

New International Geothermal M.Sc. Program in Iceland

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Keywords: Iceland, geothermal, education, M.Sc.-program, RES, renewable energy

ABSTRACT

In 2006 a new graduate school was established in Iceland concentrating on renewable energy science. The name of the new school is *RES | The School for Renewable Energy Science*, or just *RES*. The school is a private institute, affiliated with the University of Iceland in Reykjavik and the University of Akureyri in Northern Iceland. The new school offers a 1-year (12 months; 90 ECTS) intensive M.Sc. program in renewable energy resources. It started in February 2008 and the first 30 students graduated in February 2009. This new M.Sc. program is one of a kind in the world. All instruction and correspondence are conducted in English. Teaching staff are researchers and professors from affiliated universities, energy experts from engineering and energy consulting firms and power companies in Iceland, and international experts from other research universities and institutes. The students in the geothermal specialization of the school come from all parts of the world and obtain solid theoretical and practical training in a specified field in geothermal research or geothermal utilization. The school fills a gap in geothermal education in offering a concentrated education on M.Sc. level, and is open to students from all countries worldwide.

1. INTRODUCTION

The main academic objective and goal of *RES | The School for Renewable Energy Science* is to offer excellent education programs in renewable energy science and technologies, and to strengthen future cooperation between leading Icelandic and international academic and research institutions in the utilization of renewable energies. Many countries worldwide have recently developed or are in the process of developing ambitious plans to radically increase their usage of renewable energy sources in the near future. An example of such a plan is "Poland's Energy Policy until 2025". To implement such ambitious plans, Eastern European countries are seeking support of local professionals as well as international expertise in renewable energy to establish a new generation of young engineers and scientists, educated abroad and enthusiastic about renewable energy technologies. Another example is increased emphasis on development of geothermal energy and other renewable energy resources in the United States of America.

Iceland has much to offer when it comes to the increasingly important field of renewable energy science, technology, and renewable policy implementation. Over the last few decades a vast knowledge has been built up in Iceland in the utilization of high- and low-temperature geothermal resources as well as hydropower. More recently Iceland has taken a lead in the technology of production, storage, and demonstration of hydrogen as an energy carrier in the transportation sector.

During the course of the 20th century, Iceland changed from being among Europe's poorest countries, to a country with all stationary energy and about 80% of the primary energy coming from indigenous renewable energy sources, the highest of any country. In particular, Icelandic researchers and consultants are regarded as one of the world leading experts in all aspects of geothermal energy utilization. Icelandic researchers have coordinated and participated in a number of European Union (EU) funded projects focusing on sustainable use of renewable energy sources. Therefore, Iceland is an ideal place to educate engineers and scientists in the harnessing and utilization of renewable energy.

By surveying training opportunities in Europe and America, it appeared that very few universities or schools were offering concentrated and comprehensive training on a M.Sc. level in renewable energy. In geothermal there was the UNU Geothermal Training Program in Iceland, that is of only 6 months duration and now only available for students from the developing countries (Fridleifsson, 2005). Further, there was the M.Sc. and Ph.D. program at the Geothermal Institute of the University of Auckland in New Zealand preparing the students for research work in geothermal (Hochstein, 2005). But in 2005 the Geothermal Institute was closed and a new Institute of Earth Science and Engineering was founded. This new institute offers short, 1-3 week long, courses in various topics of geothermal research and a 17 weeks long postgraduate certificate studies in geothermal research.

There seemed to be lack of practical and concentrated M.Sc. program preparing the students for work in the geothermal industry as well as for further study at the PhD level. After some further investigations, the decision was taken to establish a new private institution of higher learning in Iceland, named *RES | The School for Renewable Energy Science*. The school was founded in 2006 and the graduate school started in February 2008 offering an intensive one-year M.Sc. program (90 ECTS) in renewable energy science, including geothermal research.

