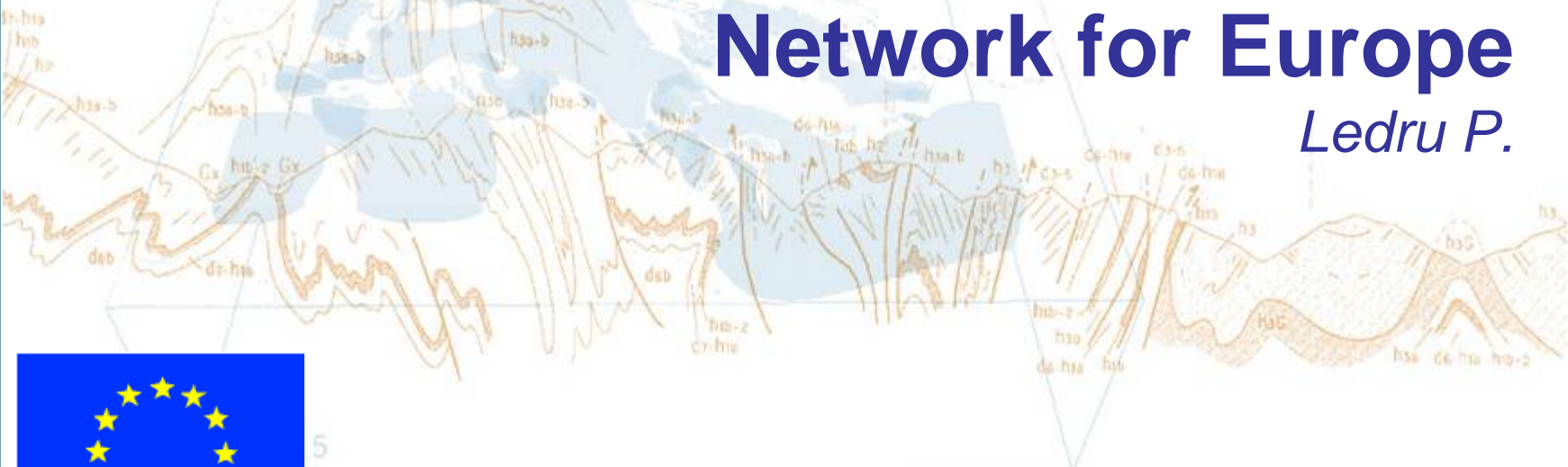




ENhanced Geothermal Innovative Network for Europe

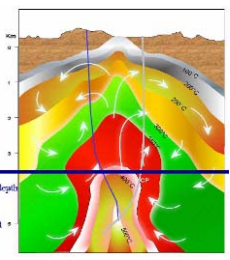
Ledru P.



Geothermal activity in Europe



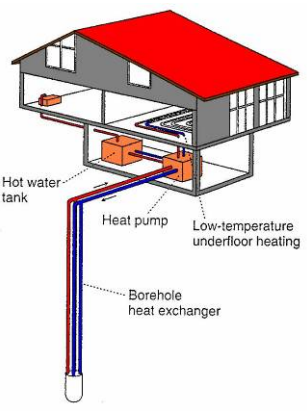
Iceland



Icelandic Deep Drilling project



★ Guadalupe



Geothermal Heat Pumps



Pyrzyce



Groß Schönebeck



Soutz



Neustadt-Glewe



Altheim

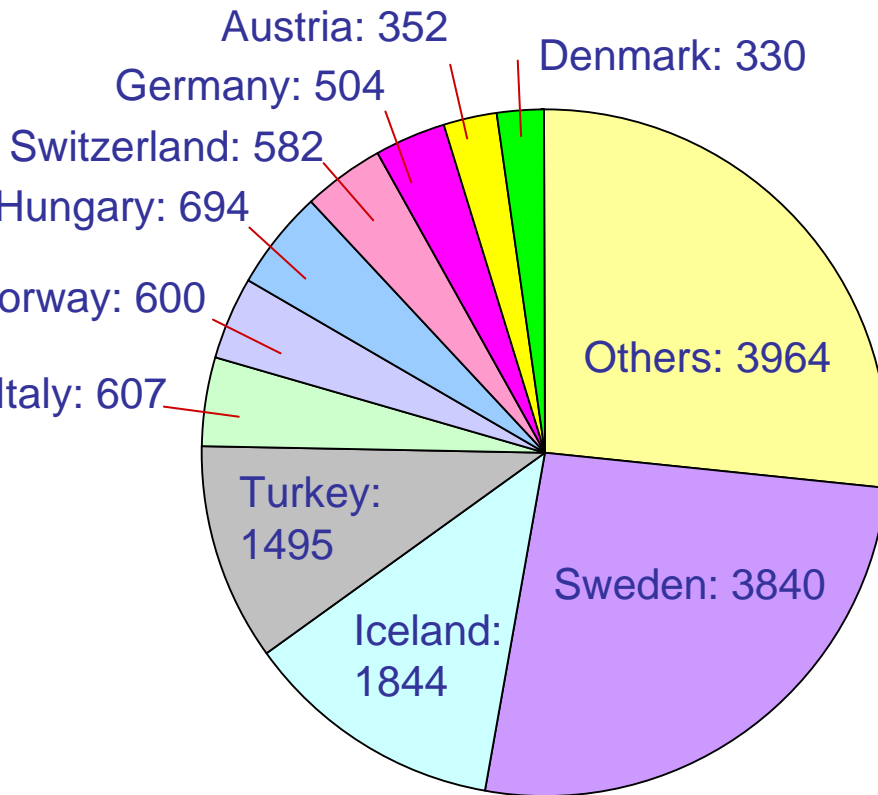


Larderello, 1904-2006

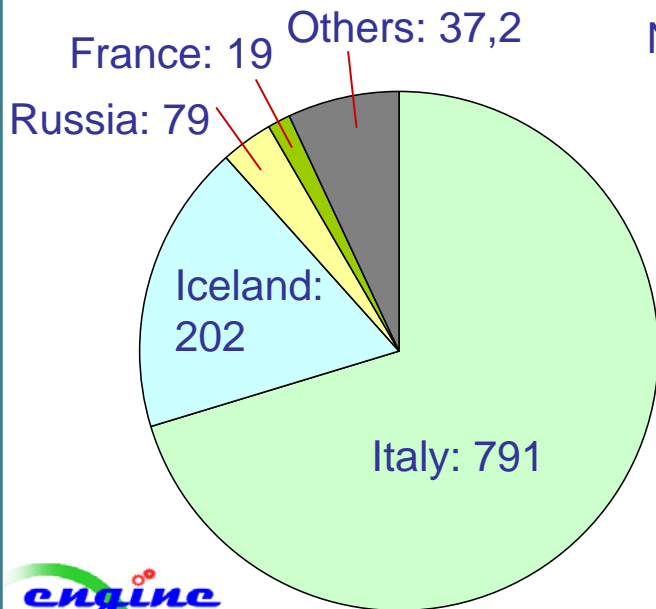
engine

Geothermal power and direct use production

Geothermal direct use capacity 2005
13626 MWt



Geothermal power capacity
2004, 1179 MWE



Compilation, L. Rybach, GRC 2006



The strategy of the European commission and the R&D programs

- Directive 2001/77/EC : doubling the contribution of renewable energy from 6 to 12% of total energy consumption by 2010.
- The White Paper (Community Strategy and Action Plan, 1997) : doubling (500 to 1000 MW) of electricity production capacity, increase from 750 to 25000 MW for heat production capacity of geothermal origin by 2010
- To be compared with in 2004: electricity production capacity: 1179 MWE, and in 2005: heat production capacity 13626 MWt



A paradox in 2005

- > Europe is a pioneer for the development of geothermal energy
 - Larderello
 - Iceland
 - Paris basin
 - GHP in Scandinavia
 - R&D in Soultz-sous-Forêts
 - Power generation by binary plants
 - ...
- > but there is no major ambition for the development of geothermal energy at the scale of Europe because:
 - a lack of political support
 - no coordination of communication compared to other lobbies
 - no major companies involved
 - the division of the scientific community



A need for a co-ordination action about R&D in Enhanced Geothermal Systems

- > A need for building an innovative research network for Europe (An expression of interest from the EC FP6)
- > A renewed interest for the geothermal energy from deep sources



