



## **ANNEX I**

### **Project Plan**

# **The Icelandic participation in the EU supported project Geothermal Engineering Integrating Mitigation of Induced Seismicity in Reservoir (GEISER)**

Project ID: 09-01-005

Coordinator: Kristján Ágústsson , ISOR

Start date: nn/2010

Duration: 3 years/36 months

Partners:

**List of participants:**

Participant no. *	Participant legal name	Country	Organisation type
1 Coordinator	GFZ - HelmholtzZentrum Potsdam Deutsches GeoForschungsZentrum	Germany	Public research centre
2	BRGM - Bureau de Recherches Géologiques et Minières	France	Governmental institution
3	ISOR - Iceland Geosurvey	Iceland	Self-funded governmental institution
4	TNO - Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek	The Netherlands	Governmental organisation
5	ETHZ – Eidgenössische Technische Hochschule Zürich	Switzerland	University
6	STHY – StatoilHydro	Norway	Industrial Energy company
7	GEOWATT AG	Switzerland	SME geothermal engineering
8	NORSAR	Norway	Public research institute
9	ARMINES	France	Public research institute
10	EOST - École et Observatoire des Sciences de la Terre de Strasbourg	France	University
11	KNMI - Koninklijk Nederlands Meteorologisch Instituut	The Netherlands	governmental organization
12	AMRA - Analisi e Monitoraggio del Rischio Ambientale	Italy	Research consortium
13	INGV – Osservatorio Vesuviano	Italy	Research centre

A group of stakeholders will follow the activities of the project closely and give input, feedback and support by supplying data and information. They will be informed about progress, results and meetings but they do not wish to be actively involved as partners within the consortium.

These stakeholders include: ENEL, Italy; Shell, The Netherlands; Electricité de Strasbourg-Geothermie, France.

## 1 Project description

Attached to the Annex is the proposal to EU with full description of the project. Below are the main topics of the GEISER projects listed and how they will be addressed:

- to understand why seismicity is induced in some cases but not in others;
- to determine the potential hazards depending on geological setting and geographical location;
- to work out licensing and monitoring guidelines for local authorities, which should include a definition of what level of ground motion is acceptable; and
- to develop strategies to fulfil the task of the stimulation and improve the hydraulic properties of the geothermal reservoir without producing large magnitude earthquakes (LME) that pose a threat to buildings and disturb the public.

To address these objectives, *four main topics* are identified:

- 1 Analysis of induced seismicity
- 2 Understanding the geomechanics and processes
- 3 Consequences of induced Seismicity
- 4 Strategies for the mitigation of induced seismicity

The list of work packages in GEISER is:

Work package No <sup>1</sup>	Work package title	Type of activity <sup>2</sup>	Lead partic no. <sup>3</sup>	Lead partic. short name	Person - months <sup>4</sup>	Start month <sup>5</sup>	End month
WP 1	Project management	MGT	1	GFZ	36	1	36
WP 2	Compilation of induced seismicity data from geothermal sites	RTD	3	ISOR	30	1	6
WP 3	Analysis of Induced Seismicity in Geothermal Reservoirs	RTD	1	GFZ	141	1	36
WP 4	Understanding the Geomechanical Causes and Processes of Induced Seismicity	RTD	2	BRGM	150	1	36
WP 5	Seismic hazard assessment	RTD	5	ETHZ	118	1	36
WP 6	Strategies for EGS operations with respect to Induced Seismicity (Mitigation)	RTD	4	TNO	122	1	36
WP 7	Dissemination	RTD	2	BRGM	24	1	36
	TOTAL				621		

## 1.1 Objectives and GEORG WP relevance

The concept and objectives of GEISER is the development of a clean and secure energy supply with greatly reduced carbon dioxide emissions is a central goal of the European Commission's energy policy, which is similar to the overall goal of GEORG. Geothermal energy will play an important role in the world's future energy mix and help reach the goals for 2020 defined by European leaders in March 2007.

The aim of the project is to contribute to the improvement of the concept of Enhanced Geothermal Systems by addressing the need to investigate the role of induced seismicity, which is twofold

- as an instrument to image fluid pathways induced by hydraulic stimulation treatments, which has been done to some extent in previous projects; and
- as an implication of such treatments to potential seismic hazards.

The term *induced seismicity* (IS) refers to typically minor earthquakes and tremors that are caused by human activity altering the stress field of the Earth's crust. IS events are predominantly of very low magnitudes and, in most cases, human activity is merely the trigger for an earthquake that would have occurred naturally in any case but at a later time. Despite there being many similarities between IS and natural earthquakes, there are also

notable differences. The most significant being the aspect of human intervention in natural processes.

