



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

Ledru P., Huenges E., Flovenz O.



A renewed interest for geothermal resources of deep origin

- > R&D task force
 - The support of the European Commission
 - The ENGINE contribution
 - Other International initiatives
- > Growing interest of industry and investors
 - The heat rush in Australia and Germany
 - A rising force for investing in exploration in Europe
- > A favorable context for preparing new ambitious projects within an European geothermal drilling program

> **Drilling : a key issue**



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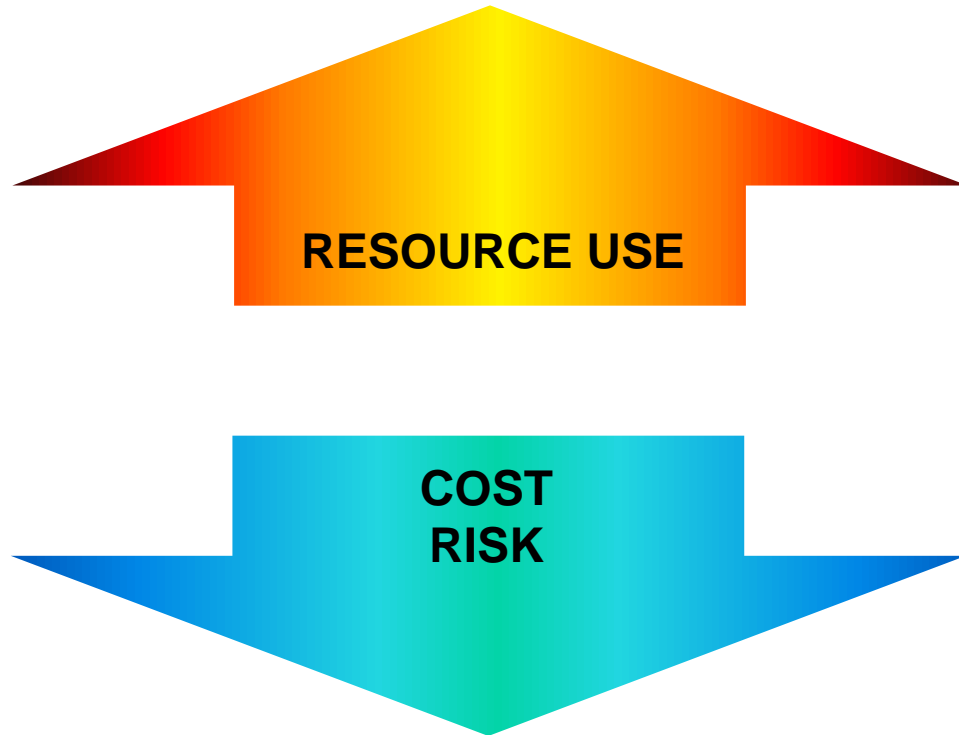
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Drilling and the EGS challenge



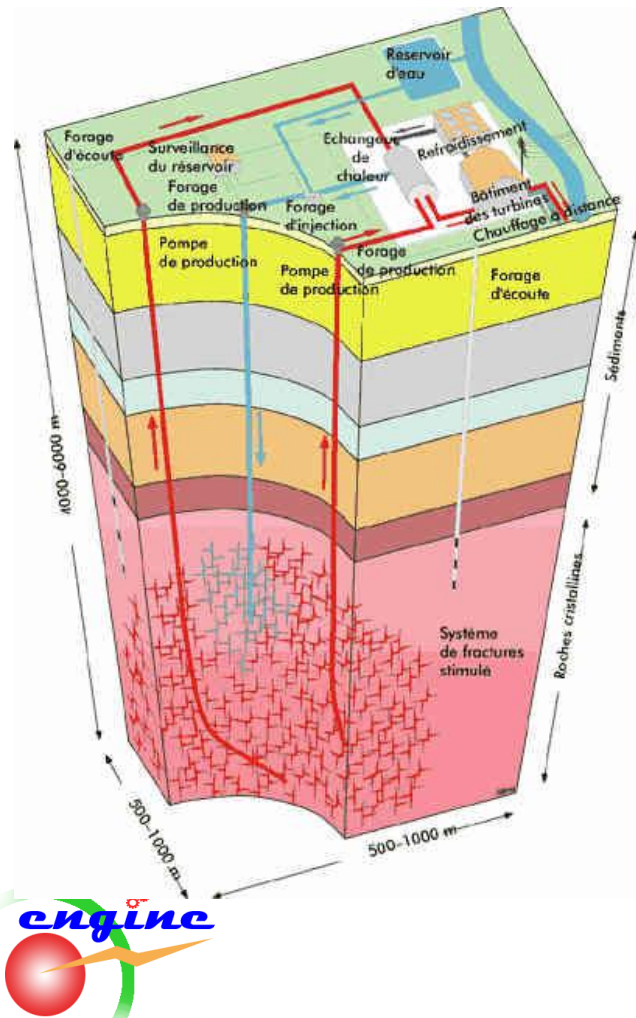
- o exploration
- o resource assessment
- o resource management
- o advanced drilling
- o advanced stimulation
- o efficient power cycles
- o environmental impact



