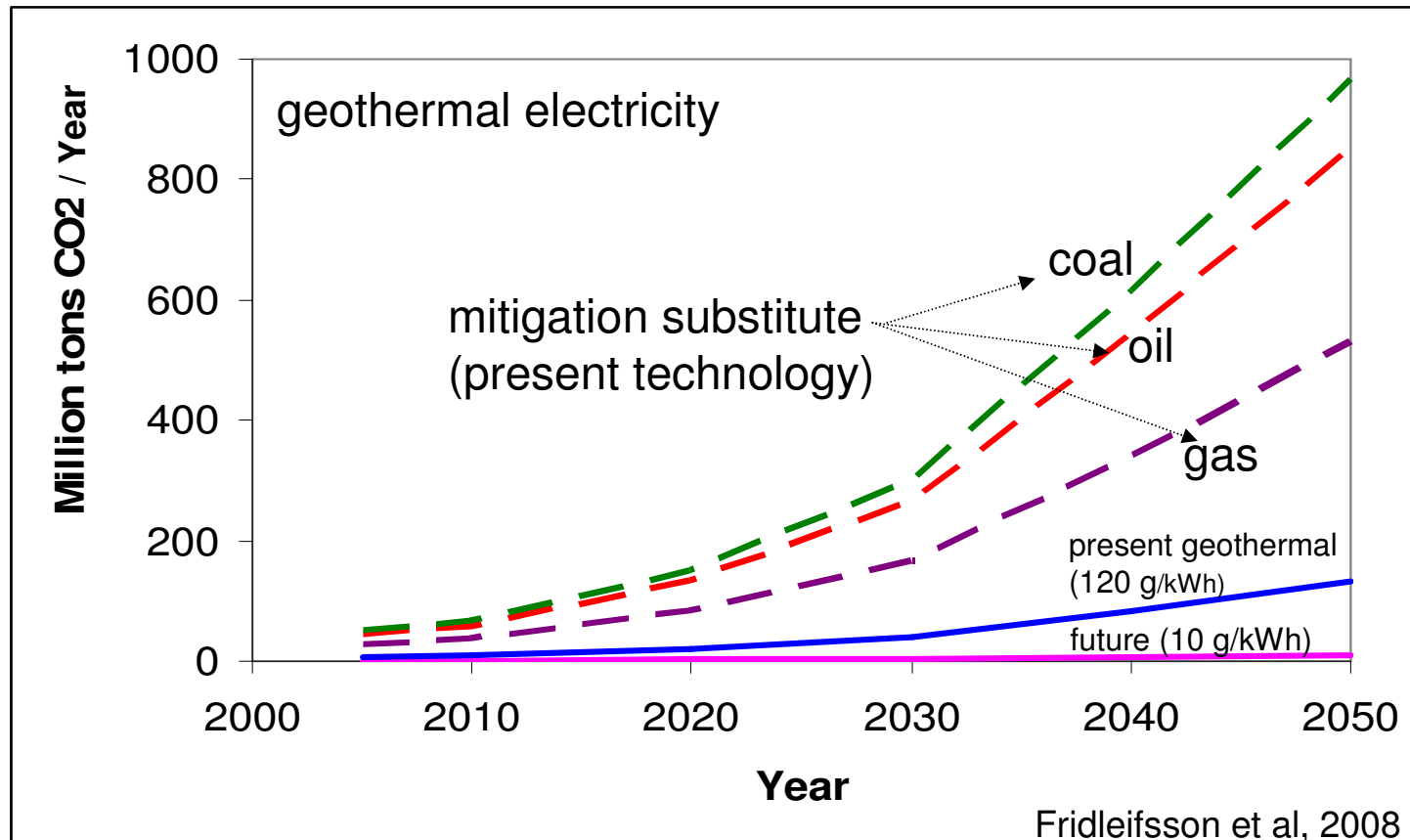
- World market (2020/2050) only electricity/Year
  - (200/ >1000 TWh) (conservative estimation), EGS: ~ order of magnitude higher