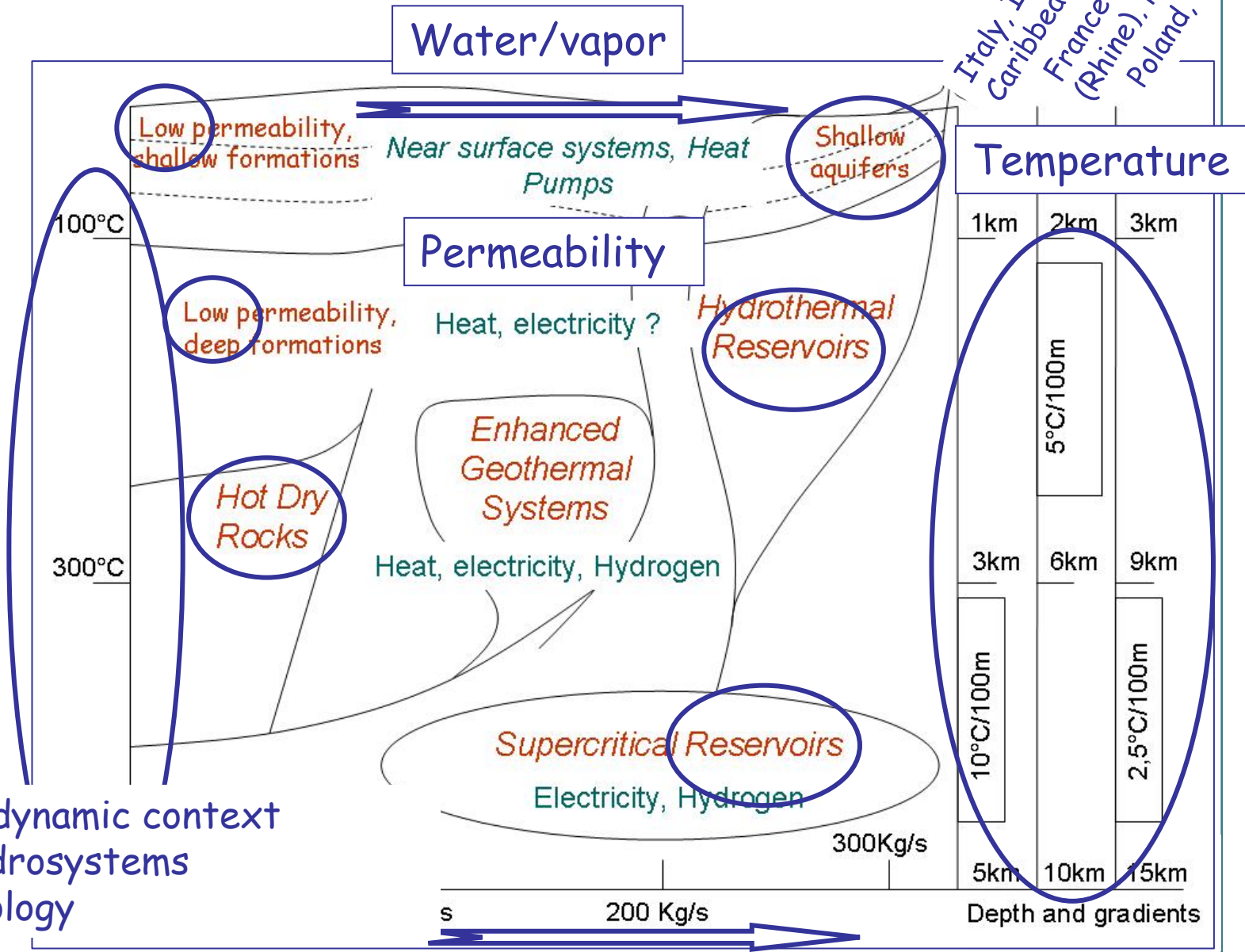
Objectives of the coordination action

- > to motivate the scientific community to face up to the above-mentioned challenges
- > to capitalise the know-how acquired in the framework of the EGS Soultz experiment but also from the exploration and exploitation of Italy, Bouillante and Iceland geothermal fields
- > to define new integrated projects that will federate the scientific community working in the "geothermal field", in partnership with industry, in order to achieve the strategic objectives of the European Community



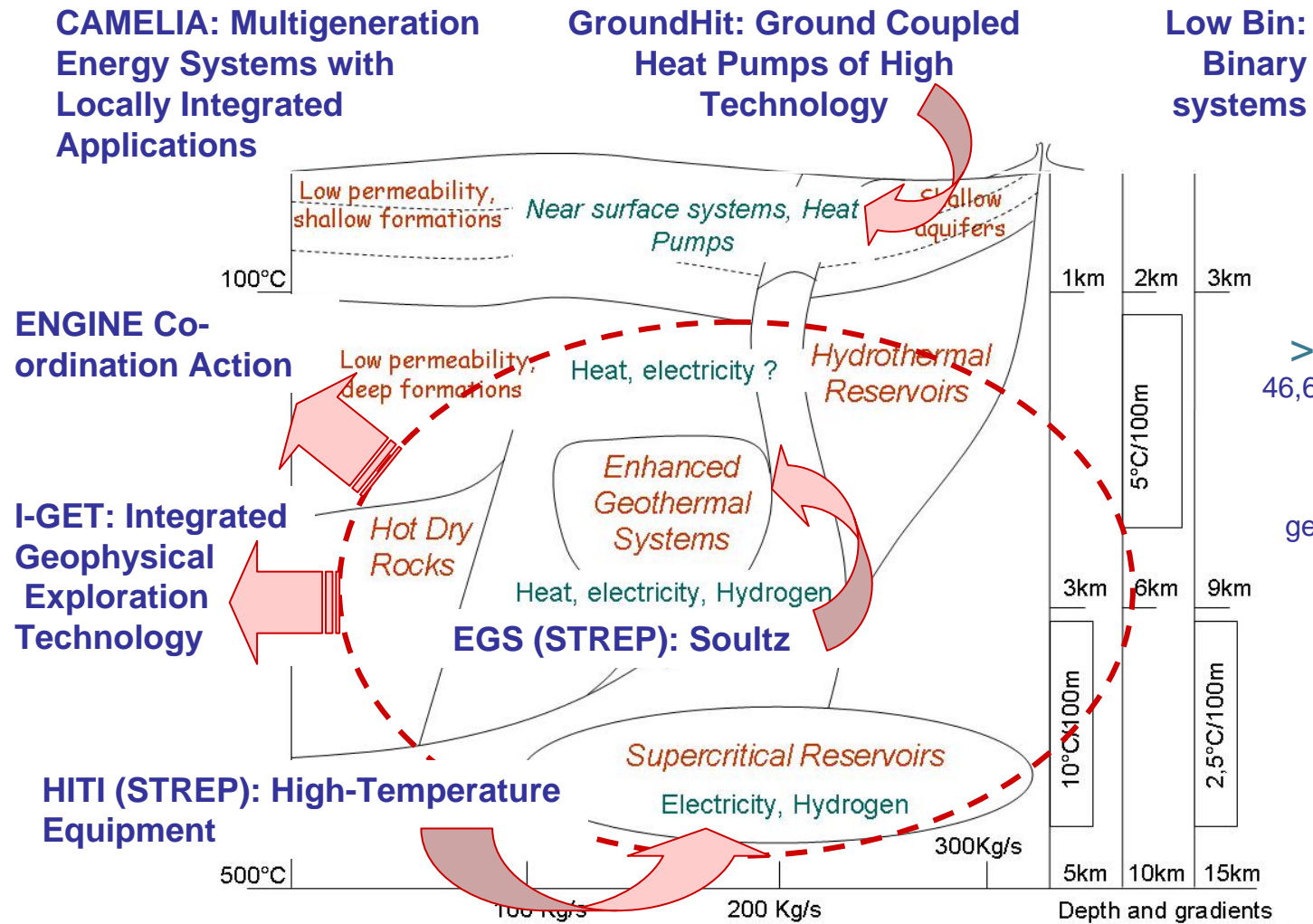
Strategy for defining targets for Geothermal energy

Italy, Iceland,
Caribbean Islands
France-Germany
(Rhine), Hungary
Poland, Spain



the geodynamic context
 • the hydrosystems
 • the geology

FP6 projects: a significant R&D investment



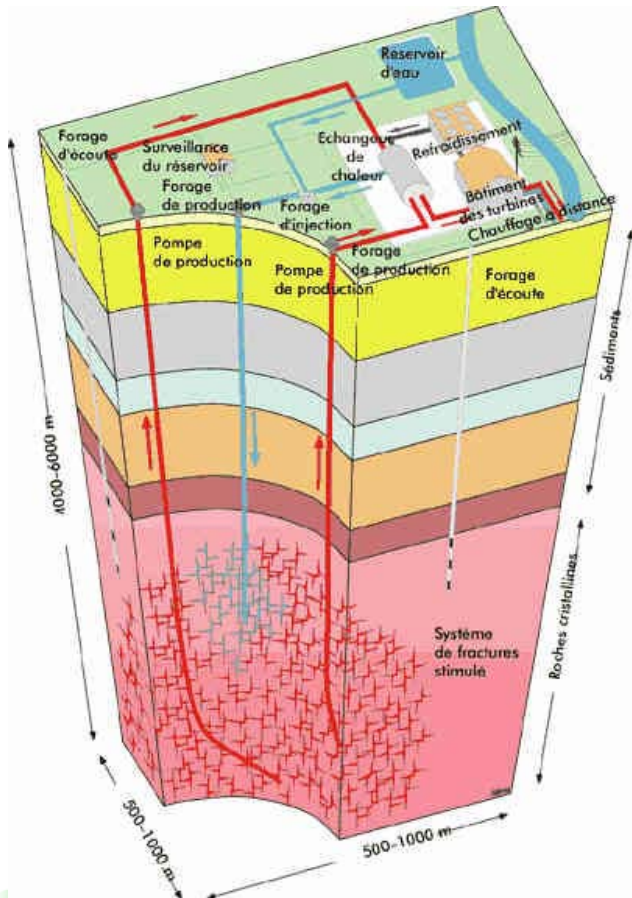
>A total budget of 46,6M€ over 4 years and a support of 17,6M€ from EU dedicated to geothermal energy



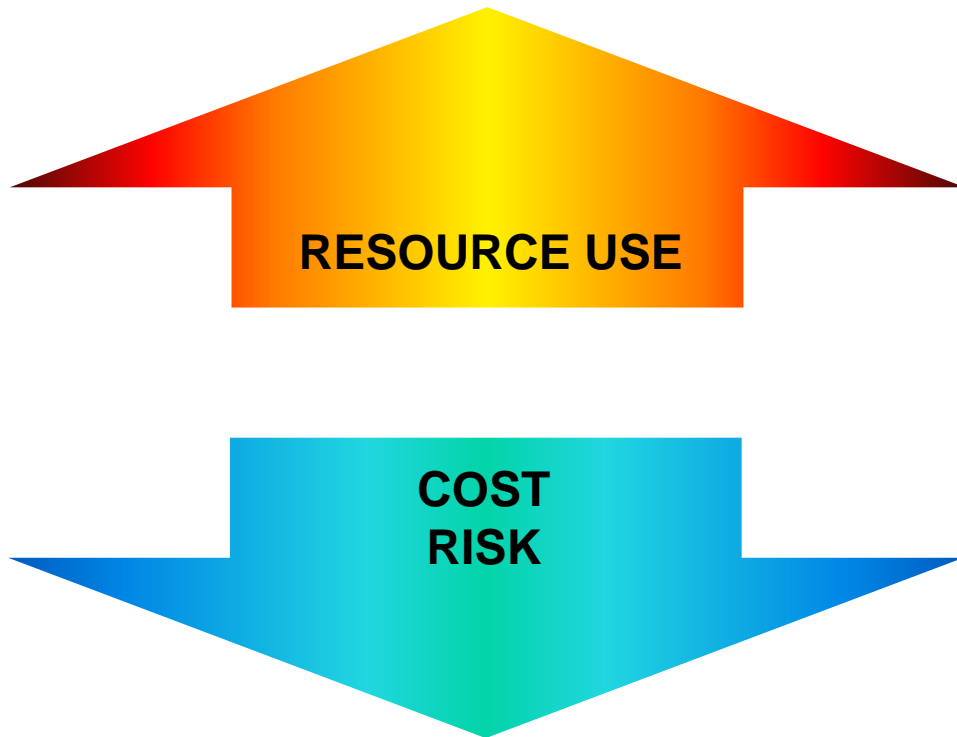
Enhanced Geothermal Systems: the concept

