

# *GEO3EN- INTELLECTUAL OUTPUT 8*

Course Syllabus in Geothermal Innovation

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## 1. Introduction

One of the areas that the Geo3en is trying to target through the development of a MSc in Geothermal Engineering is the promotion of innovation and entrepreneurship in geothermal development. As most science and engineering graduates will be involved in research and development of new products, it is important for them to understand the development of a business model for a technical idea.

Entrepreneurship and innovation in geothermal is urgently required to help geothermal contribute to the energy transition. Students will be charged with developing an innovative technical idea in geothermal energy. Some topics the students may work on include district heating and cooling, geothermal fluids, currently under or unused reservoir systems, thermal storage, shallow and low-temperature resources, geothermal gases, cascading use, minerals, machine learning methods and data science, advanced reservoir simulation techniques and integration of geothermal into smart cities.

The proposed course below aims to address how skills and competencies in entrepreneurship and innovation management can be integrated within the future Erasmus Mundus MSc Geothermal Engineering. ULS will contribute to the entrepreneurship portion of the teaching. This course will be available in the baseline courses pool to be selected by the MSc students. This course is not intended to be an introduction to project finance which will be covered by other courses in the course catalogue. This course can be seen below with learning objectives, associated teaching staff, teaching methods, means of evaluation, and associated literature/working material

## 2. Course Syllabus - SE-800-EIG Innovation in Geothermal

**General information:**

**Year of study:** First or second year MSC.

**Semester:** Fall or Spring.

**Level of course:** Second cycle, intermediate.

**Type of course:** Elective.

**Prerequisites:** No prerequisites.

**Schedule:** 25 teaching hours a week for 3 weeks.

**Lecturer:** Dr. Juliet Newson

**Teaching assistant:** Yes

**Learning Outcomes:**

**Knowledge:**

After the course the student shall be able to explain the following terms:

Business plan, design and implementation plan, market analysis, expected sales curve, plan for market implementation, technical feasibility, development of a prototype, calculations of financial need, financing, income, cost, profitability and evaluation of business idea.

The value in geothermal:

- The geothermal resource in terms of heat, fluid (including gas) and host rock
- Common methods of processing geothermal fluid (including classic problem points, & opportunities)
- Geothermal heat: Different forms of heat utilization and relation to heat content.
- Geothermal fluid: chemical content, behavior of solutes
- Case studies in geothermal innovation (including failures)

**1.1. Disciplinary skills:**

On the completion of the course the student shall be able to formulate technically complex ideas with respect to geothermal utilization and develop and implement them for a competitive market. Through case studies in geothermal innovation and their own ideas, the student will learn how to develop ideas through the Canvas Business Model method, build a business plan, feasibility study, carry out a financial plan and test the idea by developing and testing a prototype.

**1.2. Skills:**

Students shall be able to adapt the most important methods in optimizing business opportunities by analyzing current situation and suggesting methods and actions that are likely to lead to optimal results in Innovation. Also, students shall be able to describe how to realize their proposals and partly realize them in the form of working prototype.

**1.3. Personal skills:**

- Apply engineering methods to complex projects, i.e. have the ability to assess engineering projects, identify the key factors in a given situation, and develop an approach to solution.
- Formulate and work on open-ended problems, including creative thinking.
- Formulate a project plan for development and design of an engineering product.
- Integrate theoretical knowledge and practice through critical analysis of a project.
- Realize the limits of his/her expertise and know when it is necessary and appropriate to seek specialist advice.
- Have insight into how to manage all aspects of a project within a team, including conceptual development/design, prototype creation, market analysis, etc. Fabrication, documentation and testing, business plan.
- Manage and motivate people by disciplines of human resource management and provide leadership.

**1.4. Interpersonal skills:**

- Communicate effectively and professionally and formulate sound arguments, both in writing and by means of presentations, using appropriate professional language, including statistics, figures, illustrations, equations, tables and video.
  
- Use time management and work planning related to the organization, implementation and successful completion and reporting of a project.
  
- Be an effective team member and contribute to the management of team projects.
  
- Recognize the interdisciplinary nature of technical problems and work with other professions to arrive at a solution for complex engineering problems, respecting the different skillset of individual team members.
  
- Propose, plan, structure and manage well defined projects involving a team of individuals from different professional disciplines. Prioritize, organize and schedule work activities effectively.

### **1.5. Competence:**

- Possess the knowledge to present and interpret the outcome of a business plan and be able to establish and/or operate minor and innovative geothermal companies.
- Participate in research and product development within the broad field of geothermal science & engineering, recognizing their roles in the innovation process.
- Know how to avoid making mistakes when searching, developing and evaluating geothermal business opportunities.

### **1.6. Description of Course:**

Technology does not exist in isolation but is dependent upon natural sciences, technical feasibility and market need. This is what makes technological development challenging but if it is successful in integrating these factors it can be very rewarding. The objective of this course is to give the student a comprehensive experience of combining these factors for technological innovation, development and marketing.

**To accomplish this, students will go through the conceive, design, implement and operate process with the aim to target market need and ensure technical feasibility.**

The course will cover innovation, entrepreneurship and writing a complete business plan for a „start up“ of a technical, innovative geothermal idea, in light of market needs, research, technical development, planning and financial presumptions. We deal with the terms innovation and entrepreneurship and their significance for modern management. We also cover the value of knowledge, intellectual property and patent rights.