# advantages for an expanded geothermal industry

- World market (2020/2050) only electricity/Year
  - (200/ >1000 TWh) (conservative estimation), EGS: ~ order of magnitude higher
  - mitigation (substitute coal or gas) of (0,1...0,2/0,5...1) Giga tons CO<sub>2</sub>-emissions

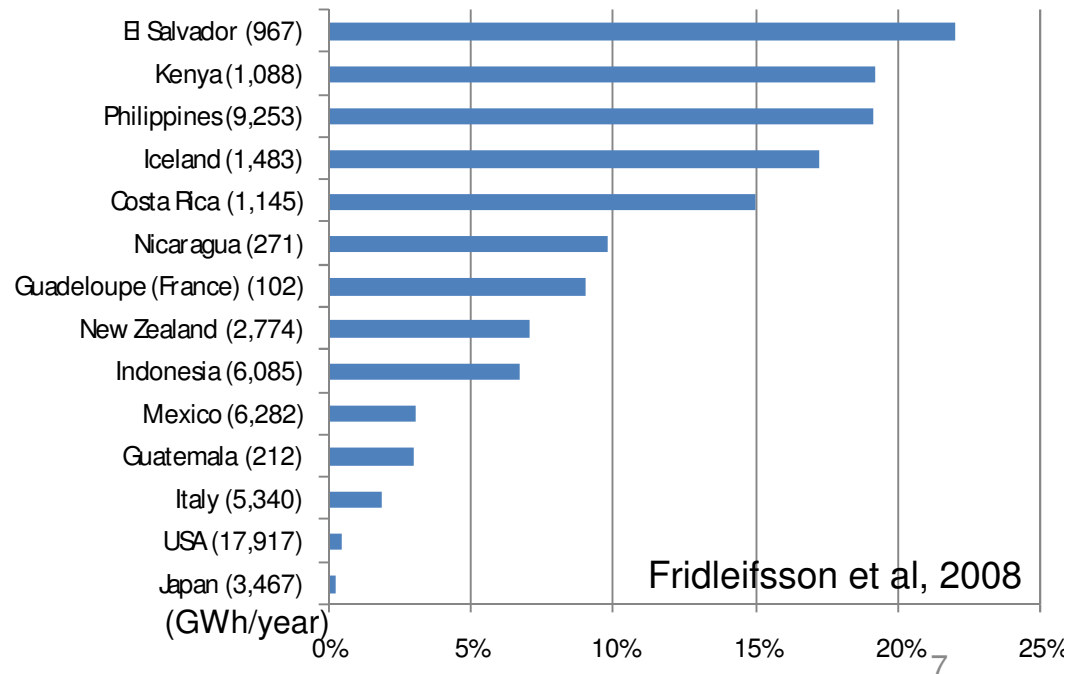




# advantages for an expanded geothermal industry



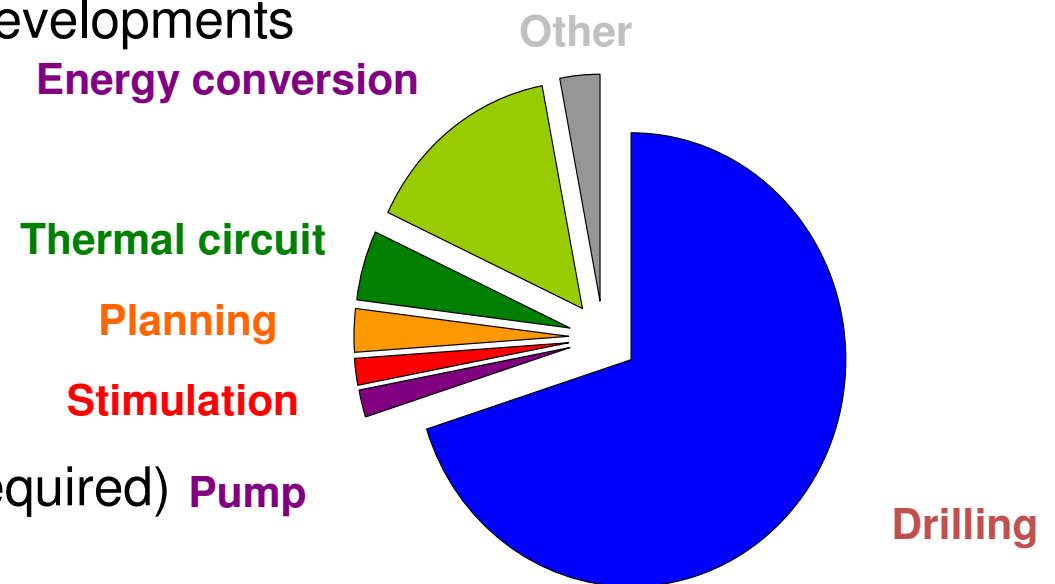
- World market (2020/2050) only electricity/Year
  - (200/ >1000 TWh) (conservative estimation), ~ times 1 order higher using EGS
  - Mitigation (substitute coal or gas) of (0,1...0,2/0,5...1) Giga tons CO<sub>2</sub>-emissions
- Value added
  - transmute hydrocarbon industry and its services
  - significant proportion to future energy provision
  - bring electricity in remote areas
  - clean energy





## specific geothermal requirements

- improve the yield of geothermal repositories and reduce the risks associated with their exploration and exploitation
- reduction of costs (2/3 of it is drilling)
- investments in technology developments
  - exploration
  - drilling
  - stimulation
  - completion (corrosion)
  - conversion
  - reservoir assessment
- public acceptance (locally required)



**Drilling is main bottleneck of further development**

Frick et al. 2007





## existing activities



- EU in the past years, for example at Soultz-sous-Forêts (Alsace) for HDR
- Geothermal rush (Australia, Germany & other countries). Some projects failed!
- ICDP



Ernst Huenges, Towards a European Geothermal Deep Drilling Program, Vilnius 14.02.2008