➤ Enhancing and broadening geothermal energy reserves

- stimulating reservoirs in Hot Dry Rock systems,
- enlarging the extent of productive geothermal fields by enhancing/stimulating permeability in the vicinity of naturally permeable rocks
- enhancing the viability of current and potential hydrothermal areas by stimulation technology and improving thermodynamic cycles,
- improving drilling and reservoir assessment technology,
- improving exploration methods for deep geothermal resources
- defining new targets and new tools for reaching supercritical fluid systems, especially high-temperature down-hole tools and instruments



The EGS challenge

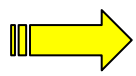


- o exploration
- o resource assessment
- o resource management
- o advanced drilling
- o advanced stimulation
- o efficient power cycles
- o environmental impact





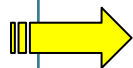
BRGM
3, avenue C. Guillemin
BP 36009 - 45060 Orléans Cedex
FRANCE



GEIE
BP 38 - Route de Sultz
67250 Kutzenhausen
FRANCE



GEUS
Oster Voldgade 10
1350 Copenhagen
DENMARK



GFZ
Telegrafenberg
14473 Potsdam
GERMANY



IGGL
T. Sevcenkos g. 13 - 03223 Vilnius
LITHUANIA



UOR
Aramtei Romane, 5-9
410087 Oradea
ROMANIA



ISOR
Gresasvegi 9 - 108 Reykjavik
ICELAND



MeSy
Meesmannstr. 49 - 44807 Bochum
GERMANY



GEMRC IPE RAS
Box 30 - Troitsk
142190 Moscow Region
RUSSIAN FEDERATION



SIEP B.V.
Carel van Bylandtlaan 30
2596 HR Den Haag
NETHERLANDS



VUA
De Boelelaan 1085
1081 HV Amsterdam
NETHERLANDS



IVT RAN
Izhorskaya str. 13/19
125412 Moscow
RUSSIAN FEDERATION



TNO
PO Box 6060
2600 JA Delft
NETHERLANDS



FEDCO
60 T. Evangelista St
BF Homes - Parañaque City
PHILIPPINES



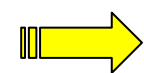
JSC
9/1 Krasnokazarmennaya Str.
111250 Moscow
RUSSIAN FEDERATION



IGR DSC RAS
Imama Shamil str. 39-A
Makhachkala
RUSSIAN FEDERATION



IIE
Reforma St. 113 - Palmira
62490 Cuernavaca - Morelos
MEXICO



DHMA
Haering Geo-Project- Im Unter
Tollacher 2 8162 Steinmaur
SWITZERLAND



CNR-IGG
Via G. Moruzzi 1 - 56124 Pisa
ITALY



CRES
19th km, Marathonos Ave
19009 Pikermi Attiki
GREECE



GEOWATT AG
Dohlenweg 28 - 8050 Zürich
SWITZERLAND



CFG
3, avenue Claude Guillemin
BP 6429 - 45064 Orléans cedex 2
FRANCE



NCSRD
Patriarchou Grigoriou & Neapoleos st
Aghia Paraskevi - 15310 Attiki
GREECE



ORME
Hosdere Cad. 190/7-8-12
06550 Ankara
TURKEY



IE
Torgauer Str. 116
04347 Liepzig
GERMANY



GPC
14, rue de la Perdrix, ZI Paris Nord 2,
Lot 109, BP 50030
95946 Villepinte CDG cedex
FRANCE



IGME
Rios Rosas, 23 - 28003 Madrid
SPAIN



ELTE
Egyetem tér 1-3 - 1053 Budapest
HUNGARY



IFE
PO Box 40 - 2027 Kjeller
NORWAY



CERTH
6th km Charilaou-Thermi Road
PO Box 361 -
57001 Thermi-Thessaloniki
GREECE



CNRS
PO Box 20 - 23, rue du Loess
67037 Strasbourg
FRANCE



PGI
Rakowiecka 4
00-975 Warszawa
POLAND



CICESE
Km. 107 Carretera Tijuana
2732 - Ensenada
B.C. - MEXICO



GGA-Institute
Stilleweg 2 - 30655 Hannover
GERMANY



LaGeo
Col Utila Santa Tecla
EL SALVADOR

<http://engine.brgm.fr/>

Coordination action breakdown structure: <http://engine.brgm.fr/>

ENGINE: ENhanced
Geothermal Innovative
Network for Europe

A scientific and technical European Reference Manual for
the development of Unconventional Geothermal Resources
and Enhanced Geothermal Systems

An updated framework of activities concerning
Unconventional Geothermal Resources and Enhanced
Geothermal Systems in Europe

Best Practice Handbook
and innovative concepts

**WP2
Information and
dissemination system**

- General information
- Information on training and education
- Reports and results, publications
- Data management
- Publication policy
- Connection with media

Deliverables

- a web site
- access to databases, models and open-source software
- on-line access to articles and reviews

**WP1
Project Management**

- 1 co-ordinator and secretary
- follow up time / quality / cost
- 1 executive Group
- 1 steering committee
- Connection with international agencies, national programmes, industrial partners

Deliverables

- quarterly reports to EU
- stronger links with potential partners for new projects

**WP9 Risk evaluation for the
development of geothermal energy**
Report on the integration of results in a
Decision Support system

**WP8 Expertise on
exploitation, economic,
environmental and social impacts**
Synthesis on best practices,
barriers holding back development and
possible solutions

**WP7 Expertise on drilling, stimulation
and reservoir assessment**
Synthesis on best practices,
barriers holding back development and
possible solutions

**WP6 Expertise on investigation of
unconventional Geothermal
resources and EGS**
Synthesis on best practices,
barriers holding back development and
possible solutions

**WP5
Exploitation,
economic,
environmental and
social impacts**

- Integrated economic approach for cost-effectiveness
- Policy makers and public awareness
- Gaps and barriers holding back development

Publications

- state-of-the-art
- proceedings of conferences
- definition and analysis of bottlenecks and solutions

**WP4
Drilling, stimulation
and reservoir
assessment**

- Drilling technology, reservoir modelling and management
- Gaps, barriers and cost effectiveness

Publications

- state-of-the-art
- proceedings of conferences
- definition and analysis of bottlenecks and solutions

**WP3
Investigation of
Unconventional
Geothermal
Resources and EGS**

- The scientific and technological challenges of the exploration phase
- Gaps, barriers and cost effectiveness

Publications

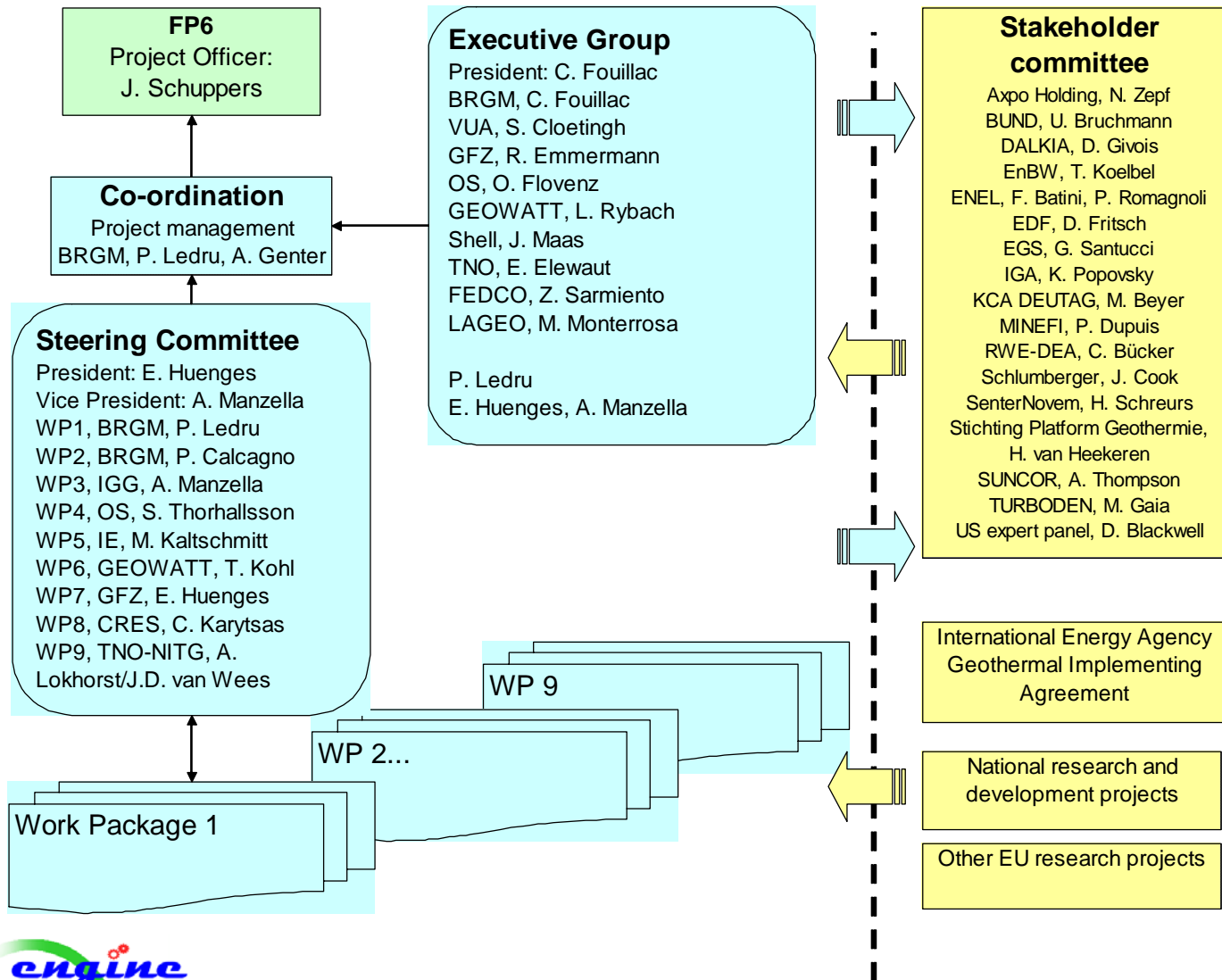
- state-of-the-art
- proceedings of conferences
- definition and analysis of bottlenecks and solutions

One major target: How to prioritise R&D needs?