2. RES | THE SCHOOL FOR RENEWABLE ENERGY SCIENCE

The company Orkuvordur Ltd. is the owner of *RES | The School for Renewable Energy Science*. The company was established early in 2006 and registered in April 20 the same year. Shareholders are several Icelandic companies and institutions. Among them are the Akureyri Municipality, Landsbankinn (the biggest bank in Iceland), KEA Ltd. (investment fund), Landsvirkjun (The National Power Company), RARIK and Nordurorka (power companies), University of Iceland, University of Akureyri, and few smaller partners.

Although Orkuvordur is based on a commercial law, the company has a public character with none-profit aims based on its Articles of Association. The main purpose of

Orkuvordur is to provide higher education and transfer of scientific knowledge in the field of renewable energy science and technologies. The company is based in Akureyri, Northern Iceland.

RES is located within a newly established science park at the Solborg Campus of the University of Akureyri. The picturesque town of Akureyri, is located in the fjord of Eyjafjordur in central North-Iceland, with about 18.000 residents (and 30.000 in the whole Eyjafjordur area), and is the largest community outside the Reykjavik metropolitan.

Iceland is one of the European EFTA countries (Iceland, Norway, Switzerland, Lichtenstein), who are closely affiliated with the European Union (EU). When the East-European countries (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia) became members of the EU a development fund was established jointly by EU and EFTA to support the new member states in fields including utilization of renewable energy resources, higher education, and sustainable development. RES in Iceland and a consortium of Polish technical universities, led by Warsaw University of Technology, obtained a financial support from this development fund, enough to pay the cost of M.Sc. studies at RES for 40 Polish engineering students over a period of two years. This grant and the support from the shareholders made it possible to start RES | The School for Renewable Science in February 2008.

It soon became clear that the interest in a M.Sc. program in renewable science in Iceland was not confined to the East-European countries. There was a great interest from South and West Europe, from Central and South America and from the USA. Hence, RES became right from the start an international school open to students from all countries, both developing and more evolved countries. The only requirement is that the students have a B.Sc. degree and a solid education in engineering or natural sciences (RES, 2009).

2.1 M.Sc. Program Structure

The new M.Sc. Program at RES covers all types of renewable energy resources – geothermal energy (with a particular emphasis on low-temperature utilization), hydropower, wind power, wave (tidal) power, solar energy, biofuels/bioenergy, and also hydrogen as an energy carrier in the transportation sector. The program puts strong emphasis on technical and practical aspects of energy utilization, but also on minimizing environmental impacts of energy use, on energy economics, and energy and environmental policies.

RES is committed to follow the rules and promote the implementation of the Bologna process, which is an EU initiative to harmonize higher education in Europe. It includes the use of the European Credit Transfer and Accumulation System or ECTS, which makes teaching and learning more transparent and facilitates the recognition of studies. The system is used across Europe for credit transfer (student mobility) and credit accumulation from various universities into one degree. The system assumes the principle that the workload of a full-time study for one year in two semesters (1500-1800 hours) corresponds to 60 ECTS credits. One ECTS credits, stands for around 25-30 working hours, and one-week intensive module is therefore worth 2 ECTS. For further details, see reference EU (2009). The new M.Sc. program is an intensive one-year (12 month, without major breaks) program of study, and carries 90

ECTS credits. All instruction and correspondence is in English.

The year is divided into three parts or trimesters, each carrying 30 ECTS credits. All M.Sc. courses are in the form of condensed teaching modules of 1-3 weeks duration. Students take only one module at a time, and attend lectures for up to 4 hours each day, in addition to daily lab-exercises and demonstrations in the utilization of renewable energy, for additional 3-4 hours.

2.1.1 First Trimester

During the first trimester (15 weeks; February - June) the students take 30 ECTS credits. Courses include an introduction and comparison of the main physical/chemical properties, technologies, and distribution, of various energy sources, i.e. fossil fuels (oil, natural gas, and coal), nuclear power, and various types of renewable energy sources. Remaining teaching modules cover the methodology of energy research; methods of exploration, exploitation, and technical aspects regarding utilization of different forms of renewable energy; life-cycle assessment (LCA), cost-benefit analysis (CBA), and environmental impact assessments of renewable energy use.