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



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

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
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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](#)

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



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
...						



IEA/GIA Annex VII – Advanced Geothermal Drilling



Participants:

The European Commission

Iceland

Mexico

New Zealand

United States (Operating Agent)

GIA Annex VII

Notes from Annex VII meeting: Active Subtasks

Subtask A: Compilation of Geothermal Well Drilling Cost and Performance Information

Jaime Vaca, - CFE Mexico

Subtask B: Identification and Publication of "Best Practices" for Geothermal Drilling Handbook Best Practices Development

Subtask Leader: Jaime Vaca CFE, Mexico

Subtask C: Collaborations on Advanced Drilling

Subtask Leader: Steve Bauer SNL, USA

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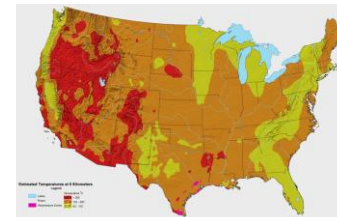
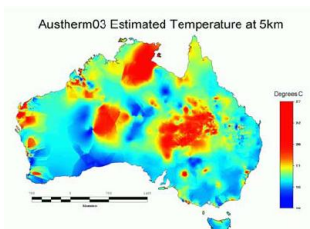
> **Drilling : a key issue**



Growing interest of industry and investors

- The development of conventional geothermal energy shows the cost-efficiency of short term projects
 - 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 in Europe, to be compared with in 2004: electricity production capacity: 1179 MWE, and in 2005: heat production capacity 13626 MWt
- 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
- There is a “heat rush” in Australia and Germany

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

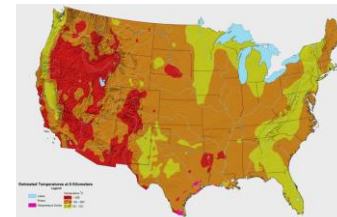
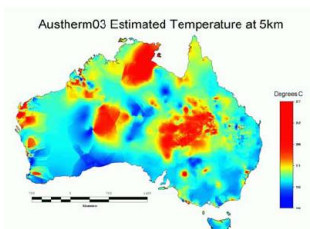