EGS technology	Priority A	Impact of innovation	Priority B	Impact of innovation	Priority n	Impact of innovation
Resource investigation	Topic 1	x%	Topic 2	y%	Topic n	z%
Drilling, stimulation and reservoir assessment	
Exploitation, reservoir management and monitoring	
Economic, environmental and social impacts	...	high	...	medium	...	low
...						



An efficient network: <http://engine.brgm.fr/>



Extension of the network to Third countries (Mexico, El Salvador, Philippines)



WP1, Project Management

WP2, Information and dissemination system

WP3. Investigation of UGR and EGS ★ Italy (04/2007)

★ Germany (11/2206)
★ Mid-term Conference

WP6. Expertise on investigation of UGR and EGS

WP4. Drilling, stimulation and reservoir assessment

★ Switzerland (06/2006)
★ Mid-term Conference

★ Iceland (07/2007)
WP7. Expertise on drilling, stimulation and reservoir assessment

WP9. Risk evaluation for the development of geothermal energy

WP5. Exploitation, economic, environmental and social impacts

★ France (9/2006)
★ Mid-term Conference (Germany 01/2007)

★ Greece (09/2007)
WP8. Expertise on exploitation, economic, environmental, social impacts

★ The Netherlands (11/2007)
★ Final Conference (Lithuania, 02/2008)

★ Specialised workshops

Beginning of contacts with the Stakeholder Committee



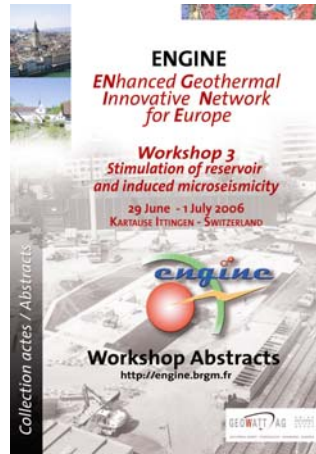
Launching Conf. (France 2/2006)



Publication policy and Meeting management



> **Launching Conference**
Orléans, France



> **Workshop 3**
Zurich, Switzerland



> **Workshop 5**
Strasbourg, France



> **Workshop 1**
Potsdam, Germany



> **Mid-Term Conference**
Potsdam, Germany

<http://engine.brgm.fr/>

Publication policy

> Next issue
#7 June 2007



ENGINE Newsletter
Enhanced Geothermal Energy for Europe
N°1 - January 2006

Editorial
1. ENGINE V
2. Launching
3. Relations

Editorial

November 1st, 2005 is the official starting date for the ENGINE Co-ordination Action. So what has been achieved during the two first months of the project? The **kick-off meeting of the Steering Committee and Co-ordinators** were held in Potsdam on November 1st and 11th. You have been informed of the main achievements of these meetings, and the **minutes are available on the web site**.

The web site is one of the 52 deliverables of the Co-ordination Action and was opened in mid-December. Its aim is to provide and manage all kinds of information circulating between partners, and to serve as a showcase for progress of the ENGINE project. The **ISGICO software** for the management of meetings, conferences and workshops has fulfilled our needs and is use-friendly. Information can be modified and updated on-line by those organisers that have editing access rights, and the few remaining problems of connection and registration were quickly resolved. Information and training will be provided during the conference for the partners in charge of the coming events.

The launching conference constitutes a unique opportunity to present the state-of-the-art and to identify topics for which a significant gain could be made through technology transfer, exchanging know-how and information. It is considered as a "starter" for preparing and motivating the partners for their participation in the "integration phase" of the project through the preparation of the workshops. Thus, the speakers have been invited to focus their talks on synthesis and general reviews of the various aspects of Enhanced Geothermal Systems. Specific topics and detailed

ENGINE Newsletter N°1 - January 2006

> #1 01/2006



ENGINE Newsletter
Enhanced Geothermal Energy for Europe
N°2 - April 2006

Editorial
1. The
2. New
3. The
4. New

Editorial

Co-ordination actions within the Sixth Framework Programme (FP) are intended to complement other FP instruments, in contributing towards integrating research at European level through well-planned networking or co-ordination activities. The explanatory notes for Co-ordination Actions define a whole range of medium to long-term networking or co-ordination activities, such as monitoring performance of studies, analyses, benchmarking exercises; exchanging and disseminating information and good practices; exchanging personnel; organising conferences, seminars and meetings; setting up common information systems; setting up expert groups; defining, organising and managing pilot or common initiatives. This means that the launching conference that was held in Orleans on 12-15 February 2005 must be considered as a first step towards a medium- to long-term process that is aimed at strengthening our community to promote research projects on geothermal energy. Several positive aspects have been underlined by the steering committee:

- The successful mobilisation of the geothermal community: 103 registered participants, involvement of 29 partners of the ENGINE network, 46 presentations that can be downloaded from the [Website](http://www.egs.eu), 19 European countries represented. The audience proved to be highly attentive and collaborative. Let's try and repeat this for the upcoming workshops and conferences.
- The significant participation of 15 non-partner research institutes, demonstrating

ENGINE Newsletter N°2 - April 2006

> #2 04/2006



ENGINE Newsletter
Enhanced Geothermal Energy for Europe
N°3 - August 2006

Editorial
Next EN
Share
Public
Strasbourg

Editorial - Feedback from the 2

In the framework of the ENGINE Project, a first workshop has been held in a former monastery next to Zurich, Switzerland. The Workshop 3, "Stimulation of reservoir and microseismicity" was organized from 20 June - 1st July 2006 in the Karlsruhelingen. The meeting was attended by a large number of scientists of the geothermal community, 52 registrants came from 12 countries and 4 continents. During the 2 days of the meeting, 3 sessions have been held with a total of 25 contributions.



A break between two sessions.

The talks were mostly documented by Extended Abstracts (88 pages). The final contributions will be published by September on a CD-ROM. The sessions were grouped as "Review of stimulation techniques" (chaired by Ernst Huenges), "Case studies on reservoir stimulation" (chaired by Svends Thorvaldsson) and "Reservoir characterization during stimulation" (chaired by Thomas Kohl). The participants came from industry and universities, and the interaction between major companies such as Shell or THO with institutions (BRGM, Tokyo University...) was found to be very fruitful. It is encouraging and stimulating for the geothermal community to observe that discussion was continuing late in

ENGINE Newsletter N°3 - August 2006

> #3 07/2006



ENGINE Newsletter
Enhanced Geothermal Energy for Europe
N°4 - October 2006

Editor
Hoop
Geoth
Intern
Public

Editorial - Strasbourg works

Workshop 5 of the ENGINE project dealing with "Electricity generation from Enhanced Geothermal Systems" was hosted from 14th to 16th of September 2006 in the charming quarter "La Petite France" in Strasbourg, France where 56 participants coming from 15 countries could be welcomed. Thereof 16 ENGINE representatives from a dozen partner organisations (more than one third of the overall partners) were sent to present and debate with numerous external participants (36) mostly coming from industry and private companies (24).

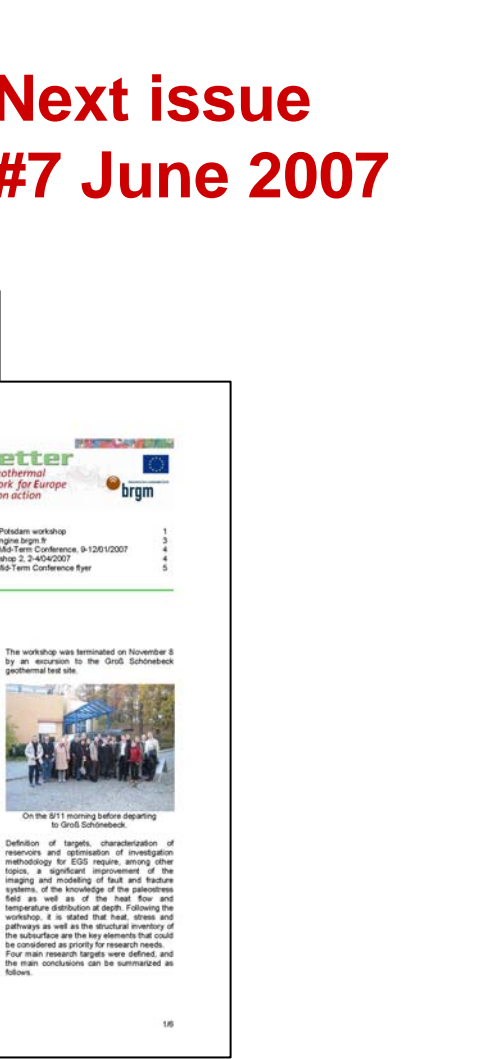


Industry and academic participants.

20 presentations were given and various debates conducted based on opinions, courtesy and also concision. Apart from this general convenient understanding in discussing also therspers demanding mutual information exchange and insisting on accurate phrasing came up at times. The driving force for all participants however was clear:

ENGINE Newsletter N°4 - October 2006

> #4 10/2006




ENGINE Newsletter
Enhanced Geothermal Energy for Europe
N°5 - December 2006

Editorial - Potsdam workshop
News
Potsdam Mid-Term Conference, 9-12/01/2007
Peak workshop 2, 2-4/04/2007
Potsdam Mid-Term Conference flyer

Editorial - Potsdam workshop

Workshop 1 of the ENGINE project dealing with "Defining, exploring, imaging and assessing reservoirs for potential heat exchange" was hosted from 6th to 8th November 2006 in the conference rooms of the Geoforschungszentrum Potsdam. 65 participants coming from 13 countries attended the workshop. 51 ENGINE representatives from 14 partner organisations (more than one third of the overall partners) were sent to present and debate with numerous external participants from 13 different organisations mostly from industry. The goal of the workshop was to discuss all parameters that should be known before drilling for exploitation of potential geothermal reservoirs.