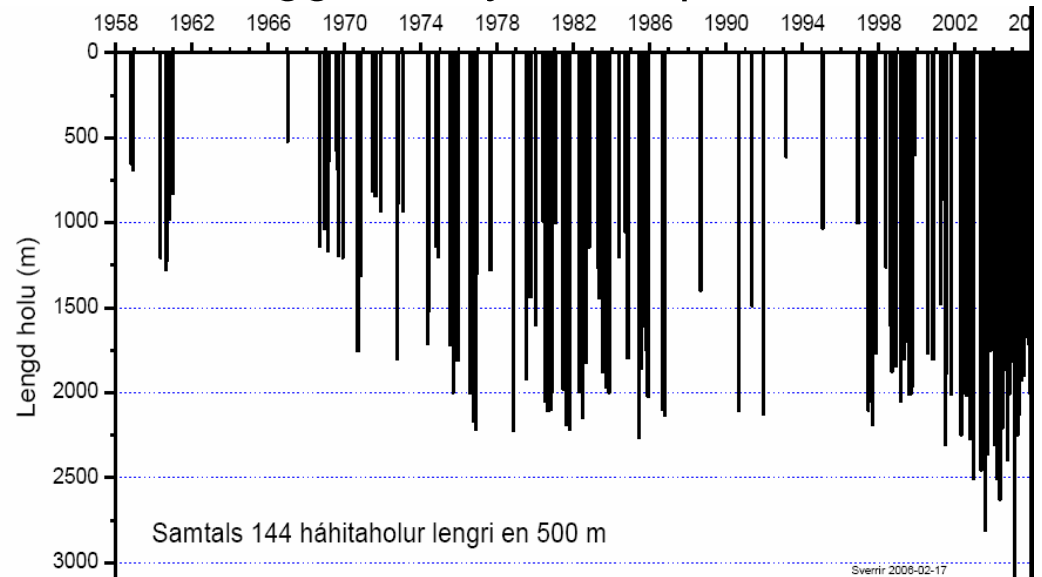




## existing activities



- EU in the past years, for example at Soultz-sous-Forêts (Alsace) for application to HDR processes
- Gold rush (Australia, Germany & other countries)
- ICDP → restricted to scientific goals, nevertheless, synergies exists
- US DOE will start EGS-demonstration triggered by MIT report
- And last not least
  - tremendous experience in shallow high temperature reservoir drilling





## Outline



- introduction
- **EU regional peculiarities**
  - **shallow high temperature reservoirs**
  - **deep high temperature reservoirs**
  - **specific „market“ aspects**
- technological challenges
- road map towards the European Geothermal Drilling Program
- conclusions



## EU regional peculiarities

- shallow high temperature reservoirs (Italy, Iceland, Turkey,...)
  - Standardisation of drilling exists
  - Drilling with low mud weight into the reservoir (air drilling)
  - Extending the existing fields (3D seismics in Tuscany)
  - Entering into deep reservoirs (IDDP)
- deep high temperature reservoirs (Central Europe,...)
  - drilling to 3 to 6 km required
  - Standardisation for geothermal wells required
  - Mitigation of formation damage, large diameter, directional drilling,..
  - Application of EGS – concepts is the rule including all implications
- specific „market“ aspects
  - politically vulnerability due to dramatic lack of energy, substitution of oil&others is required..
  - Demonstration of EGS technologies for export (competition EU-US)
  - Capacity building – training of employees for future EGS deployment



## Outline



- motivation
- EU regional peculiarities
- **technological challenges**
  - **required standardisation**
  - **optimisation of the access to the reservoirs**
  - **scientific accompaniment**
- road map towards the European Geothermal Drilling Program
- conclusions



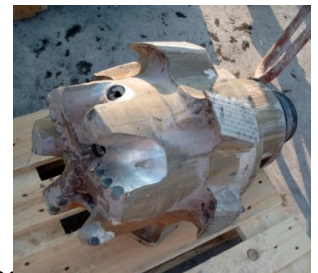
## technological challenges - standardization



standardization of geothermal drilling and stimulation operations



- reliability of drilling by system studies with focus on operational issues
- development of drilling instruments and tools and completion components (corrosion), drilling large diameters,
- high deviation and large drill holes using directional drilling based on innovative 3D seismic geothermal exploration,
- drilling mud technologies,
- “intelligent” well completion designs allowing reservoir monitoring,
- learning from traditional geothermal areas such as Larderello/Italy, Iceland or the Philippines as well as from the hydrocarbon industry,
- and fulfil R&D needs as follows