As part of the first trimester, site visits are to various geothermal fields in Iceland (low-temperature and high-temperature, to geothermal power plants, geothermal district heating systems, to a Kalina power plant, hydropower plants, a methane production plant, hydrogen fueling station, and visits to energy and engineering firms as well as research institutions.

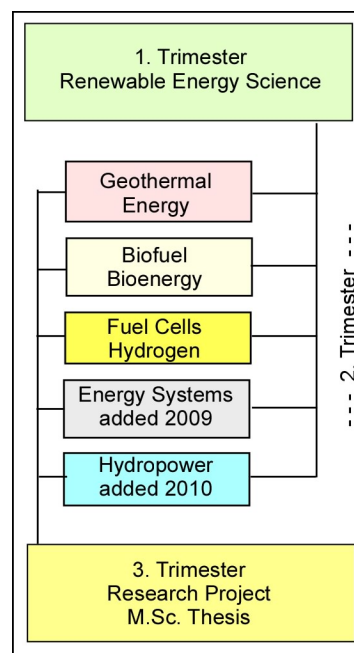


Figure 1: The figure above shows the main structure of the 12 month M.Sc. program at RES | The School for Renewable Energy in Iceland. The first trimester is common for all students. In the 2nd trimester students split into five specializations and in the 3rd trimester the students write and defend their Master degree thesis.

2.1.2 Second Trimester

During the second semester (15 weeks; June - September) the students take another 30 ECTS credits. Emphasis is on a more detailed analysis of renewable energy production and

energy use, as well as on feasibility studies of various renewable energy sources. During this trimester, the students are divided into different fields of specialization, concentrating on one particular type of renewable energy source or energy systems. In the first year of the school in 2008, three lines of specialization were offered, i.e. Geothermal Energy, Biofuel & Bioenergy, and Fuel Cell Systems & Hydrogen. In 2009 an additional line in Energy Systems (integrated or hybrid energy systems) was added to the program and in 2010 the fifth specialization will be Hydropower. Concentrations in Wind & Wave (Tidal) Power and Solar Energy are planned for the near future.

2.1.3 Third Trimester

During the third and last trimester (15 weeks; September - February) M.Sc. students must complete their 30 ECTS Master Thesis, under the supervision of professors. The thesis supervisors may come from RES, University of Iceland, University of Akureyri, energy and engineering firms, the power industry, or professors from foreign research universities and institutes affiliated with RES. The accepted final thesis (manuscript) needs to be of near publishable quality in a peer-reviewed journal. Each student must present his/her findings with a formal presentation at RES and at our foreign partner academic institution involved in the project.

2.2 Admission Criteria

A minimum requirement for admission to the M.Sc. Program in Renewable Energy Science at RES is a B.Sc. degree with top grades in engineering or physical/natural sciences (chemistry, physics, geology and related fields). Some of our students have already completed their Masters, and are seeking a second master in renewable energy science and/or are using the course work and research in Iceland as part of their PhD studies at their home institutions. An admission committee reviews the student applications, transcripts, and interviews students for the final selection.

Students will have to demonstrate a good understanding of English, both in reading and writing and must prove their ability to follow a postgraduate course in English. Non-native English speaking students who did not follow a university degree conducted in English must take the TOEFL exam and obtain a score of at least 80 or provide RES with another equivalent exam as prove of sufficient understanding of English.

The selection process is competitive as a maximum of only 50-60 students will be accepted to the school each year from our foreign partner universities, at least during the first few years of operation. A great number of the students come from eastern, central and southern European countries on full scholarships (i.e. EFTA support). Other students with top grades may get scholarships from RES or have only to pay reduced tuition fees whereas others pay the total cost themselves or have grants from their home countries.

2.3 Accreditation

RES graduates get their degrees from the University of Iceland and University of Akureyri. Both Universities are accredited higher education institutions by the standardized European Union Quality Control and Accreditation System, and are jointly responsible for the admission of students, the academic programs, and for awarding of RES's Masters Degree.