On the 6/11 morning before departing to Groß Schönebeck.

The workshop was strongly focused on debates about the definition of targets, characterization of reservoirs and optimization of investigation methodology for EGS. To achieve this focus, four thematic sessions were defined (Signatures of temperature field for defining and exploring potential geothermal reservoirs, Signatures of fluid transport in Earth's crust, State-of-the-Art in the exploration of potential geothermal reservoirs, Processes in geothermal reservoirs). Each session was introduced by two invited speakers, followed by poster presentations (10-15) and plenty of time for discussion. The talks were mostly documented by PowerPoint presentations and Posters, which are already available on the [website Web page](http://www.egs.eu). The final contributions will be published by January 2007 on a CD-ROM.

ENGINE Newsletter N°5 - December 2006

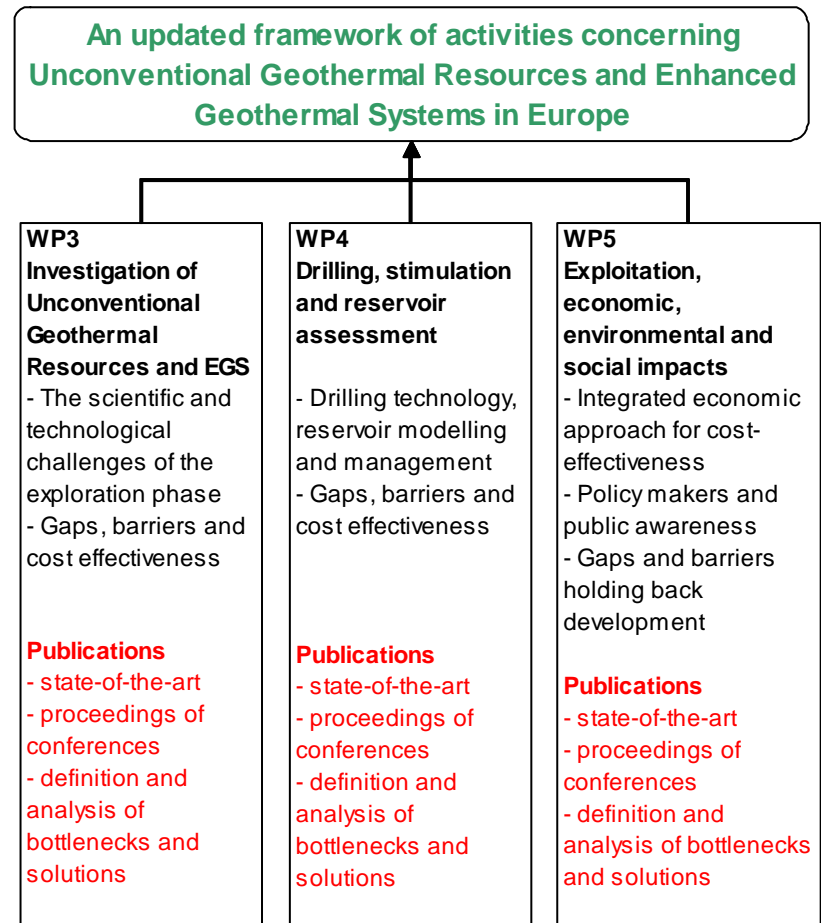
> #5 12/2006

<http://engine.brgm.fr/>



A framework for some of the R&D issues that will result from the ENGINE project

- > An illustration of the bottom-up approach
- > to capitalise the know-how and to define new integrated projects
 - Investigation of Unconventional Geothermal Resources and Enhanced Geothermal Systems
 - Drilling, stimulation and reservoir assessment
 - Economic, environmental and social impacts



A framework for some of the R&D issues that will result from the ENGINE project

> to capitalise the know-how and to define new integrated projects

- Investigation Enhanced Geothermal Systems
- Drilling, stimulation and reservoir assessment
- Economic, environmental and social impacts

An updated framework of activities concerning
Unconventional Geothermal Resources and Enhanced
Geothermal Systems in Europe

WP3
Investigation of Unconventional Geothermal Resources and EGS
- The scientific and technological challenges of the exploration phase
- Gaps, barriers and cost effectiveness

Publications
- state-of-the-art
- proceedings of conferences
- definition and analysis of bottlenecks and solutions

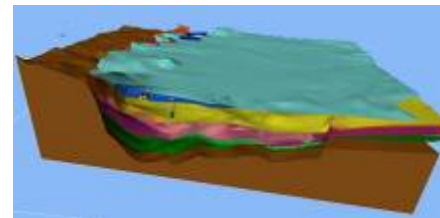
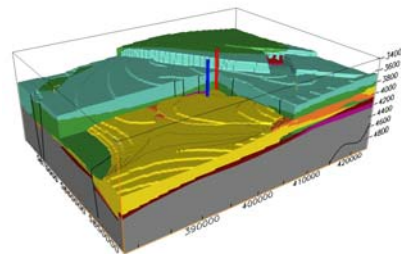
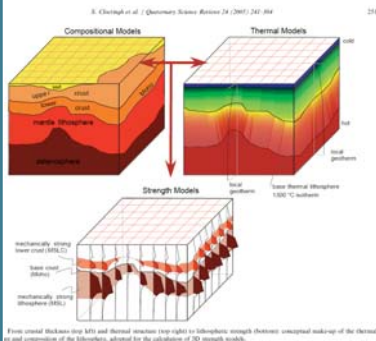
6-8 November 2007 [Defining, Exploring, imaging and assessing reservoirs for potential heat exchange - Potsdam, Germany, Workshop1](#)

1-4 April 2007 [Exploring high temperature reservoirs: new challenges for geothermal energy, Volterra, Italy, Workshop2](#)

Investigation of Unconventional Geothermal Resources and Enhanced Geothermal Systems

> Geological knowledge

- Architecture, geometry and nature of the target deduced from geological context and structural analysis: a 3D model
- Geophysical methods are suitable but existing methods must be improved and used in combination with different, highly sensitive techniques in order to meet the specific requirements of modern geophysical exploration for geothermal purposes: links with IGET



Investigation of Unconventional Geothermal Resources and Enhanced Geothermal Systems

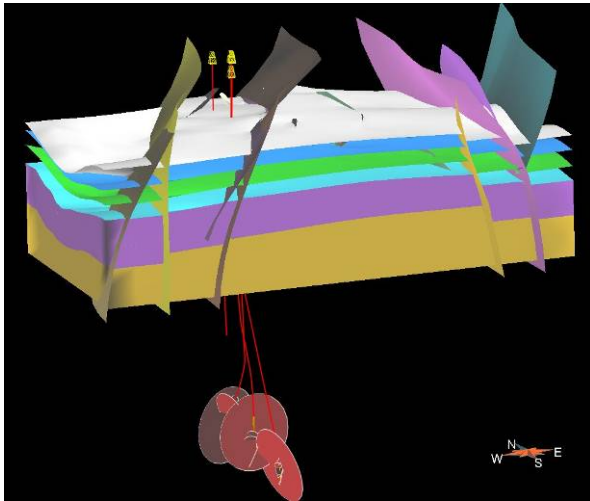
> Geological knowledge

> Finding heat at depth

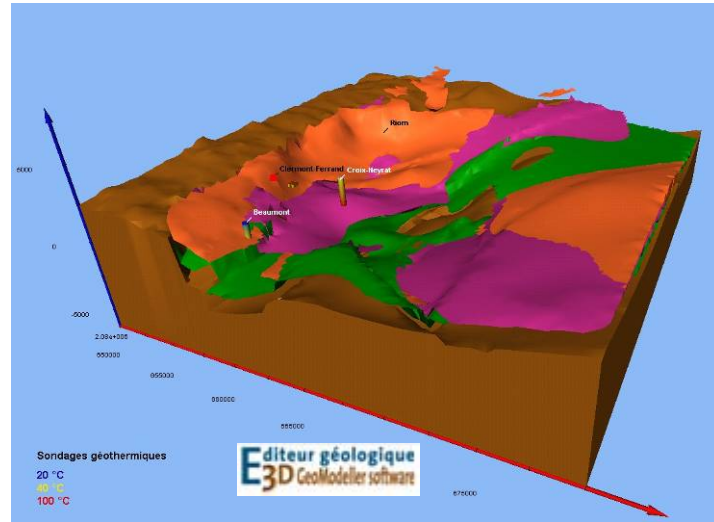
- Extension of large-wavelength heat-flow anomalies at depth is often inaccurate (insufficient knowledge of the causes of heat-flow anomaly and of thermal properties of the main lithologies)
- Several physical parameters are coupled with temperature and can be imaged by different geological, geophysical and geochemical methods
- The definition of possible targets for EGS could be improved by the use of a 3D modelling platform, in which all solutions from geological, geochemical and geophysical modelling, direct and inverse, could be combined and analysed



