

## **Geothermal Training course**

**Pisa**

**from 8 to 11 of October 2012**

**Location: Scuola Superiore Sant'Anna,**

**Piazza Martiri della Libertà, 33**

**Pisa - Italy**

**Programme:**

**Oct. 8 - 9, 2013**

- Technical Course

**Oct. 10, 2013**

- Market aspects
- Legal, environmental, financial aspects

**Oct. 11, 2013**

- Site visit: ENEL geothermal power plant  
Larderello Area

## Day 1, Oct.8, 2013

**8:30 – 8.45**    **Welcome and Introduction**

*Philippe Dumas, European Geothermal Energy Council (EGEC)*

*Adele Manzella, National Research Council (CNR)*

**8.45 – 9.00**    **Participants Introductory ice breaker**

### **Session I: Geothermal Exploration**

*Pierre Durst, Bureau de Recherches Géologiques et Minières (BRGM), France*

*Jan-Diederik van Wees, Organization for Applied Scientific Research (TNO), Netherlands*

*Adele Manzella, CNR IGG, Italy*

*Isabella Nardini, CNR-IGG, Italy*

The session will provide an overview of geothermal exploration methodologies, describing a step-by-step procedure on how to locate a reservoir using different techniques. It will introduce different tools and approaches to investigate resources from regional, local and reservoir scales. Examples will be provided to various geo-environments depending on the geological context of the site: from sedimentary to volcanic to crystalline reservoirs, both for natural system and EGS perspectives.

**9.00 –9.30**    **What is geothermal energy: origin and relation with earth dynamics**

- Thermal phenomena and earth internal structures
- Plate tectonics and geothermal energy
- The different types of geothermal energy

**9.30 – 10.45**    **Resource assessment: targets and tools**

- An overview of targets
- Geophysical methods
- Geochemical methods

**10.45 – 11.15**    **Coffee break**

**11.15 – 13.00**    **Resource assessment: targets and tools**

- Geological and hydrogeological assessment
- Remote sensing
- Stress field analysis for EGS
- Site screening: Best practice to localize a geothermal site
- Case Studies: Various examples from known geothermal systems will be described and discussed

**13.00 – 14.30**    **Lunch**

## Session II: EGS Technology

*Jan-Diederik van Wees, Organization for Applied Scientific Research (TNO), Netherlands*

*Pierre Durst, Bureau de Recherches Géologiques et Minières (BRGM), France*

The session provides an insight into the process of hydraulic fracturing and induced seismicity in EGS projects. Basic concepts of geomechanics and hydraulic fracking, results of hydraulic stimulation and induced seismicity in EGS projects will be covered by lessons learned from the GEISER FP7 project.

### 14.30 – 16.00 Basic concepts

- Rock mechanics and tectonics
- Hydraulic stimulation : objectives, physical principles, and best practices from oil and gas

### 16.00 – 16.30 Coffee Break

### 16.30 – 17.30 Case studies

- Enhancing flow rates
- Induced seismicity
- Outlook
- The Soultz projects: toward the deep geothermal exploitation

### 17.30 – 18.00 Conclusion/Feedback

## Day 2, Oct.9, 2013

## Session III: Plant operation, energy supply and grid integration

*Franz Heilemann, EnBW Energie Baden-Württemberg, Germany*

*Sören Reith, Univeristy of Stuttgart, Germany*

The session provides a broad understanding of the grid integration of geothermal energy. Although electric power cables are the most obvious precondition for a grid connection, many other topics become important in this context. The session will therefore answer beside technical also regulatory and economical questions.

### 9.00 – 10.30 Fundamentals of energy economics

- regulation and energy trade

- electricity grid
- demand for geothermal power

## 10.30 – 11.00 Coffee Break

## 11.00 – 12.00 Grid integration of geothermal power

- approach for the grid integration of an increasing share of renewable power generation
- process of grid integration
- costs of grid integration

## 12.00 – 12.30 Plant operation

- demand for geothermal power
- lesson learned

## 12.30 – 14.00 Lunch

## Session IV: Flash steam & binary technology

*Fabio Sabatelli, ENEL GreenPower, Italy*

*Paola Bombarda, Politecnico Milano, Italy*

The session provides an overview of geothermal power plants with focus on flash and binary thermodynamic cycles, geothermal steam gathering system and mechanical equipment used in the power plant. The course will provide examples and highlight the special features of utilizing geothermal fluid for power generation and different design considerations compared to conventional steam plants.