WP Number:	Project relevance %
WP 2	20
WP 3	10
WP 4	20
WP 5	
WP 6	50
WP 7	
WP 8	

The objectives according to the WPs of GEORG in the table above will be achieved in the following way:

**WP2:** Research activity and training of a PhD student (**Task 2.1**) with involvement of local and foreign experts (**Task 2.2**).

**WP3:** Hosting workshops (**Subtask 3.1.1**) and organization of seminars (**Subtask 3.1.3**).

**WP4:** The project touches upon several tasks in this work package. In particular **Task 4.1(c)** (Surveys to reveal the deep structure of active geothermal fields), **Task 4.2(a)** (Detailed analysis of focal mechanisms of earthquakes, **Task 4.3(c)** (Microseismic data collection and detailed analysis of seismic activity in geothermal systems).

**WP6:** The main objective of GEISER is coupled to enhancement of geothermal reservoirs which inevitably is associated with seismicity. **Methods to mitigate seismic risk** in such operations are essential part of the project (**Task 6.3**).

**WP8:** Presentation of results and progress will be through standard methods of publications and presentations in conferences with emphasis on mini-conferences to strengthen relationships with Energy Authorities (**Tasks 8.2, 8.3 and 8.4**).

## 2 Work plan and time schedule

The EU project covers three and a half year and the starting date is January 1<sup>st</sup> 2010. The time schedule for the topics supported by GEORG covers three years. ISOR will lead WP2 with Deliverables D2.1 and D2.2 and Milestones number M4 and M6.

## Milestones

Milestone number	Milestone name	Work package(s) involved	Expected date <sup>10</sup>	Means of verification <sup>11</sup>
M1	Kick-off meeting, annual meetings	1,7	1, 12,24	Minutes
M2	Approval of project planning and time schedule	1	2	Report
M3	Consortium agreement in place	1	3	Contract
M4	Final list of sites	2	4	Report
M5	Website accessible	7	4	Website
M6	Database in place	2	6	Database
M7	Description of the role of LME in controlled reservoir stimulation	3,4	24	Report
M8	Guideline for Best Practise	5,6	36	Report
M9	Newsletter	7	3,9,21,30, 35	Report
M10	Final Conference	7	33	Conference

**Deliverables:**

Del. no. <sup>6</sup>	Deliverable name	WP no.	Nature <sup>7</sup>	Dissemination level <sup>8</sup>	Delivery date <sup>9</sup> (proj. month)
D1.1	Project management structure	1	O	PU	1
D1.2	Project planning and time schedule	1	O	PP	2
D1.3	Technical and administrative 6-month progress reports	1	R	PP	36
D2.1	Updated review of literature	2	R	PU	6
D2.2	Accessible meta-database	2	R	CO	6
D3.1	Evaluation of systematic relations between the seismic response to fluid injection and depth, injection pressure, crustal stress state, and local structural geology	3	R	PP	27
D3.2	Source characterisation of LME and their occurrence in time and space	3	R	PU	27
D3.3	Guidelines for techniques/methodologies for seismological investigations to be applied in future EGS operations, developed on the basis of successful analyses of past sequences	3	R	PU	36
D4.1	Catalogue of synthetic events based on numerical modelling with focus on uncertainties	4	R	PU	24
D4.2	Earthquake scenario for the real case in WP5	4	R	PU	24
D4.3	Report on the role of pore pressure changes	4	R	PU	24
D4.4	Report on the role of temperature changes	4	R	PP	24
D4.5	Report on the role of existing fault segments	4	R	PP	24
D4.6	Report on important physical processes and modelling schemes of induced microseismicity with emphasis on the shut-in effect and associated delayed events	4	R	PP	36
D4.7	Scientific publications	4	R	PP	36
D5.1	Report on task 5.1, describing methodologies, results, tests and calibrations	5	R	PU	18
D5.2	Report on task 5.2 describing methodologies, results, tests and calibrations	5	R	PU	24

D5.3	Hazard models for specific test areas	5	R	PU	30
D5.4	Report on task 5.3 describing methodologies, results, tests and calibrations	5	R	PU	30
D5.5	Report on task 5.4 describing methodologies, results, tests and calibrations	5	R	PU	27
D5.6	Input for guidelines for best practice	5	R	PU	33
D6.1	Description of the effect of different stimulation techniques on seismicity and strategies to mitigate induced seismicity	6	R	PU	36
D6.2	Description of optimized monitoring strategy, both for the permanent receiver network and the network specifically installed during stimulation treatments	6	R	PU	36
D6.3	Report summarizing the results of the tasks in form of input and boundary conditions for regulatory guidelines	6	R	PU	36
D6.4	Report on development of public awareness and acceptance	6	R	PP	36
D7.1	Website	7	O	PU	6
D7.2	Meetings, workshop, conferences	7	O	PP, PU	12,24,33
D7.3	Newsletter	7	R	PU	3, 9, 21, 30, 35
D7.4	Publications, science/industry meetings	7	O	PP, PU	36

<sup>6</sup> Deliverable numbers in order of delivery dates. Please use the numbering convention <WP number>.<number of deliverable within that WP>. For example, deliverable 4.2 would be the second deliverable from work package 4.