August 31, 2005

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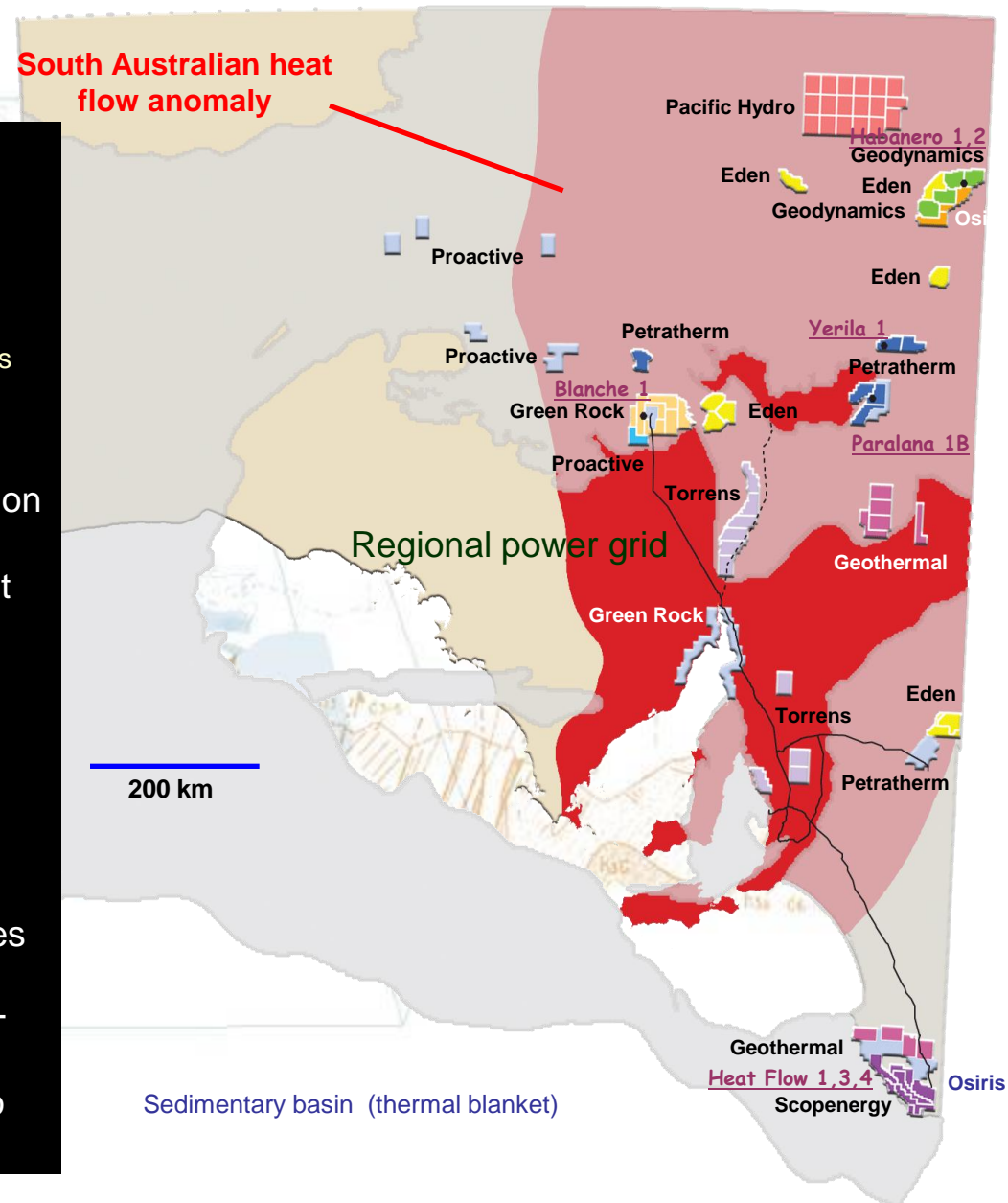


August 31, 2005

The Heat rush

Hot Rock Projects in South Australia (from B. Goldstein, 2006)

- 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)



The Heat rush and the drilling issue



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Email: info@hotdryrocks.com
Web: www.hotdryrocks.com

HDRPL Geothermal Newsletter

News from the Australian Geothermal Energy sector

Issue 9

1 July 2007

Highlights from the month of June...

A couple of news items from late May didn't quite make it into last month's Newsletter. Firstly, **Geodynamics Limited**'s new drill rig left Houston by ship on Wednesday 30th May, bound for Brisbane. It was projected to arrive in Brisbane towards the end of June (no fresh word on this as of 1st July) and be on site at the Habanero project about 10 days later. Also on 30th May, **KUTh Energy Limited** was incorporated and acquired **KUTh Exploration Pty Ltd**, in preparation for an IPO expected later in 2007.

Firstly, **Petratherm Limited** had a big day of announcements on Monday 4th. PTR has appointed California-based geothermal energy consultancy Global Power Solutions to provide technical oversight to well design and drilling processes at Paralana, together with planning and engineering design work for a power generation plant. On the same day, PTR announced that the Paralana Energy Joint Venture, consisting of PTR and Beach Petroleum, has approved the commencement of deep well design and the rig selection process to develop an underground heat exchanger at Paralana by the end of July next year.