Part of the master's degree studies (i.e. third trimester) can be pursued at other universities or accredited research or scientific institutes, on approval of the parties concerned. Detailed description of the study program, its structure and learning outcomes are attached to the graduation certificate according to EU requirements. This makes it easier for the students to incorporate their studies at RES into further studies at their home universities or elsewhere at other universities.

RES students graduate with the M.Sc. Degree in Renewable Energy Science.

2.4 RES-net – A Network of Partner Universities and Research Institutions

RES has already established partnerships with some of the best technical universities in Europe, United States and elsewhere in the world to actively participate in the buildup of a strong graduate program in renewable energy science and technology. RES is also collaborating with a number of key institutions and companies in Iceland, which are in the forefront of renewable energy research, as well as researchers from key institutions in Western Europe, the United States, Canada, and the other Scandinavian countries.

Some of our leading partner universities include the following institutions: Warsaw University of Technology (Poland), AGH University of Science & Technology (Poland), Technical University of Ostrava (Czech Republic), Technical University of Kosice (Slovakia), Eotvos Lorand University (Hungary), University of Ljubljana (Slovenia), The Technical University of Lisbon (Portugal), Tallinn Technical University (Estonia), Kaunas University of Technology (Lithuania), Tecnologico de Monterrey (Mexico), Universidad Tecnica Federico Santa Maria (Chile), Technical University of Darmstadt (Germany), University of Padova (Italy), Colorado School of Mines (USA), University of Connecticut - Global Fuel Cell Center (USA), Upper Austria University of Applied Sciences (Austria), Norwegian University of Science & Technology, and many others.

2.5 Teaching Staff

Teaching staff are researchers and professors from RES, the University of Akureyri, University of Iceland, energy experts from engineering and energy consulting firms in Iceland such as Mannvit Engineering and ISOR - Iceland Geo-Survey, as well as international experts and professors from foreign research universities and institutes. In 2009 a total of 65 professors taught in the RES M.Sc. program, 25 from Iceland and 40 foreign professors. Largest number of foreign visiting professors came from the United States, representing universities such as Columbia University, MIT, University of Colorado at Boulder, Colorado School of Mines, Case Western Reserve University, UCA at Davis, University of Massachusetts, University of Connecticut, and University of Maine. Other visiting professors came from leading universities in Norway, Sweden, Portugal, Poland, Slovakia, Brazil, Germany, Italy, Czech Republic, and Switzerland.

3. THE GEOTHERMAL ENERGY SPECIALISATION AT RES

3.1 Iceland and Geothermal Energy

Iceland is known for its world renowned knowledge and experience in the utilization of geothermal energy, both for space heating and for electricity generation. Further, geo-

thermal water is used directly in Iceland in industry, green-houses, swimming pools and spas, fish farming, and for snow melting. Students of the M.Sc. program get acquainted with all these different ways of geothermal utilization in Iceland.

Subsequently, RES is an ideal place to educate engineers and scientists in the harnessing and use of geothermal energy sources. The M.Sc. program is built around this sound knowledge and expertise, which along with an acclaimed international faculty, ensures high standard and quality. First Trimester courses and teachers are listed in Table 1.