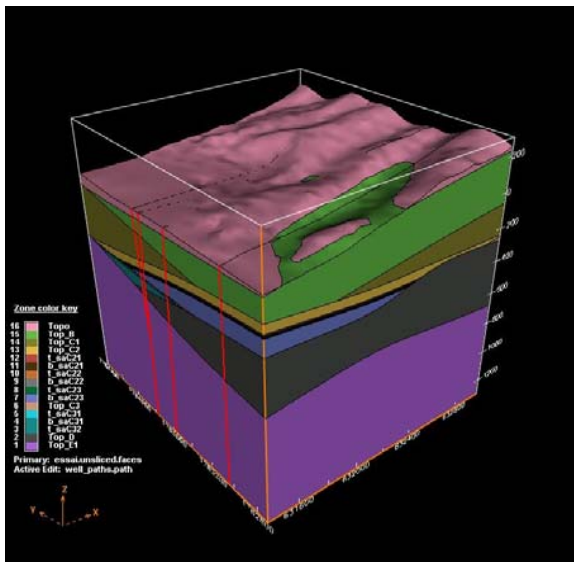
a 3D modelling platform



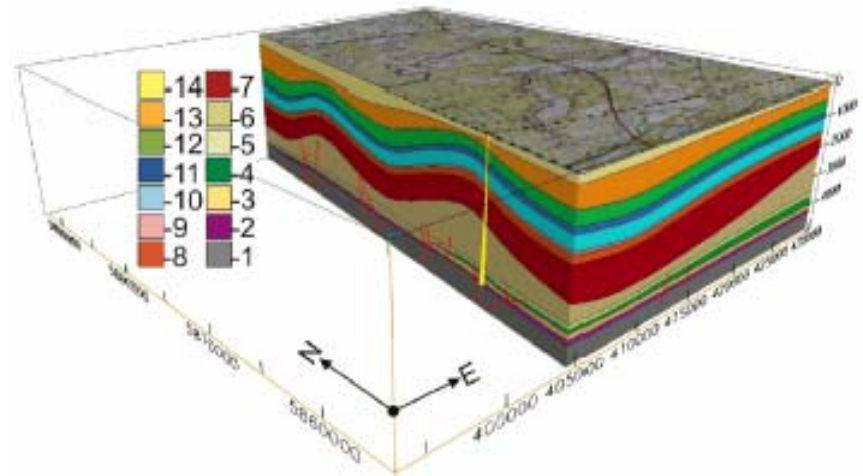
Soutz fault model, GOcad



Limagne clastic reservoir, 3D Geomodeller, BRGM



Bouillante volcanic reservoir, EarthVision, BRGM



Gross Schönebeck model, EarthVision, GFZ



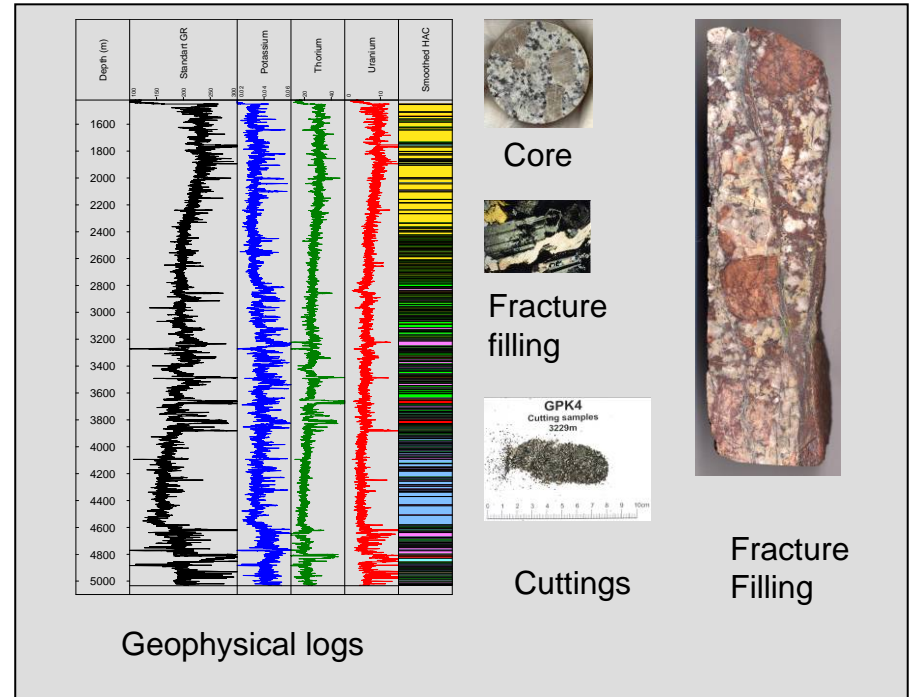
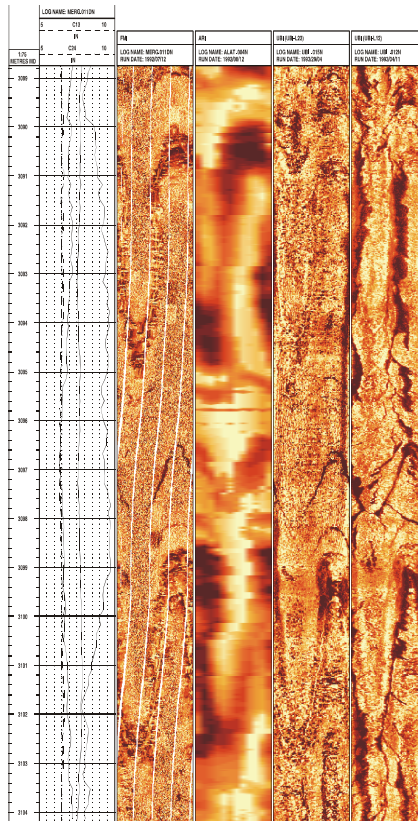
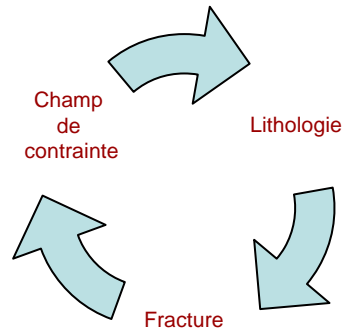
Investigation of Unconventional Geothermal Resources and Enhanced Geothermal Systems

- > Geological knowledge
- > Finding heat at depth
- > Stress field
 - Ability of fault and fracture systems to channel fluids is directly dependant on the stress field. Stress field and hydro-fracturing are linked
 - Mechanisms of rupture and propagation of an existing fault system and related displacement remain debated as well as the permeability associated with
 - **Favourable and unfavourable stress field conditions must be evaluated, depending of the different stimulation methods**

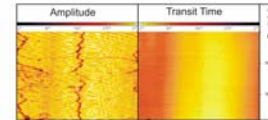


Complex interaction between lithologies, fractures and stress field

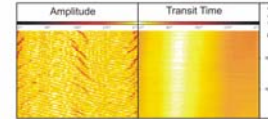
- Visualisation of fractured zones
- In situ measurement of their properties
- Measurement of the stress field
- Evaluation of interaction between lithologies and fluid circulation
- Understanding the history
- Modelling the fractured reservoir



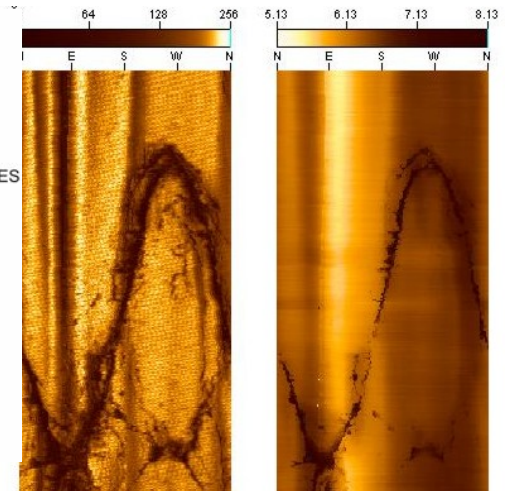
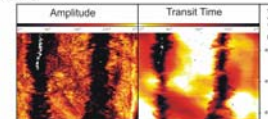
AXIAL DRILLING INDUCED TENSION FRACTURES



EN ECHELON DRILLING INDUCED TENSION FRACTURES



BREAKOUTS



Imagery of fractures par by geophysical logging

The Soultz case history

A framework for some of the R&D issues that will result from the ENGINE project

> to capitalise the know-how and to define new integrated projects

- Investigation of Unconventional Geothermal Resources and Enhanced Geothermal Systems
- **Drilling, stimulation and reservoir assessment**
- Economic, environmental and social impacts

An updated framework of activities concerning
Unconventional Geothermal Resources and Enhanced
Geothermal Systems in Europe

WP4
**Drilling, stimulation
and reservoir
assessment**

- Drilling technology,
reservoir modelling
and management
- Gaps, barriers and
cost effectiveness

Publications
- state-of-the-art
- proceedings of
conferences
- definition and
analysis of
bottlenecks and
solutions

29 Jun - 01 Jul 2006 [Stimulation of reservoir and induced microseismicity - Zurich, Switzerland, Workshop3](#)

1-05 July 2007 [Drilling cost effectiveness and feasibility of high-temperature drilling - Reykjavik, Iceland, Workshop4](#)

Commercial

Potentially commercial

Productive hydrothermal

Hot Dry Rock

Basaltic rocks IS

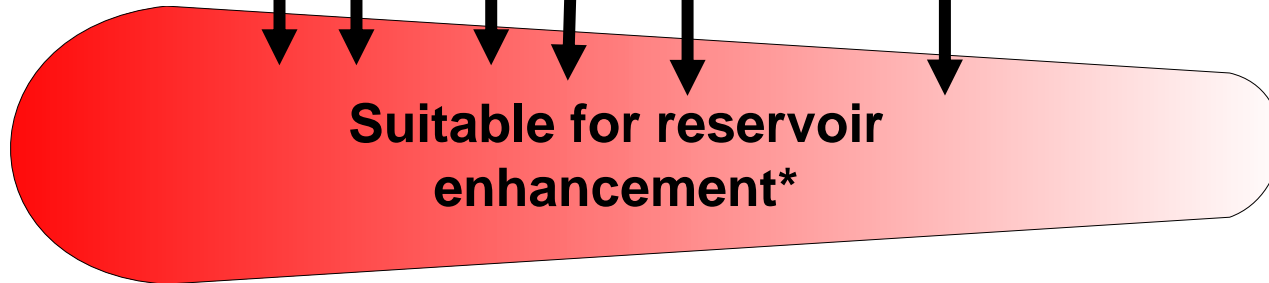
Unterhaching

Landau

Soultz-sous-Forêts

Groß Schönebeck

Cooper Basin AU



High

natural permeability

Zero

*Mechanical, chemical or thermal stimulation, directional drilling etc.



Drilling, stimulation and reservoir assessment

- > Enhancing or engineering the reservoir is a key issue for EGS
- > Mechanical and chemical stimulations are commonly used to enhance their hydraulic properties.
- > Induced microseismicity, geochemical tracing and thermal evolution of the system is an exceptional opportunity to characterize the reservoir and its dynamics
- > The success of these experiences is still a matter of trial and error, depending on the variety of geological contexts and site conditions. More detailed reviews are needed about some stimulation methods, and exchanges with hydrocarbon industry and underground nuclear waste and CO2 storage platforms are likely



Drilling, stimulation and reservoir assessment

- > As it is already partly expressed in the FP7 work program, researches should
 - define conceptual models for irreversible enhancement of permeability of the reservoirs
 - analyse the distribution in time and space of the magnitude of seismic events in order to improve the 3D imaging of the fracture system and stress field
 - set requirements for seismic monitoring and recommend management strategies for prolonged field operation,
 - provide a methodology for the estimation of site-specific seismic hazard prior to development of potential sites for EGS.