<sup>7</sup> Please indicate the nature of the deliverable using one of the following codes:

R = Report, P = Prototype, D = Demonstrator, O = Other

<sup>8</sup> Please indicate the dissemination level using one of the following codes:

PU = Public

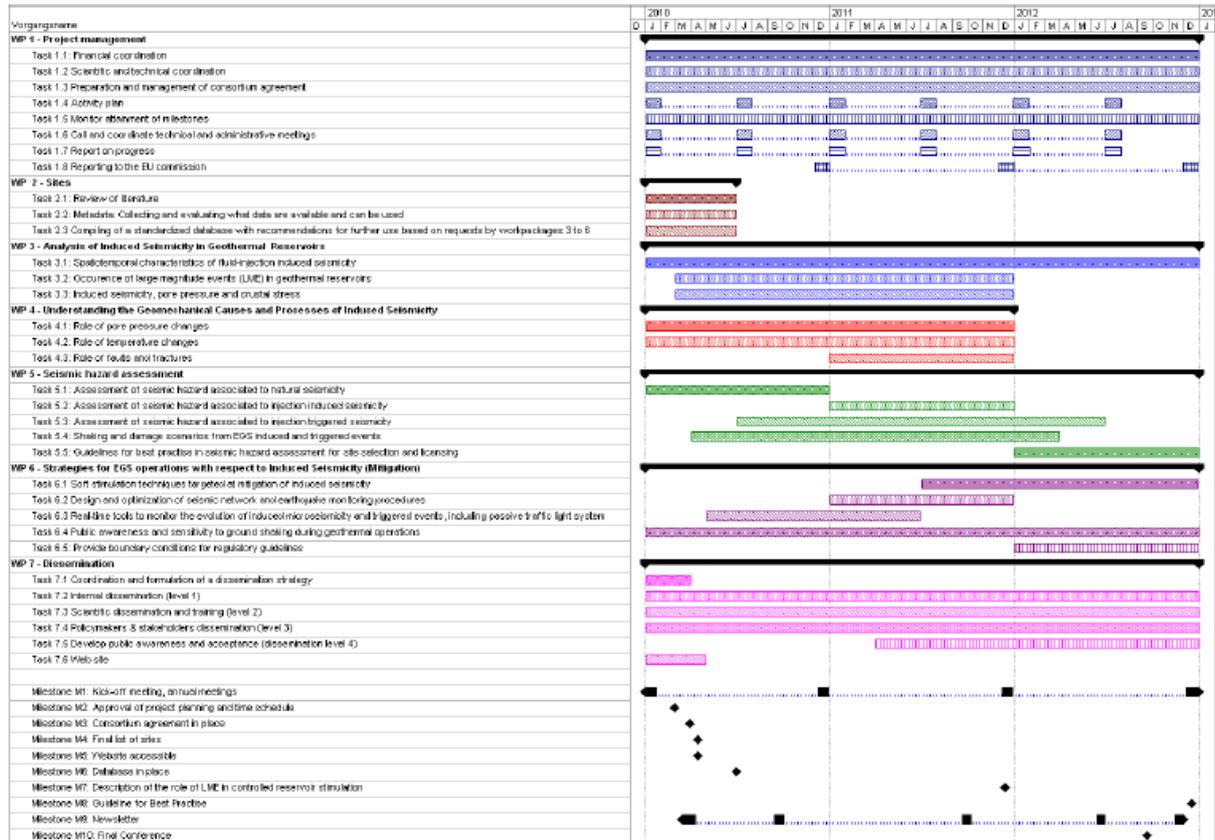
PP = Restricted to other programme participants (including the Commission Services).

RE = Restricted to a group specified by the consortium (including the Commission Services).

CO = Confidential, only for members of the consortium (including the Commission Services).

<sup>9</sup> Measured in months from the project start date (month 1).

## Time schedule:



## 3 Project Management

The co-ordinator of the EU project, GFZ Potsdam, will be responsible for the administration and organisation of the project, providing the organisational platform and professional support for the participants. The project management of the collaborative project will be performed by one co-ordinator, Ernst Huenges, with David Bruhn as project manager. Project management must ensure

- (i) the preparation, start up and closure of the project administration and organisation,
- (ii) the reporting with the Authorities of the 7th Framework,
- (iii) the smooth and streamlined information flow within the consortium, and
- (iv) the controlling duties of the project.

On ISOR's behalf the coordinator for WP2 of GEISER is Kristján Ágústsson.

## 4 Budget overview