p on Wednesday 30th
wards the end of June
o project about 10
orated and acquired

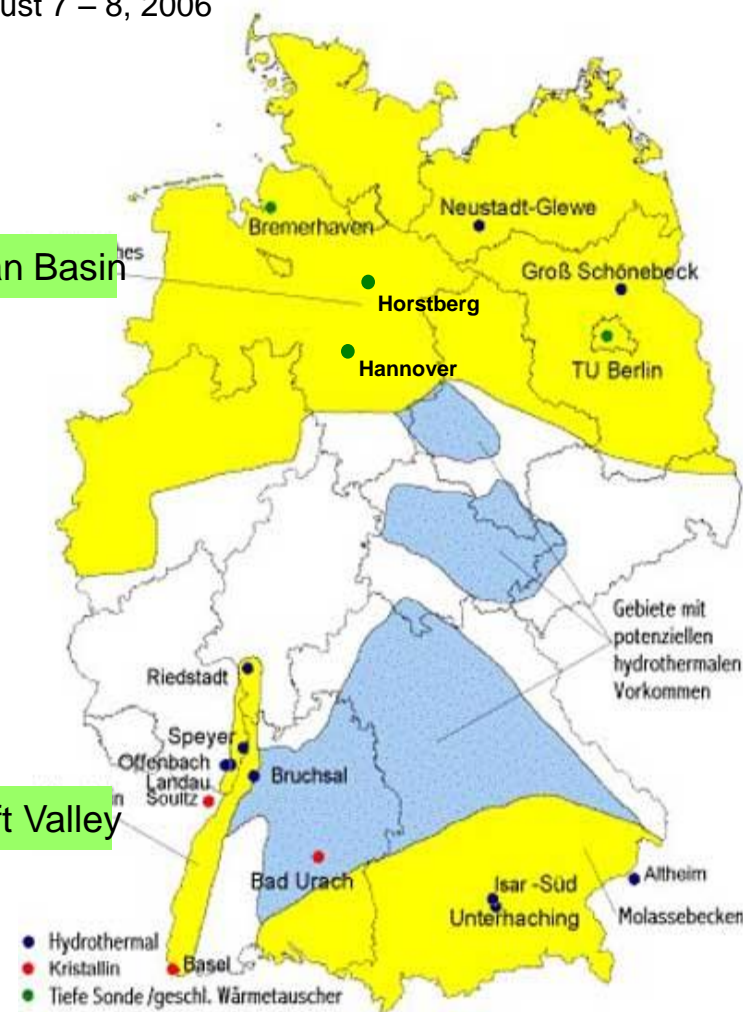


German Regions of Interest

Dr. Lothar Wissing, 16th ExCo meeting GIA IEA, San Diego August 7 – 8, 2006



North German Basin

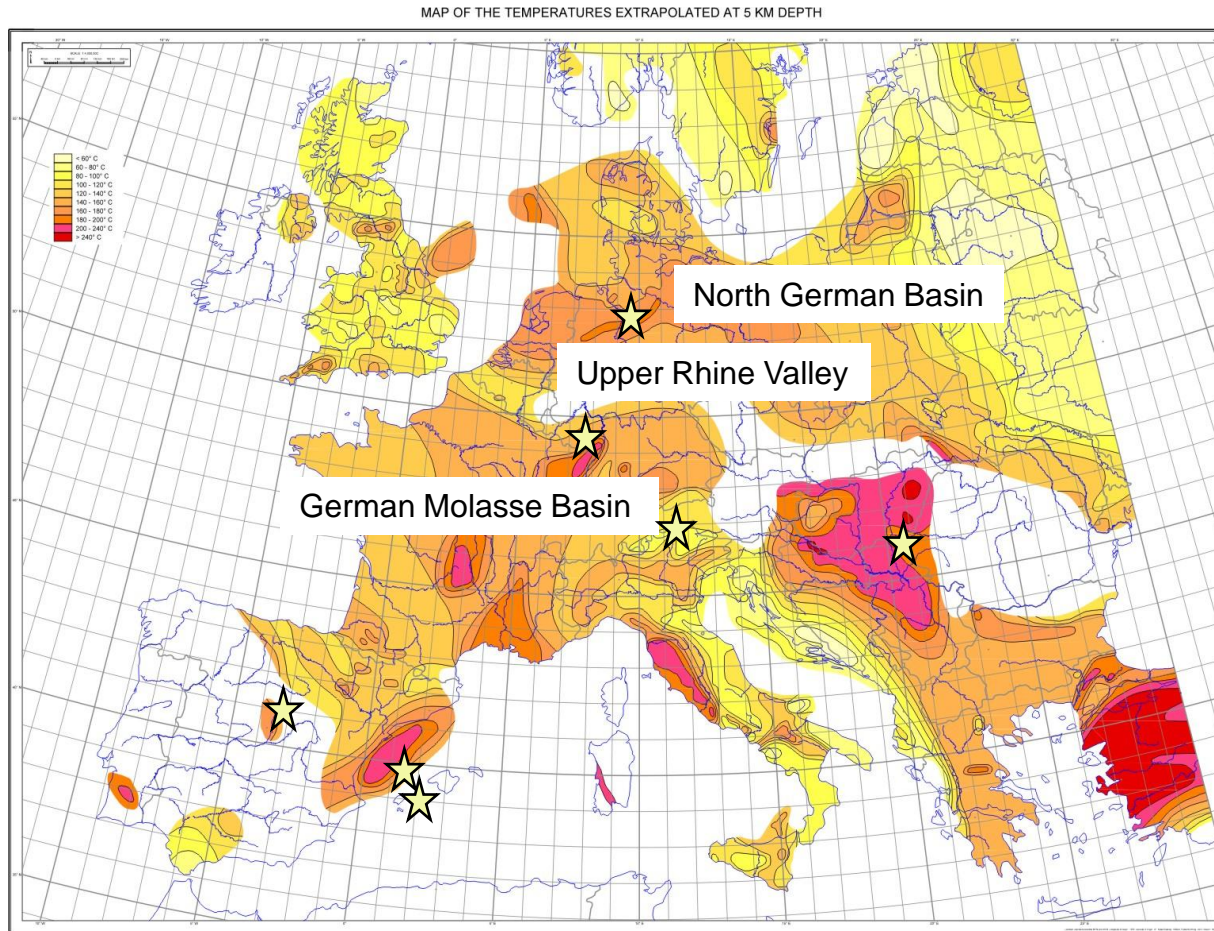


Upper Rhine Rift Valley

German Molasse Basin



The heat rush in Germany...



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

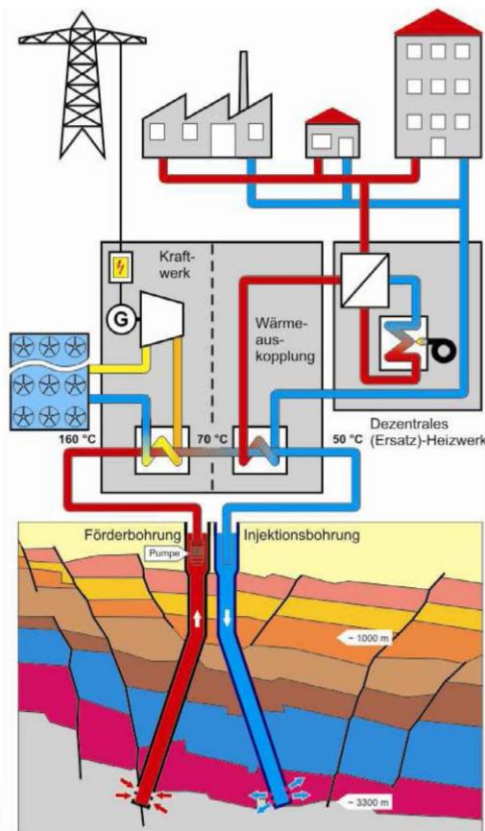


and precursors in Spain and Hungaria...

The Landau case history



Landau: Die Planung



7

BESTEC: J. Baumgärtner - 2007

Kenndaten

**Jährliche Einsparung:
5000 Tonnen CO₂**

- Projektstart 2004
- Inbetriebnahme 2007
- Thermalwassertemperatur 150 grad C
- Fördermenge 70 l/s
- Erzeugter Strom
- Leistung 2,58 MW
- Arbeit 19.591 MWh
- Benutzungsstunden 7.600 h/a
- Erzeugte Wärme
- Leistung 5,1 MW
- Arbeit 9.183 MWh
- Gesamtinvestitionen 15,2 Mio €