The course will also give an overview of the importance of continuous innovation through technical development processes and market need analysis in relation to product and corporate lifecycles.

**1.7. Evaluation:**

Groups of 5 students deliver a complete business plan including; market research, technical feasibility study and planning the prototype, estimates of capital need and financing and a financial model for running the operation for 3 to 5 years after entering the market.

Assessment methods: Four reports total 62%, final report 16%, verbal exam 22%.

Oral/Verbal exam/project defense takes place at the end of the course, where each group presents their results for 15 minutes, and answer questions from teachers and two examiners for 5 to 10 minutes.

**1.8. Reading material:**

1. Various materials will be used in the tuition supplied by the teacher on CANVAS Learning Management System, also links to websites and various articles connected to the study-material.

2. Handbók Athafnamannsins Gerð rekstrar og viðskiptaáætlana. The process of creating a Business plan, Innovation, Income and cost calculations and analysis, Profitability analysis, Evaluation methods. Author Páll Kr. Pálsson. Skyggni ehf. Sept. 2018.

## 1.9. Teaching and learning activities:

Lectures in classroom on the themes we cover. Students will be split in groups of 5, each group working on their business plan. 6 hours each week for 12 weeks.

**Language of instruction:** English.

### Teaching material:

- Lecturers and notes from teachers uploaded to CANVAS modules for course.
- Various material which will be used in the tuition including links to websites and various articles connected to the study-material.

#### 1.9.1. Reading material:

Kennslufni: HANDBÓK ATHAFNAMANNSINS Gerð rekstrar og viðskiptaáætlana. Chapters 2 and 3 and slides from book; part 1 and 2.

- Preparation; the education program presented and discussed.
- Discussion and analysis of the CDIO methodology: <https://en.wikipedia.org/wiki/CDIO>(Links to an external site.)Links to an external site.(Links to an external site.)Links to an external site.(Links to an external site.) (Links to an external site.)
- Discussion on how to write a business plan and plan the technical development of a prototype and examples from previous courses presented.
- Divide into groups of 5 students each group.
- Presentation of project ideas from academic staff of RU and outside companies.

- Innovation, entrepreneurship, and models for writing business plans and develop prototypes.
- Idea evaluation and selection using simple optimization model and Business-Canvas-model.
- Evaluation of project ideas. The project ideas can originate from academic staff, outside companies or the students themselves.

- Each group picks an idea to work on and presents it to teacher:

1. Complete Canvas Business Model for two or three Ideas.

2. Work-, time-, and cost estimates for the business plan and development of prototype (Report 1; 8%).

- A visit to a startup company (Depending on COVID situation)

Deliverable 1: A preliminary project idea description including motivation, and description of selection process (8%).

Each project group will focus on their project, mainly working together but partly focusing on the market report and partly technical issues, depending on the members strength. All group together in financial models. In each report the project group works together.

## **1.10. Market report:**

### **1.10.1. Reading material:**

Kennslufni: HANDBÓK ATHAFNAMANNSINS Gerð rekstrar og viðskiptaáætlana. Chapters 4 and slides from book; part 3.

Competition analysis, market segmentation, analyzing impact of external factors, Market research, the 4 pts of marketing, create a marketing and sales plan that define future customers and market demands, ending with the predicted sales curve of the solution for the next 3 to 6 years after it enters the market. (Report 2; 18%).

## **1.11. Execution plan - Technical report:**

### **1.11.1. Reading material:**

Kennslufni: HANDBÓK ATHAFNAMANNSINS Gerð rekstrar og viðskiptaáætlana. Chapter 5 and slides from book; part 4.

Technical analysis of the solution and planning of development phase and preparation for production. Main issues to cover: Legal issues concerning product and/or processes. Intellectual property rights. R&D, design, prototypes and testing. Process analyzing and testing. Supporting material (manuals etc.) and training. Analyzing quantity demands, machines and equipment for value creation, premises, space, layout (build or rent), etc. Software systems and other systems needed for value creation. Distribution. Time (Gant, Microsoft Projects etc.) and cost plan for the whole technical process. (Report 3; 18%). See also course description 2018 – Students with specialized engineering background.

Visit to Intellectual Property Rights specialists. Depending on COVID situation

### **1.11.2. Reading material:**

Kennslufni: HANDBÓK ATHAFNAMANNSINS Gerð rekstrar og viðskiptaáætlana. Chapters 6, 7, 9 and 10 and slides from book; part 5, 6, 8 and 9.

Financial models and technical challenges. Estimating total capital need and funding for bringing the solution from idea to market. Revenue and cost estimates, balance sheet and cash flow plan. Also, profitability calculations and -analysis, value estimation and sensitivity analysis and human aspects in building the company and bringing solution successfully to market. (The team, strategy, organizational chart and human resource management). (Report 4; 18%).

Final report 16%  
Verbal exam 22%.

## **3. Conclusion**

It is believed that entrepreneurship learning is of primary in terms of engineering education. The lectures given in the Geo3En program offer all pre requisites for students to become leaders in the geothermal business. This includes a global knowledge in terms of "above surface" and "below surface" engineering and a set of transverse competences where entrepreneurship is at the front line.