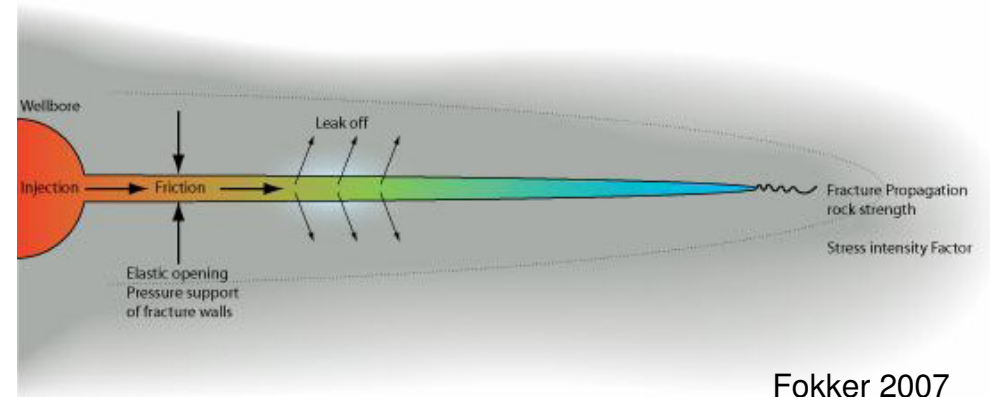




## R&D needs



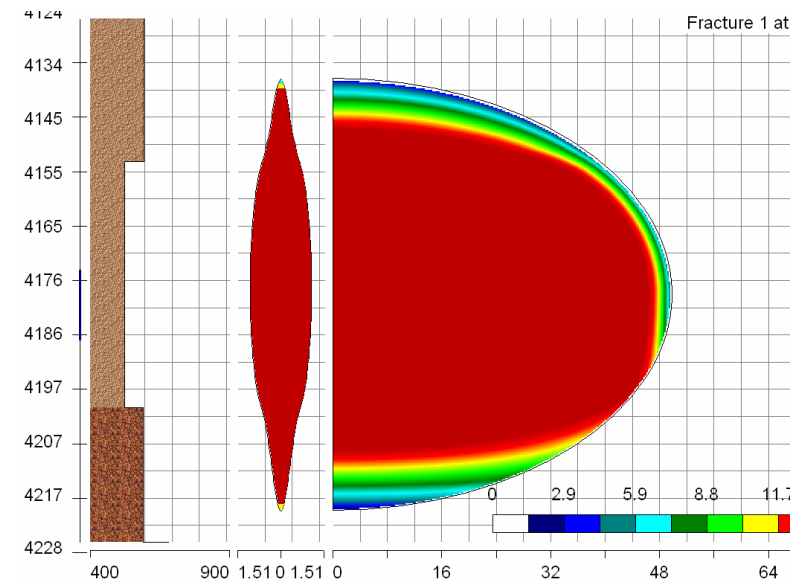
stimulation



## engineering geothermal reservoirs

- mechanically, thermally, and chemically
- self propping, propping, or hybrid fracs
- standards for treatments, well heads, and frac strings

