Geothermal R&D, new projects and perspectives for applied as well as basic scientific research

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ABSTRACT

Multinational geothermal research initiatives have been growing significantly over the past few years. Within the framework of the EC funded Horizon 2020 programme, 11 geothermal projects were positively evaluated, 9 already started in September 2017. Together with on-going projects funded from the seventh framework programme FP7, the European Commission have allocated around 82M€ in grants, whereas total project costs are up to 145M€ for the coming years. In addition, several national initiatives complement the European R&D projects. Research proposed in these projects covers aspects along the entire value chain from exploration, drilling and completion, stimulation concepts and monitoring technologies and value added use of brine before reinjection. Although dedicated to increasing the market penetration for geothermal energy - i.e., designed with the perspective of applied research - current projects are lined up to tackle basic research questions as well. The size and diversity of current geothermal research activities is unprecedented in Europe. In order to maximise the impact of these efforts and to use this unique opportunity to bring geothermal energy provision a critical step forward, a close exchange across national as well as project boundaries is of key value. Within this presentation, an overview of the current European research projects will be given.

1. OVERALL SCOPE OF PROJECTS

To increase the market penetration of geothermal energy several national as well as multinational initiatives were established. Their overall goal is to increase the utilization of continental Europe's large geothermal potential which amounts to estimated 50GW, with electricity provision and district heating being the main target for deep geothermal projects, while the provision of heat and chill is in the focus of shallow geothermal projects. To realize the ambitious goal of increasing the amount of electricity provision from currently 1.4GW to 5-6GW in 2020 and 15-30GW in 2030 beside installation of district heating systems to supply heat & chill for industry and large urban areas. Current research activities aim at the development and market introduction of new cost-effective technologies in order to:

- enhance the provision of energy from already identified and utilized resources
- explore new untapped deep seated hydrothermal systems at the large scale
- make engineered geothermal systems ready for market penetration
- access high potential fluids from suitable sources such as active magmatic systems

Beside the technological challenges other aspects of relevance for the further development of geothermal energy require our attention and must be addressed with innovative approaches and tools to:

- improve the risk assessment and management for a reliable evaluation of the technical, environmental and economic sustainability of the projects
- secure the social acceptance of geothermal projects by ensuring that potential site and technology specific side effects are relatively minor compared to the benefits
- provide guidelines to Regulatory Authorities and Policy Makers in Europe for sustainable development of geothermal initiatives

For shallow geothermal systems, some of the key issues include

- Controlled quality and best practice standards for the installations
- the use of the enormous subsurface potential for the seasonal storage of heat & chill
- Development of the next generation of high performance heat pumps for buildings with COPs >5 and with optimized seasonal COPs

2. LIST OF PROJECTS

Below, the different projects are briefly introduced (see also <www.geothermalresearch.eu>. A list of the different projects can be found in Table 1.

Cheap-GSHPs: Cheap and efficient application of reliable ground source heat exchangers and pumps
The basic idea of Cheap-GSHPs project is to substantially reduce the total cost of ownership, composed out of investment and operating costs, increase the safety of shallow geothermal systems during installation and operation and increase the awareness of this technology throughout Europe.

CHPM2030: Combined Heat, Power and Metal extraction from ultra-deep ore bodies
The strategic objective of CHPM2030 is to develop a novel and potentially disruptive technological solution that can help satisfy the European needs for energy and strategic metals in a single interlinked process.

DeepEGS: Deployment of Deep Enhanced Geothermal Systems for Sustainable Energy Business
The goal of the DEEPEGS project is to demonstrate the feasibility of enhanced geothermal systems (EGS) for delivering energy from renewable resources in Europe. Testing of stimulation technologies for EGS in deep wells in different geologies will deliver new innovative solutions and models for the wider deployment of EGS with sufficient permeability for delivering significant amounts of geothermal power across Europe.

DESCRAMBLE: Drilling in dEep, Super-CRitical AMBient of continentaL Europe

The DESCRAMBLE project proposes to drill in continental-crust, super-critical geothermal conditions, and to test and demonstrate novel drilling techniques to control gas emissions, the aggressive environment and the high temperature/pressure expected from the deep fluids.

DESTRESS: Demonstration of soft stimulation treatments of geothermal reservoirs

DESTRESS is aimed at creating EGS (Enhanced geothermal systems) reservoirs with sufficient permeability, fracture orientation and spacing for economic use of underground heat. The concepts are based on experience in previous projects, on scientific progress and developments in other fields, mainly the oil & gas sector.

GEMex Geothermal Cooperation Europe Mexico for EGS and super-hot geothermal systems - ***Coming soon***

GEOTeCH: Geothermal Technology for €conomic Cooling and Heating

GEOTeCH aims at stimulating and promoting greater utilization of renewable heating and cooling using shallow geothermal GSHP systems through advancement of innovative drilling and ground heat exchanger technologies that are significantly more cost-effective, affordable and efficient than current technology.