Table 1: Renewable Energy Science - First Trimester

RES601 Energy - Past, Present, and Future
<i>Dr. Dean Abrahamson</i>
RES602 Energy Technologies - Conversion, Storage & Energy Systems
<i>Dr. Piotr Furmanski, Dr. Dusan Holoubek, Dr. Roman Domanski</i>
RES604 Life-Cycle Assessment & Energy Efficiency Analysis
<i>Dr. Paulo Ferrao, Dr. Sergio Pacca</i>
RES603 Carbon Capture & Sequestration Technologies
<i>Dr. Klaus Lackner, Dr. Sigurdur R. Gislason</i>
RES605 Geothermal Energy
<i>Dr. Axel Bjornsson, Dr. Hrefna Kristmannsdottir, Dr. Pall Valdimarsson</i>
RES606 Fuel Cell Systems & Technologies
<i>Dr. S. David Dvorak, Dr. Thorsteinn I. Sigfusson</i>
RES607 Hydropower
<i>Dr. Jonas Eliasson</i>
RES608 Biofuels & Bioenergy
<i>Dr. Johann Orlygsson, Mr. Asgeir Ivarsson, Ms. Agusta S. Loftsdottir</i>
RES609 Solar Energy
<i>Dr. Michael J. Brandemuehl</i>
RES610 Wind & Wave (Tidal) Power
<i>Dr. Hans C. Soerensen</i>
RES611 Study Tour
<i>Dr. Axel Bjornsson, Dr. Hrefna Kristmannsdottir, Dr. Johann Orlygsson, Dr. Thorsteinn I. Sigfusson, Dr. Jonas Eliasson</i>

3.2 Geothermal Courses – Second Trimester

Following the completion of the first trimester at RES (see Table1) students attend courses in their chosen field of specialization. In the Geothermal Energy concentration students complete seven courses, each 1 to 3 weeks in duration. Here students obtain a thorough understanding of the nature of various geothermal systems in different geological settings, overview over geological, geophysical and geochemical exploration methods, various drilling techniques and geophysical and geological logging of wells.

Further, they will obtain a basic knowledge of reservoir physics, well-test analysis and monitoring of geothermal exploitation and forecasting reservoir productivity. They will be able to construct conceptual models of geothermal systems and know how to visualize various geothermal data (i.e. with PETREL software).

The students will learn about direct and indirect use of low-medium- and high-temperature geothermal water and steam in heating and/or cooling systems and for other utilizations like swimming pools, health spas, aquaculture and various industrial processes. They will also have obtained thorough insight into the design and operation of various types of geothermal turbines like steam and binary-cycle turbines in power plants and combined heat and power plants (CHP).

Most of the professors within the geothermal specialization come from Iceland but few are from USA, Germany, Slovakia, Norway and Sweden. In 2008 a total of 14 students attended the Geothermal Energy specialization (out of 30 Master students at RES) and in 2009 the number was 15 out of a total of 38 students. So far, the geothermal students come from the following countries: Iceland, United States, Mexico, Kazakhstan, Hungary, Slovakia, Poland, Chile, Germany, and Russia.

During the second trimester, along with the course work, the students also start planning their Master thesis projects, complete thesis proposals, and find appropriate supervisors for their projects in cooperation with the academic staff at RES.

Following is a short description of courses offered in the Geothermal Energy specialization, including the names of the professors, during the second trimester in 2009:

GEO601: Geothermal Systems

Course Description: Main characteristics of low-, medium- and high-enthalpy geothermal reservoirs in various tectonic settings, including thick continental sediment basins, continental and oceanic rifts. Hydrothermal aquifers; magmatic systems; fracture zone systems; hot dry rock (HDR); enhanced geothermal systems (EGS); and deep geothermal resources. Introduction of deep geothermal drilling; of deep geothermal projects; reservoir simulation; and man-made seismicity. Evaluation and analysis of geological-, geophysical-, and geochemical models of low- and high- temperature geothermal systems.

Course Duration: 1 week. ECTS Credits: 2

Time Schedule: 15 - 20 June

Professor: Dr. Ingo Sass (Germany)

GEO602: Geothermal Exploration Techniques

Course Description: Geophysical methods to identify structural and tectonic features, alteration/metamorphic zones and hydro-geological characteristics. Methods include heat flow surveys; DC-resistivity depth soundings and profiling; EM and MT surveys; magnetic surveys, earthquake monitoring; seismic measurements and seismic reflection. Fundamentals of chemical properties of geothermal fluids. Review of chemical thermodynamics and heat and mass transfer related to geothermal utilization. Geochemical methods used to evaluate the chemical composition of geothermal fluids and gases; methods of sampling, analysis and interpretation of results. Geothermometers. Estimation of fluid flow and mixing in geothermal reservoirs.