Adapt procedures from HC to specific geothermal demands



Zimmermann 2007



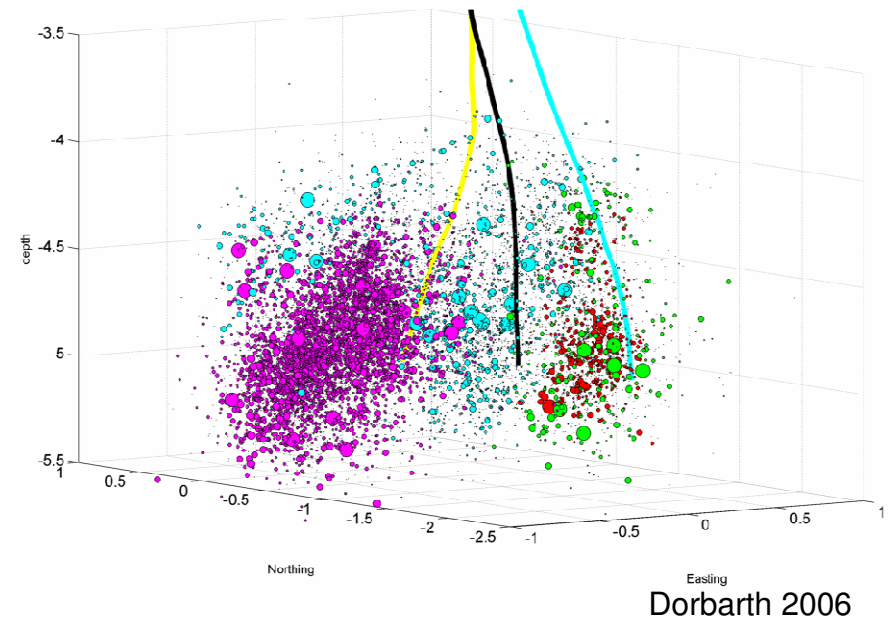
## R&D needs



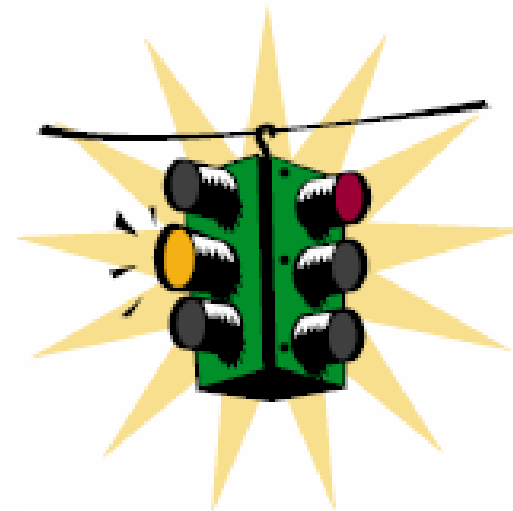
stimulation

### Improved monitoring techniques

- understand induced seismicity
- develop induced seismicity mitigation concepts



Dorbarth 2006







## technological challenges

- lowest possible pay-zone formation damage



optimisation of the access to the reservoirs

- maximum characterization of the target geology,
- drilling mud technologies,
- low pump volume at under-balanced conditions,
- aerated mud systems operated in counter-flush mode (even with large bit sizes at penetration rates equivalent to oilfield rotary drilling)
- advance this drilling method for depths beyond 3000 m and hole deviation angles up to 90 degree and long horizontal as well as multi-lateral well sections
- ...



technological challenges  
- scientific accompaniment



### Project development

- Exploration
- Drilling, Completion
- New stimulation methods.....
- Mitigation of seismic risks,...
- Monitoring thermal water loop
- Conversion systems, efficiency improvement,..
- Rate of heat extraction /sustainable life of resource



## Outline



- introduction
- EU regional peculiarities
- technological challenges
- **road map towards the European Geothermal Drilling Program**
  - **What can be done in the scientific community?**
  - **What can be expected from economy?**
  - **What can be done in each (interested) country?**
  - **What should be expected by EU?**
- conclusions



# Who has to be involved?



**geothermal science**



**European  
Geothermal  
Drilling Program**

**politics**

**economy**



# road map towards the European Geothermal Drilling Program 1



## geothermal scientific community

- solving the key issues where basic research is required
- focussing research on future geothermal energy provision;
- understand operational issues & exchanging experience,
- Create international science teams
- science partnership with industry (capacity building)

## each (interested) country

- Stimulating technology development (feed in law), Insurance of drilling
- Research and Drilling investments in chosen representative sites
- Further improvement of frame conditions (mining law, net integration..)

## economy

- Participate in geothermal industry, become stakeholder to be prepared for future markets,
- Earn money using geothermal energy or its value added
- Push development and use the acceleration (first move advantage)
- Be open for science partnership, share the knowledge