- > The induced earthquake in Basel on the 8th December 2006 reveals the urgent necessity to fill the gap in knowledge about this matter



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- Investigation of Unconventional Geothermal Resources and Enhanced Geothermal Systems
- Drilling, stimulation and reservoir assessment
- **Economic, environmental and social impacts**

An updated framework of activities concerning
Unconventional Geothermal Resources and Enhanced
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WP5
Exploitation, economic, environmental and social impacts
- Integrated economic approach for cost-effectiveness
- Policy makers and public awareness
- Gaps and barriers holding back development

Publications
- state-of-the-art
- proceedings of conferences
- definition and analysis of bottlenecks and solutions

14 - 16 September 2006 [Electricity generation from Enhanced Geothermal Systems - Strasbourg, France, Workshop 5](#)

13-14 September 2007 [Increasing policy makers' awareness and public acceptance - Athens, Greece, Workshop 6](#)



Geothermal electricity generation in Europe

	Dry Steam Plants in MW _{el}	Flash Plants in MW _{el}	Binary Plants in MW _{el}	Total Capacity in MW _{el}	Capacity by 2010 in MW _{el}
Austria			1.4	1.4	7.4
France		14.7 ^a		14.7	20.7
Germany			0.2	0.2	25.2
Iceland		161.7	10.4	172.1	392.1
Italy	770.5	20		790.5	890.5
Portugal		3.0	13.0 ^b	16	35
Russia		110 ^c		110	228
Switzerland					6
Turkey		20.4		20.4	
Europe	770,5	329.8	24.3	1,125.3	1,650.3

Compiled by Kaltschmitt & Frick, 2006 from WGC05

^a Guadeloupe; ^b Azores; ^c thereof 9 MW_{el} flash-binary unit



Economic, environmental and social impacts

> Electricity production from low enthalpy resources in Europe: a fairly young technology which lacks wide experience, both for the development of geothermal resources and power plant systems

> Discussion about the pros and cons of

- ORC vs. Kalina cycle,
- air vs. water cooling
- fancy vs. proven technology
- power vs. Combined Heat Power

is of no interest in terms of a further development of geothermal energy use

> The main task of project developers is the optimisation potential in terms of the design of the working fluid, the cycle and turbine designs as well as the cooling systems



Economic, environmental and social impacts

- > Efficiency of a power plant cycle can be improved with an increasing technical effort and innovative ideas. Before being able to break into the market these technologies need to be tested, which is generally not possible on a purely commercial basis as technical and financial risks are induced
- > Governments, national agencies and Europe must support the market access of such new and innovative technologies
 - The Renewable Energy Source Act (EEG) was introduced in Germany to facilitate sustainable development of energy supply in the interest of managing global warming, conserving nature and protecting the environment
- > The choice of a Turboden-Cryostar binary power plant for the Soultz-sous-Forêts : an application of optimisation potential and the choice of an innovative technology
- > Combining different energy options supplying heat on different temperature levels can result in a higher overall efficiency, and thus profitability, and hence be decisive for realising geothermal based electricity production



EGS activity in the German part of the Upper Rhine graben

- > The Renewable Energy Source Act (EEG) was introduced in Germany to facilitate sustainable development of energy supply in the interest of managing global warming, conserving nature and protecting the environment
 - > The EEG entered into force in 2000 and was amended on 1st of August 2004.
 - > Fees paid for electricity produced from geothermal energy:
 - At least 15 cents per KWh up to and including a capacity of 5 MW,
 - At least 14 cents per KWh up to and including a capacity of 10 MW,
 - At least 8.95 cents per KWh up to and including a capacity of 20 MW
 - At least 7.16 cents per KWh for a capacity of 20 MW and over
- *From Bestec, 2006*



EU-wide Feed-in tariffs for geothermal energy



Austria: 7,00 ct/kWh



Germany: up to 15,00 ct/kWh



Belgium: 2,50 ct/kWh



Greece: 7,31 ct/kWh



Czech Republic: 15,56 ct/kWh



Slovakia: 9,04 ct/kWh



Estonia: 5,10 ct/kWh



Slovenia: 5,85 + 2,52 ct/kWh



France: 10 ct/kWh (overseas: 12)



Spain: 6,49 + 2,94 ct/kWh

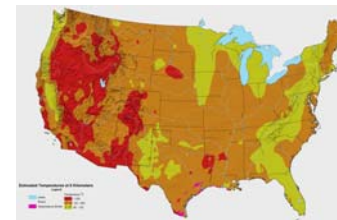
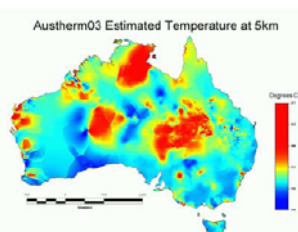


• **From Kaltschmitt, 2006**



An international framework and a renewed interest for the geothermal energy from deep sources

- > Development of geothermal energy requires the realisation of short term projects showing the use of cost-efficient geothermal energy and of medium to long term projects that concern Enhanced Geothermal Systems
- > the Soultz experiment is considered as the international reference by the Australian investors and American scientists for whom EGS is one of the few renewable energy that can provide continuous base load-power
- > The co-ordination of these short and long term projects requires a well organised scientific community at an international level, a restored political support and good links with industry and stakeholders



August 31, 2005

DOE Geothermal Technologies
Program
Multi-Year Program Plan
2006 – 2011

Hot Rock Projects in South Australia (from B. Goldstein)

• 11 GEL / GELA Holders

- ✓ Geodynamics
- ✓ Petratherm =MNGI
- ✓ Pacific Hydro
- ✓ Osiris Energy
- ✓ Geothermal Resources
- ✓ Torrens Energy
- ✓ Scopenergy
- ✓ Green Rock
- ✓ Eden (Tasman affiliate)
- ✓ Proactive Energy
- ✓ Origin Energy Resources

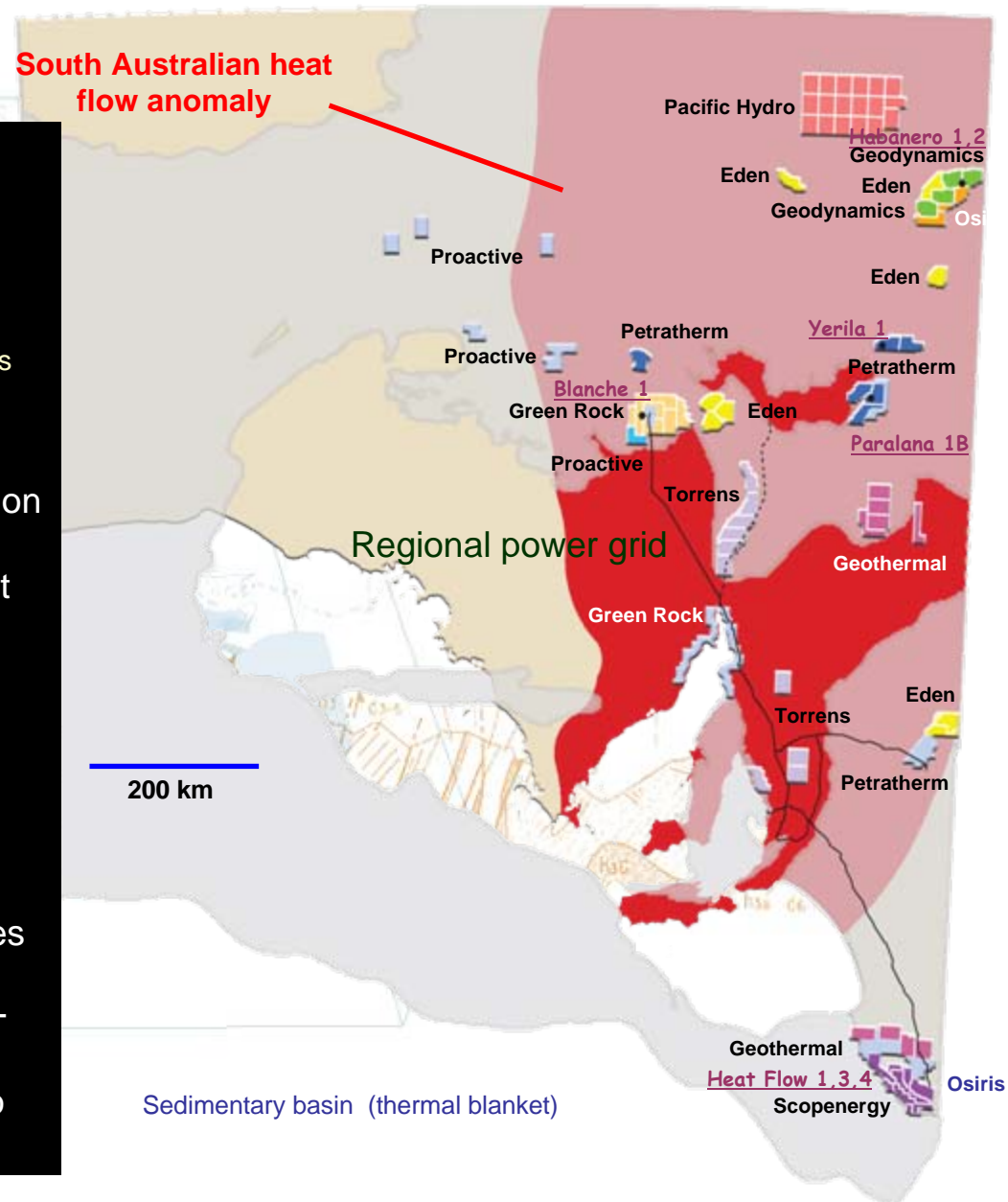
• 92 GELs / GELAs over 43,440 km²

- The 5-year GEL exploration and demonstration work programs correspond to \$500+ million, and this excludes up-scaling and deployment projects