Course Duration: 3 weeks. ECTS Credits: 6

Time Schedule: 22 June - 10 July

Professors: Dr. Laust Borsting Pedersen (Sweden),

Dr. Andri Stefansson, Dr. Hrefna Kristmannsdottir,

Dr. Axel Bjornsson

GEO603: Drilling Techniques and Logging Methods

Course Description: Drilling equipment, methods and technology; advanced drilling techniques; design of wells and casing programs, cementing techniques, cleaning and repairs of production wells; and well maintenance. Iceland's Deep Drilling Project (IDDP). Borehole geology and interpretation of alteration mineralogy of drill cuttings and cores; geophysical well logging; 3D imaging; fracture imaging; stress orientation and stress characterization; and hydraulic fracturing.

Course Duration: 2 weeks. ECTS Credits: 4
Time Schedule: 13 - 24 July
Professors: Dr. Nichols Davatzes (USA), Mr. Sverrir Thorhallsson, Dr. Hrefna Kristmannsdottir

GEO604: Reservoir Physics, Well-Test Analysis, Monitoring & Forecasting

Course Description: Reservoir physics, including hydrological characteristics and water storage capacity, conceptual models of heat and mass flow within geothermal reservoirs, and assessing the hot water and power production capacity (reserve estimation). Production engineering and flow characteristics in wells. Deliverability, flow rates and pressure. Pressure profiles in reservoirs and reservoir performance; inflow performance of water and steam; pressure profiles in wells for water, steam and two-phase flow; artificial lift and pressure profiles; well-test analysis including down-well surveys and discharge. Physical and chemical monitoring of geothermal reservoirs; monitoring parameters. Real-time monitoring and modeling, model updates, and optimal production strategies. Sustainable utilization and forecasting the long-term response of reservoirs to exploitation; effects of fluid re-injection.

Course Duration: 3 weeks. ECTS Credits: 6
Time Schedule: 27 July - 14 August
Professors: Dr. Jon Steinar Gudmundsson (Norway), Dr. Jonas Eliasson, Dr. Gudni Axelsson, Dr. Hrefna Kristmannsdottir

GEO605: Direct and Indirect Use of Geothermal Resources

Course Description: Geotechnical and hydro-geological ground investigation, engineering design, operation and maintenance of shallow geothermal systems. Capital and O&M costs. Cost comparison with conventional heating systems. Geothermal heat pumps (GHP), borehole heat exchangers (BHE) and coupled GHPs. Geothermal ground-water well systems; heat pipe heat-exchangers; analytical and numerical design of borehole heat exchanger fields. Heating and cooling systems. Geothermal response test (GRT), enhanced geothermal response test (EGRT), and geothermal site investigation in the field and in the laboratory. Design of pipe network and of pipe material. Utilization of geothermal energy for swimming pools and health spas, greenhouses and agriculture production, fish farming and aquaculture, snow-melting, and various industrial processes.

Course Duration: 2 weeks. ECTS Credits: 4
Time Schedule: 17 - 28 August
Professors: Dr. Ingo Sass (Germany), Dr. Pall Valdimarsson

EO606: 3D Visualization and Modeling Techniques

Course Description: Introduction to visualization techniques of spatial data, history, development, applications and possibilities. Pre-modeling data preparation and management. 2D/3D gridding; modeling of fault geometries, building stratigraphic sequences, constructing final 3D volumes, data output, and 2D digitizing operations. Methods of 3D geological model building based on surface data, seismic data, model analysis, validation and understanding. Determining borehole design and positioning. Introduction to the advanced mapping software PETREL and geological models; case studies from Europe of 3D model building. Tutorial on data analysis, statistics, learned workflows, export formats, validation and evaluation of calculated models.