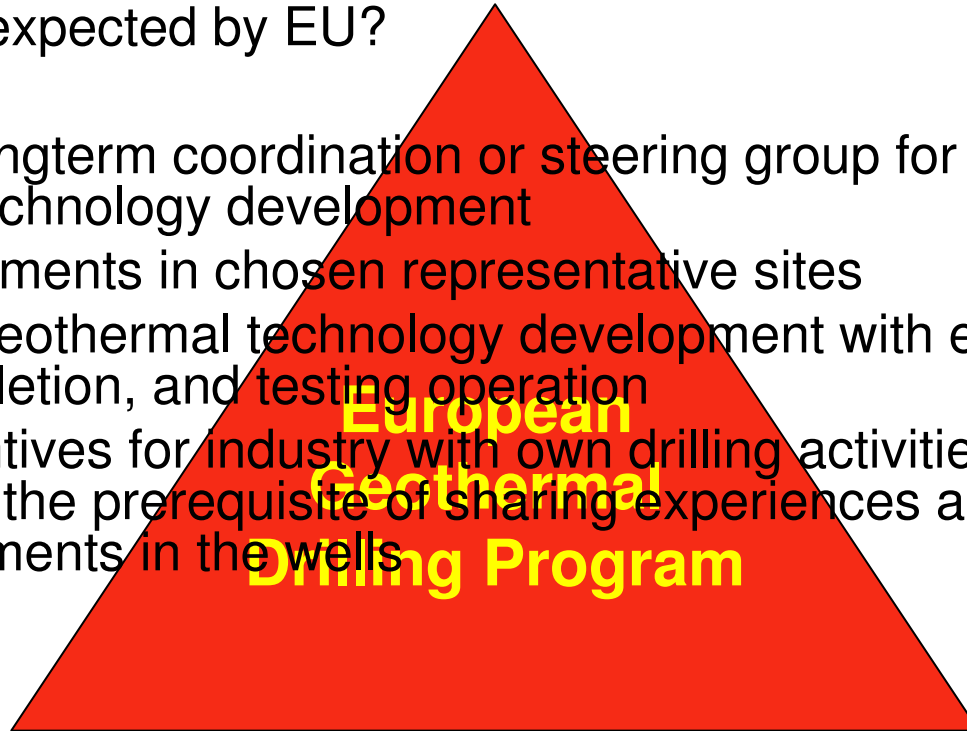
**European  
Geothermal  
Drilling Program**



# road map towards the European Geothermal Drilling Program 2



- What should be expected by EU?
  - establish a longterm coordination or steering group for geothermal drilling and technology development
  - Drilling investments in chosen representative sites
  - Successive geothermal technology development with each European drilling, completion, and testing operation
  - Provide incentives for industry with own drilling activities to join the program with the prerequisite of sharing experiences and allowing (risky) new developments in the wells