5000 Haushalte
(3800 kWh/a & Haushalt)

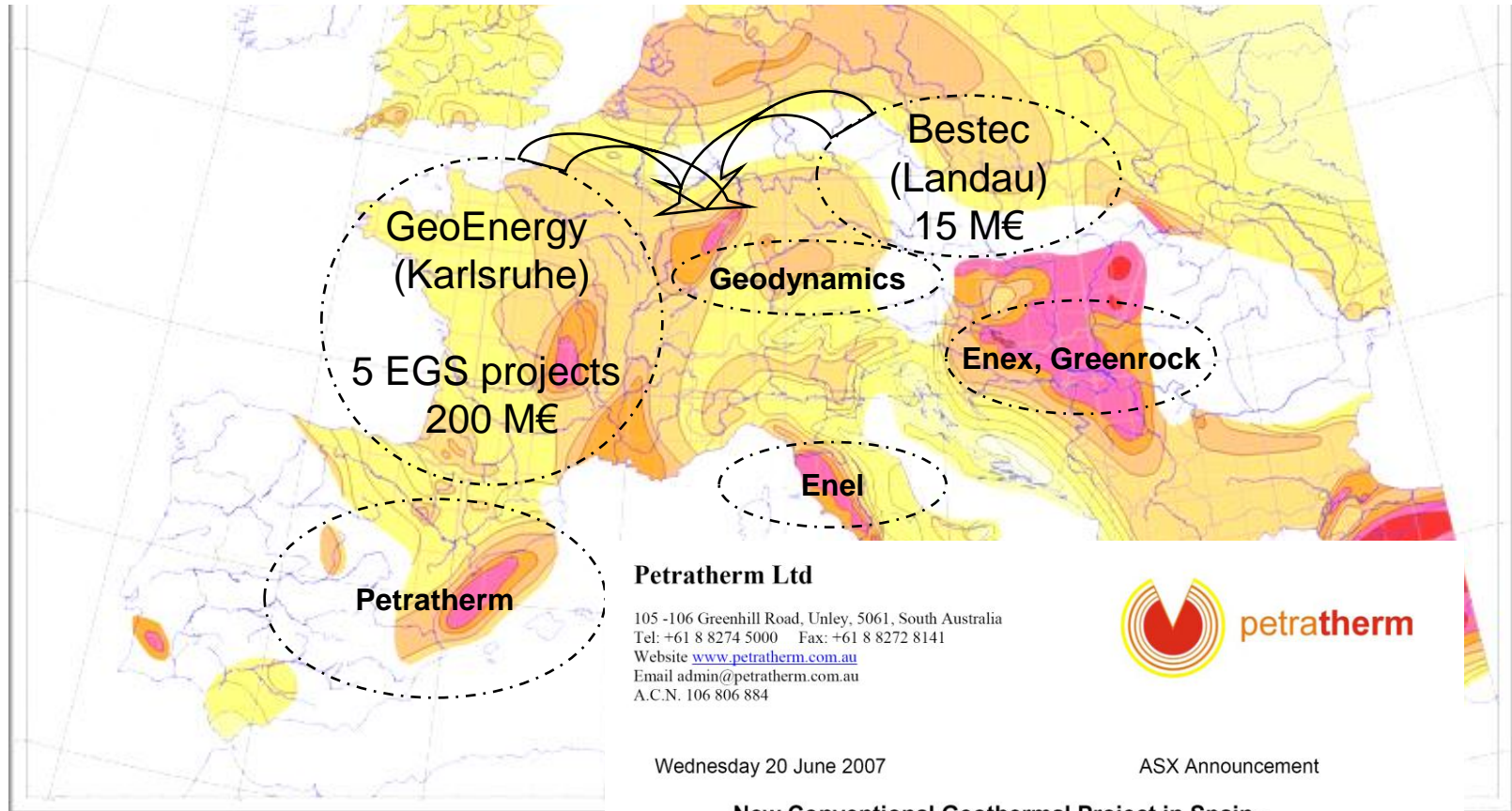
300 Haushalte



A continent explored by new investors...

Why?

- The Soultz sous Forêts case history
- A strategy for exploration based on geological knowledge
- A supported market access for geothermal innovative technologies in Germany
- A guarantee from World Bank to manage risks
- A strategy for raising funds from private investors

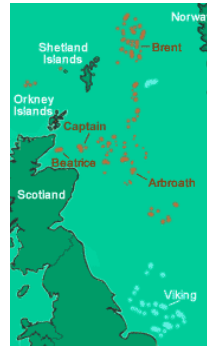


**New Conventional Geothermal Project in Spain -
Tenerife in the Canary Islands**

The use of Oil and Gas wells

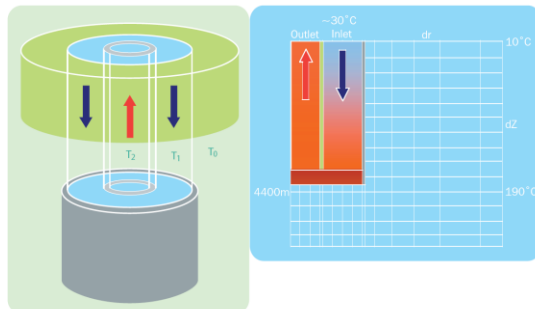
Could we exploit the geothermal potential of North Sea oil fields as their oil runs out? Some have reservoir temperatures over 100°C and so electricity generation might be possible