Course Duration: 2 weeks. ECTS Credits: 4
Time Schedule: 31 August - 11 September
Professor: Dr. Juraj Janocko (Slovakia)

GEO607: Geothermal Power Plants

Course Description: The design, thermodynamics performance, and economics of geothermal power plants for electricity generation – direct (dry) steam plants, single-, double-, and multiple-flash plants; binary-cycle plants, hybrid plants (including Kalina), and combined heat and power (CHP) plants. Power plant efficiency. Power plant equipment or components including turbines, generators, condensers/evaporators/heat exchangers, separators, pipes, pumps production/injection wells, etc. Corrosion or scaling potential. Capital cost, operation and maintenance (O&M) costs. Environmental impacts of geothermal utilization, and mitigation.

Course Duration: 2 week. ECTS Credits: 4
Time Schedule: 14 - 25 September
Professor: Dr. Ron DiPippo (USA)

3.3 Geothermal Thesis Projects – Third Trimester

During the third and last trimester students complete their Master's Thesis (30 ECTS) under the guidance of one or more thesis supervisors. RES's specialization coordinators work closely with students and their thesis supervisors during this trimester. Each student has his/her own thesis committee, composed of the academic coordinator(s), the thesis supervisor(s), and an external examiner appointed by RES's Academic Board.

Below are names and thesis topics of students that graduated from RES's Geothermal Energy specialization in February 2009:

Mr. Mateusz Tatys (Poland): Design of a CO₂-Heat Pump System

Mr. Pawel Lech (Poland): A New Geothermal Cooling-Heating System for Buildings

Mr. Maciej Lukawski (Poland): Design and Optimization of Small ORC Power Plant for European Conditions

Ms. Kriztina Marosvolgyi (Hungary): Study of High-Temperature Alteration in Drill Cores from the Theistareykir Geothermal Field in North-Iceland

Ms. Lucia Hlavacova (Slovakia): 3-D Modeling of a Geothermal Reservoir in PETREL: Case Study from the Subtatic Basin, Western Carpatians, Slovakia

Ms. Erin Anderson (United States): Aluminum Alloy Drill Pipes (ADPs) in Geothermal Drilling: A Technical & Economical Feasibility Study

Mr. Peter Whittaker (United States): Corrosion and Materials Selection in the Kalina Cycle Process

Ms. Dorottya Bartucz (Hungary): Exploration of Geothermal Systems with PETREL 3D Modeling Software

Ms. Julia Johannsson (Russia/Iceland): Theistareykir High-Temperature Geothermal Field, North-Iceland: Estimation of Reservoir Conditions & Evaluation of Pressure Interference between Wells

Mr. Sebastian Homuth (Germany): Iceland Deep Drilling Project's (IDDP's) Risk Management & Contingency Planning

Mr. Michal Pachocki (Poland): *Akureyri's Geothermal District Heating System: An Optimization Study*

Ms. Katarina Kamenska (Slovakia): *3D Modeling & Properties of a Geothermal Reservoir in the Kosice Basin of Eastern Slovakia*

Mr. Gabor Rajnai (Hungary): *Well Design & Well Completion under Acidic Conditions*

Ms. Martina Kopunicova (Slovakia): *Feasibility Study of ORC and Kalina Cycle Systems in Slovakia*

CONCLUSIONS

All who participated in the first year of RES, administrative staff, academic staff, teachers and students agreed that it first year of operation was a great success. All the 30 graduates returned home to their home universities and were able to incorporate the knowledge they obtained at RES into further academic studies or new jobs. All professors who participated in the first year were willing to come again and teach the second time in 2009.

During the second year there are 38 M.Sc. Degree candidates studying at RES, thereof 15 within Geothermal Energy. In addition, a number of students attend individual courses and even whole trimesters in 2009. These part-time

students are either university students or employees of engineering companies or experts from the power industry who seek information outside their own field of expertise, or want to broaden their knowledge.

The staff of RES observes increasing interest in this new M.Sc. program. Hence, the future is bright and still more students are expected in 2010.

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Figure 2: The figure shows the Class of 2009 at RES celebrating their graduation on the 20th of February, 2009