## 14.00 – 15.30 Flash power plants, gathering systems, equipment, operation and maintenance

- Thermodynamic aspects and optimization of flash cycles
- Main features and issues of gathering systems, power plants and equipment used
- Operation and maintenance aspects

## 15.30 – 16.00 Coffee Break

## 16.00 – 17.30 Binary power plants: thermodynamic cycles and equipment

- Thermodynamic aspects and optimization of binary cycles
- Equipment used in binary power plants

## 17.30 – 18.00 Conclusion / Feedback

## Day 3, Oct.10, 2013

### **Session V: Market aspects**

*Constantine Karytsas, Centre for Renewable Energy Sources and Saving (CRES), Greece*

*Dimitrios Mendrinou, Centre for Renewable Energy Sources and Saving (CRES), Greece*

Geothermal resources of Europe can contribute to the EU targets of 20% less greenhouse gas emissions, 20% RES share and 20% more energy efficiency by 2020. The session provides an overview of the present status and future prospects of global geothermal electricity market niche.

#### **9.00 – 9.45 International Geothermal Market overview**

Market aspects, including:

- market size (turnover, capacities, energy yields)
- near term growth, quality of resources, technologies employed,
- competition, energy costs, market barriers and incentives.

Case studies of plants in operation will be presented.

- First EGS plant: HDR project Soultz
- Low temperature plant: Simbach-Braunau.

### **Session VI: Legal, environmental & financial aspects**

*Fausto Batini, Magma Energy Italia, Italy*

*Florence Jaudin, Bureau de Recherches Géologiques et Minières (BRGM), France*

*Robert Kutschick, Gaßner, Groth, Siederer & Coll., Germany*

*Roberto Barontini, Scuola Superiore Sant'Anna, Italy*

*Matteo Borzoni, Scuola Superiore Sant'Anna, Italy*

*Francesco Rizzi, Scuola Superiore Sant'Anna, Italy*

*Marco Frey, Scuola Superiore Sant'Anna, Italy*

*Isabella Nardini, CNR-IGG, Italy*

Stringent demands of investors and banks require an accurate planning of geothermal power projects; more precisely of the technology and phases of the project and the expected financial inflow and outflow. Risk management specially focuses on drilling risks and evaluates the risks in terms of their probability and economic consequences and prospects of suitable insurance products in Europe. The development of geothermal electricity in Europe depends on national legislations, for investors it is important to know in advance about current legal barriers and law-related conflicts.

#### **9.45– 10.45 Sustainable development of a geothermal project**

- from green field exploration to operation

**10.45 – 11.15 Coffee Break**

**11.15 – 12.00 Risk insurance:**

- risk management: drilling
- existing insurance concepts to cover the geological risk in Europe
- risk insurance scheme at European level

**12.00 – 12.45 Regulatory barriers**

- regulation of geothermal electricity through national legislation
- legal barriers and law-related conflicts

**12.45 – 14.00 Lunch Break**

**14.00 – 15.30 Investment analysis**

- overview on tools and approaches

**15:30 – 16.00 Coffee Break**

**16.00 – 17.00 Investment analysis**

- social multi criteria evaluation

**17:00 – 17.30 Environment issues**

- overview of possible environmental impacts

**17:30 – 18.00 Conclusion/Feedback**

## Day 4, Oct.11, 2013

### **Site visit: ENEL power plant – Larderello area.**

**8:00** Departure (by bus)

**10:00 - 10.40** Visit to the Museum in Larderello

**10:40 – 11:10** Coffee Break

### **Session VII: Drilling**

*Alessandro Lazzarotto, ENEL GreenPower, Italy*

*Luca Serniotti, ENEL GreenPower, Italy*

The session provides a survey of technical solutions and related costs for drilling and completion of geothermal production and reinjection wells.

#### **11.15 – 12.00** Types of geothermal wells and appropriate casing schemes:

A selection of Case Studies

#### **12:00 – 13:00** Drilling and completion of geothermal wells:

- Drilling technology
- Directional and Multilateral drilling
- Costs
- Well and completion design

**13.00 – 13.45** Lunch

#### **13.45 – 15.30** Visit to Power Plant

*Roberto Parri, ENEL GreenPower, Italy*

**15:40** Departure to Pisa

**17:40** Estimated time of arrival in Pisa