## Conclusions (from ENGINE work)

### European Geothermal Drilling Program is required starting with

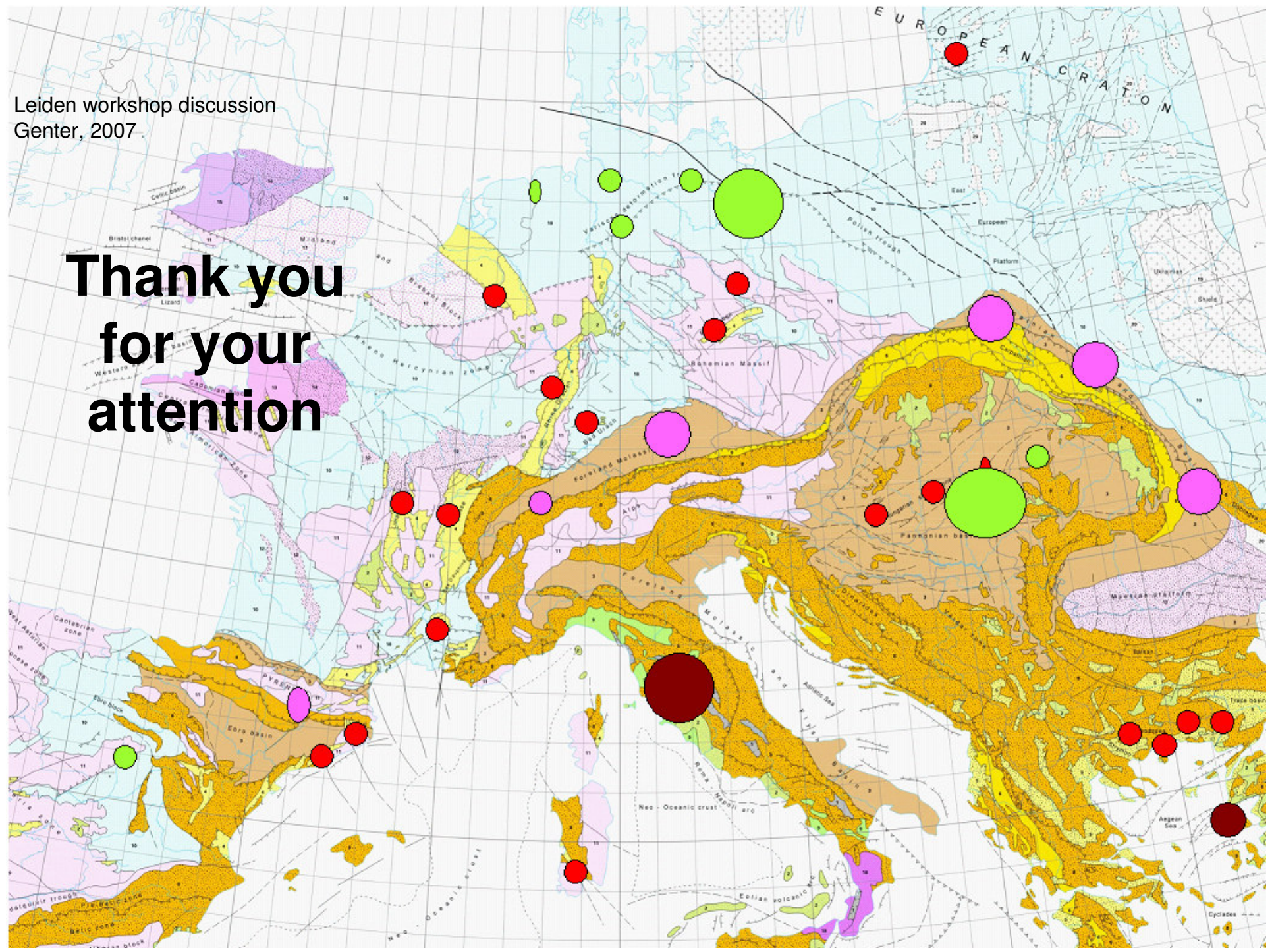
- establishing an initiation group and an advisory board (Coordination and Action)
  - key site selection - competition
  - organize incentives for industry to share experience
  - preparing **20-50 drilling projects** with accompanying scientific projects



InnovaRig in Dürnrhaar Dezember 2007

Leiden workshop discussion  
Genter, 2007

**Thank you  
for your  
attention**

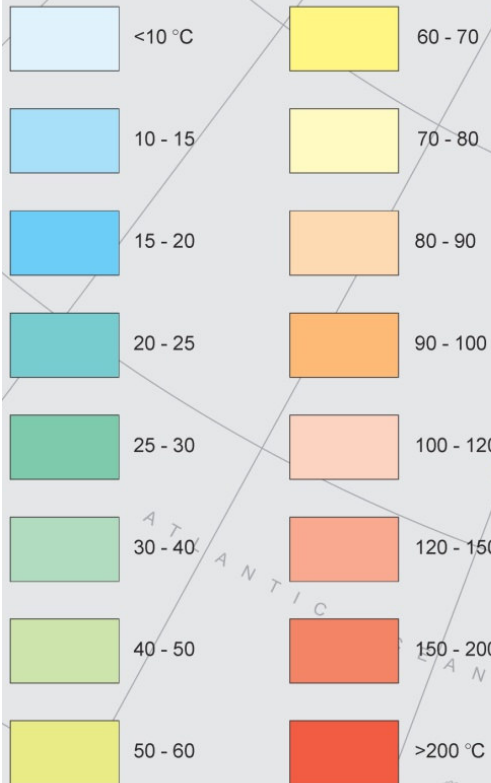




TEMPERATURE DISTRIBUTION  
at 2000 m depth

Schellschmidt & Hurter 2003

LEGEND PANEL



Thank you  
for your  
attention