GeoWell: Innovative materials and designs for long-life high-temperature geothermal wells

New concepts for high-temperature geothermal well technologies are strongly needed to accelerate the development of geothermal resources for power generation in Europe and worldwide in a cost effective and environmentally friendly way. The GeoWell project addresses the major bottlenecks such as high investment and maintenance costs by developing innovative materials and designs that are superior to the state of the art concepts

SURE: Novel Productivity Enhancement Concept for a Sustainable Utilization of a Geothermal Resource

Within the EC funded Horizon 2020 project SURE the radial water jet drilling (RJD) technology is investigated and tested as a method to increase inflow into insufficiently producing geothermal wells.

ThermoDrill: Fast track innovative drilling system for deep geothermal challenges in Europe

The ThermoDrill project is performed by an interdisciplinary team of research institutions and industrial partners from across Europe, who have joined forces to innovate deep geothermal drilling by combining proven and cost-effective technologies into a completely new process. The unique feature of the new concept is that penetration is achieved by a high pressure fluid jet which supports conventional rotary drilling by breaking the rock in front of the bit to increase bit performance. This combination of fluid jetting and rotary drilling is expected to at least double the rate of penetration.

IMAGE: Integrated Methods for Advanced Geothermal Exploration

IMAGE is a European project involving 20 partners from 9 different countries. Goal of the project is to develop an integrated geothermal exploration approach based on state-of-the-art scientific methods. The project is co-funded for four years by the European Commission within the 7th Framework Programme for

Research and Technological Development (FP7) and started on the 1st of November 2013.

Geothermal ERA-NET

The overall objective is the mutual opening up of national research programmes and research infrastructures, and the development of joint activities.

3. CROSS TOPICS

In an attempt to explore synergies between the different on-going geothermal projects, a list of relevant cross topics and associated projects could be defined:

- Database of rock properties: IMAGE, SURE
- Fracture Permeability: IMAGE, CHPM2030, DeepEGS, DESCRAMBLE, DESTRESS, GEMex, SURE
- Stress Field: IMAGE, DeepEGS, DESTRESS, GEMex, SURE
- Simulation; reservoir and/or field scale: IMAGE, DeepEGS, DESCRAMBLE, DESTRESS, GEMex, SURE, ThermoDrill
- Drilling; various approaches: Cheap-GSHPs, DeepEGS, DESCRAMBLE, SURE, ThermoDrill
- Stimulation; Field, Hydraulic/Mechanical, Chemical, Thermal, Drilling; Seismicity: IMAGE, DeepEGS, DESCRAMBLE, DESTRESS, GEMex, SURE
- Well completion; high temperature/pressure wells: DeepEGS, DESCRAMBLE, GEMex, GeoWell
- Sensing/Monitoring: Cheap-GSHPs, DeepEGS, DESCRAMBLE, DESTRESS, GEMex, GeoWell, IMAGE
- Geochemistry: CHPM2030, DESCRAMBLE, GeoWell
- Exploration: IMAGE, GEMex
- Policy and strategy coordination: Geothermal ERA NET

This list is neither exhaustive nor exclusive, but can give a valuable overview about common research interests.

3. CONCLUSIONS

Within the seventh framework programme (FP7) as well as the research and innovation programme Horizon 2020, the European Commission aims at securing Europe's global competitiveness. Several projects along the entire value chain of geothermal energy provision started in recent years. This unprecedented situation presents a unique opportunity to tackle fundamental bottlenecks in developing geothermal projects. In order to maximise the benefit for the geothermal industry a close collaboration across national as well as project boundaries is encouraged.

Some of the projects are very early on in the technology readiness level. In order to demonstrate the applicability of different technological developments, it is essential that the momentum of geothermal research achieved within H2020 will be continued after the end of the current funding period. With so many projects and the large number of research and industry partners involved, a next step should take advantage of the progress made and the resulting synergies in a number of dedicated large-scale demonstration projects

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Table 1: List of EC funded geothermal projects and respective funding scheme

Project Acronym	Project costs (M€)	EC contri-bution (M€)	Funding
Cheap-GSHPs	5.8	4.8	H2020
CHPM2030	4.2	4.2	H2020
DeepEGS	44	20	H2020
DESCRAMBLE	15.6	6.8	H2020
DESTRESS	25	10	H2020
GEMex	10	10	H2020
GEOTeCH	9	7.1	H2020
GeoWell	4.7	4.7	H2020
SURE	6.1	5.9	H2020
ThermoDrill	5.8	5.4	H2020
IMAGE	13.3	10.1	FP7
Geothermal ERA-NET	2.4	2	FP7