- Can benefit from Commonwealth renewable energy initiatives:

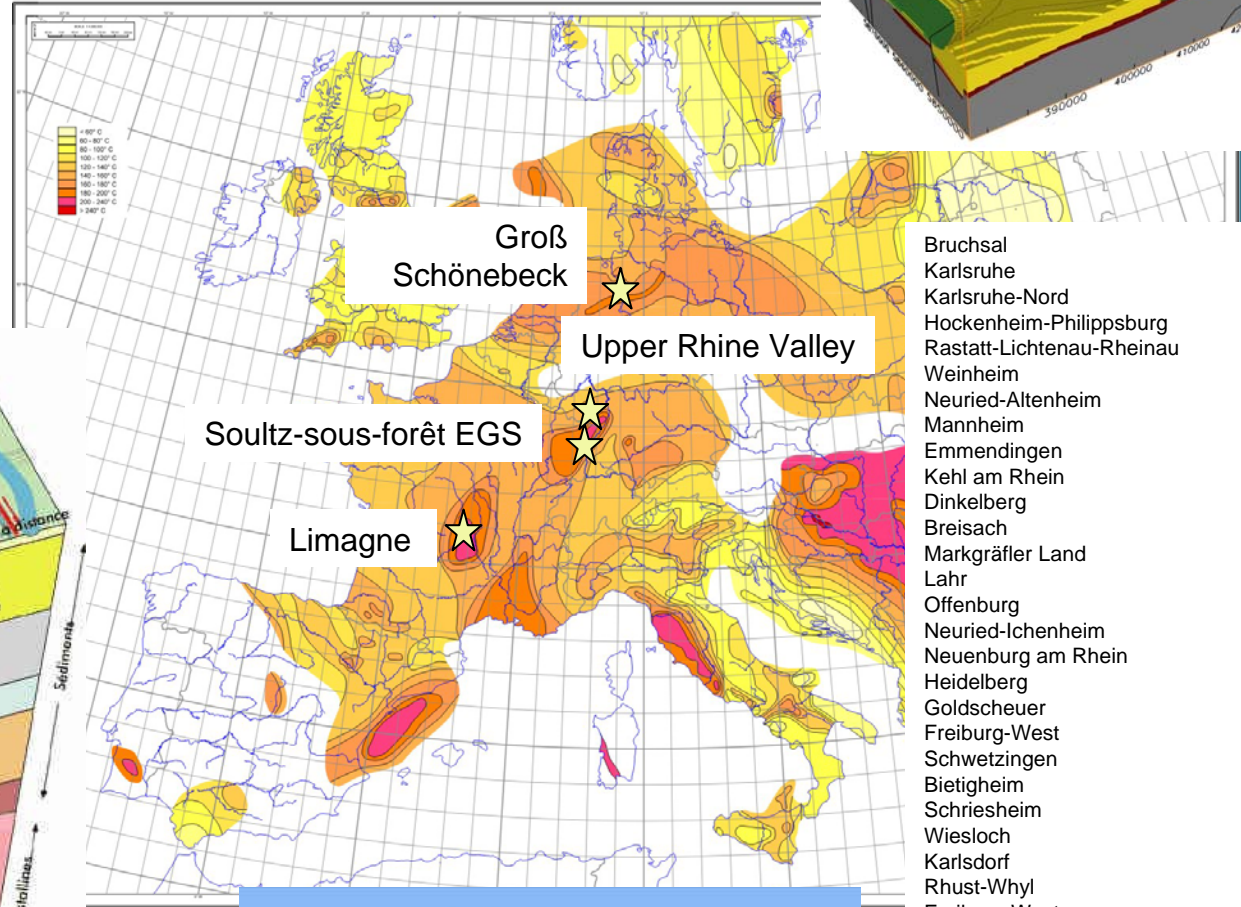
1. Renewable Energy Certificates
2. REDI Grants
3. Circa \$500 million in Federal grants to demonstrate low emissions technologies

- Just 1 GEL (500 km²) has hot rock emission-free energy potential to yield electricity equivalent to several Snowy Mountain Hydro Schemes (1 SM approx = 550 MWe)

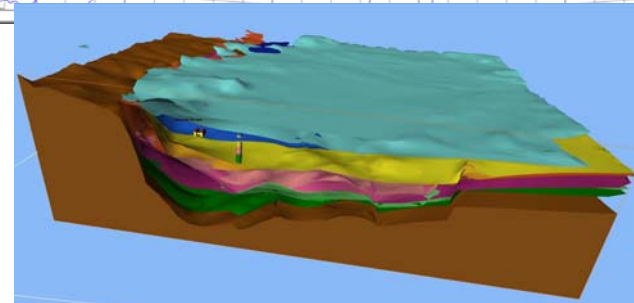
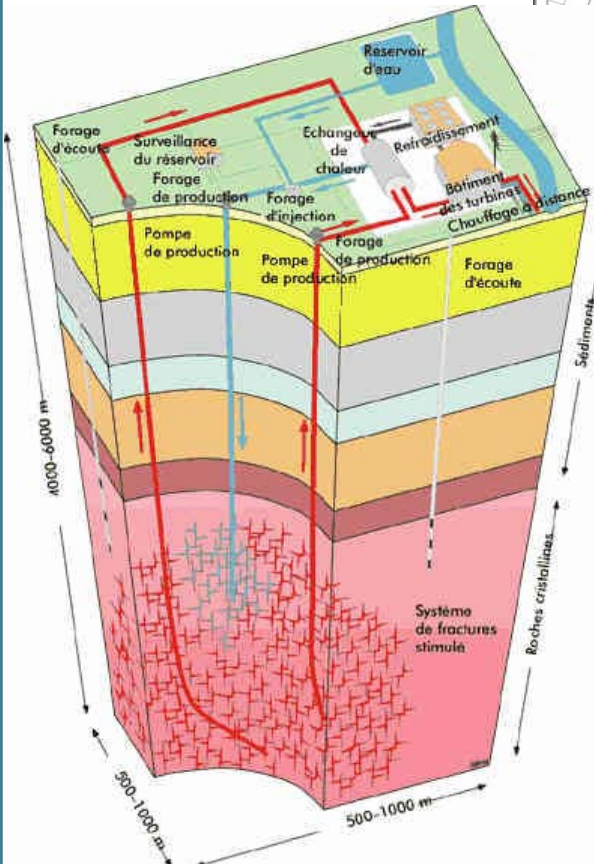


A continent to explore...

MAP OF THE TEMPERATURES EXTRAPOLATED AT 5 KM DEPT



- Bruchsal
- Karlsruhe
- Karlsruhe-Nord
- Hockenheim-Philippsburg
- Rastatt-Lichtenau-Rheinau
- Weinheim
- Neuried-Altenheim
- Mannheim
- Emmendingen
- Kehl am Rhein
- Dinkelberg
- Breisach
- Markgräfler Land
- Lahr
- Offenburg
- Neuried-Ichenheim
- Neuenburg am Rhein
- Heidelberg
- Goldscheuer
- Freiburg-West
- Schwetzingen
- Bietigheim
- Schriesheim
- Wiesloch
- Karlsdorf
- Rhust-Whyl
- Freiburg-West
- Speyerdorf
- Landau in der Pfalz
- Offenbach an der Queich
- Bellheim
- Speyer
- Riedstadt
- Bad Bergzabern
- Steinfeld
-



The use of Oil and Gas wells

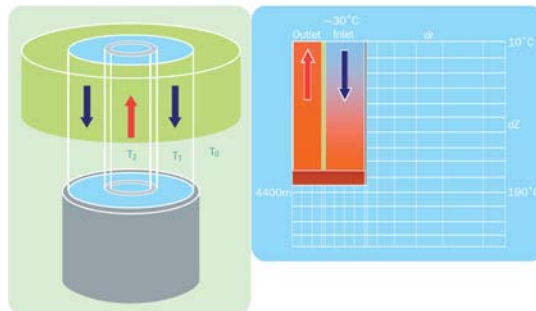
Could we exploit the geothermal potential of North Sea oil fields as their oil runs out? Some have reservoir temperatures over 100° C and so electricity generation might be possible

(J. Busby, 2006, BGS)



Re-use of E&P-boreholes for geothermal energy production

Figure 1.
(left) The tube setup with the isolated outer tube in yellow and the non isolated outer tube in grey.
(right) 2D axis-symmetric numerical finite difference grid.



- > Geothermal energy applications have gained renewed interest in recent years. One of the interesting applications is the re-use of deep boreholes drilled by oil and gas industry for a Deep Borehole Heat Exchanger (DBHE).

> (J. D. Van Wees, 2007, TNO)



From an ENhanced Geothermal Innovative Network for Europe to an European geothermal drilling program?

- > an effort of communication to be done to promote the geothermal energy as a cost-efficient alternative source of energy
- > a need of good synthesis of the knowledge and collection of existing datasets for modelling and assessment of the resources, prior to drilling
- > a need for a **scientific exchange platform** for:
 - promoting past and on-going experiences by making them visible and reproducible
 - defining **research projects** that could be presented to the EU commission as a possible contribution for the future work programme of the FP7.
 - defining **an ambitious research program at the scale of Europe** that will federate the research capacity and limit the financial risk by sharing the investment. Such a program, that could be for example an **European geothermal drilling program** requires a common approach of both scientist and stakeholders



Conclusions

- > A sound scientific and technical knowledge acquired in Europe during the 20th century
 - Conventional geothermal energy still benefits from ongoing improvements in conversion, heat distribution... and should become increasingly cost-effective (rise in energy prices, new environmental constraints, greenhouse gas reduction...)
- > A need for long-term collaborative research on international projects to develop Enhanced Geothermal Systems
 - reference to the Soultz experiment for promoting new projects in Australia, Kamtchaka, Chile..., extension of existing geothermal fields, geothermal recovery from existing oil and gas operations...
- > ENGINE, along with other initiatives (European Commission, IEA-GIA, MIT expert panel, IGA, EGEC...) can
 - contribute to the construction of an international strategy
 - consolidate the available information systems
 - propose spin-off projects that will receive the support of stakeholders, decision makers and private investors.