(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)



US DoE: Electric Power Generation Using Geothermal Energy Co-Produced with Oil and/or Gas Wells



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Electric Power Generation Using Geothermal Energy Co-Produced with Oil and/or Gas Wells



Synopsis

[Full Announcement](#)

[How to Apply](#)

The synopsis for this grant opportunity is detailed below, following this paragraph. This synopsis contains all of the updates to this document that have been posted as of **06/13/2007**. If updates have been made to the opportunity synopsis, update information is provided below the synopsis.

If you would like to receive notifications of changes to the grant opportunity click [send me change notification emails](#). The only thing you need to provide for this service is your email address. No other information is requested.

Any inconsistency between the original printed document and the disk or electronic document shall be resolved by giving precedence to the printed document.

Document Type:	Modification to Previous Grants Notice
Funding Opportunity Number:	DE-PS36-07G097033
Opportunity Category:	Discretionary
Posted Date:	Jun 13, 2007
Creation Date:	Jun 13, 2007
Original Closing Date for Applications:	Jul 31, 2007 In order for the DOE Geothermal Program to meet programmatic goals
Current Closing Date for Applications:	Jul 31, 2007 In order for the DOE Geothermal Program to meet programmatic goals
Archive Date:	Oct 13, 2007
Funding Instrument Type:	Grant
Category of Funding Activity:	Energy
Category Explanation:	
Expected Number of Awards:	
Estimated Total Program Funding:	
Award Ceiling:	\$2 400 000
Award Floor:	\$0
CFDA Number:	81.087 -- Renewable Energy Research and Development
Cost Sharing or Matching Requirement:	Yes

Eligible Applicants

Unrestricted (i.e., open to any type of entity above), subject to any clarification in text field entitled "Additional Information on Eligibility"

Additional Information on Eligibility:

<http://www.grants.gov/search/search.do?oppld=14434&mode=VIEW>



Conclusion: A renewed interest for geothermal resources of deep origin

> R&D task force

- The support of the European Commission
- The ENGINE contribution
- Other International initiatives

> Growing interest of industry and investors

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

- > ENGINE, along with other **coordinating 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.
- > A need for a scientific exchange platform: **a R&D task force for defining research projects** that could be presented to the EU commission as a possible contribution for the future work programme of the FP7
 - A result from the identification of bottlenecks and prioritisation of research needs, a direct contribution of ENGINE
- > A need for a political exchange platform: **an appropriate consortium joining R&D institutes and private investors** (an European Economic Interest Group?)
 - A promotion of past and on-going experiences by making them visible and reproducible
 - A lobby to promote supported market access for geothermal innovative technologies



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

- > A need for an ambitious research program
- > An European geothermal drilling program for demonstrating that EGS can provide continuous base load-power for Europe: 30 EGS projects for the next 15 years?
 - A required convergence between the scientific and political exchange platforms, i.e. a common approach of both scientist and stakeholders
 - Reference to the Soultz experiment and to all specific target research projects for promoting new EGS projects: highly radiogenic reservoirs at depth, extension of existing geothermal fields, geothermal recovery from existing oil and gas operations...



Our proposal is expected...

- > Topic ENERGY.2008.2.4.1: Increased electricity production from Enhanced Geothermal Systems (EGS), including Hot Dry Rock
- > Expected impact: Demonstration of efficient and sustainable electricity production from EGS; reduced costs; better understanding of plant operation
- > Topic ENERGY.2008.2.4.2: Innovative cycles for low/medium temperature geothermal power
- > Expected impact: Increase the range of potentially interesting geothermal sites for exploitation, with reduced capital costs and higher energy conversion efficiency
- > Topic ENERGY.2008.4.3.1: Innovative components and subsystems for geothermal district heating/cooling
- > Expected impact: Increased market penetration of geothermal heat supply, facilitated by affordable and easy-to-use off-the-shelf components tailored to the market needs

