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GEOTHERMAL TRAINING PROGRAMME

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PRELIMINARY PLANS FOR GEOTHERMAL TRAINING PROGRAMME IN TIANJIN

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ABSTRACT

The United Nations University Geothermal Training Programme has been a success in transferring geothermal knowledge during the last decades. Ideas of enhancing technology transfer as well as sharing experience by a similar, albeit shorter program in China have been discussed with two parties in Tianjin. In the following text the suggested three week training program is described in detail. The target groups for this program will be system operating engineers from geothermal energy companies, utilization designers and engineers from design institutes and energy companies, geothermal field specialists from research institutes and energy companies, and possibly management from geothermal energy companies. Earliest possible start for this training would be in 2009 or 2010, depending on discussion with the Chinese counterparts.

1. INTRODUCTION

The United Nations University Geothermal Training Programme (UNU-GTP) in Iceland has been a success. Fellows from all over the world have come to Iceland, and have shared their experience and knowledge during their study period. The study content has been both theoretical as well as practical, so the fellows have been participating in work in the field of geothermal research in Iceland.

A very valuable network of former fellows now exists, and it is sufficient to look at the UNU-GTP alumni on the participation list for this lecture series to see this.

The experience gained from the UNU-GTP has proves that it will be beneficial to have a shorter training program in the most important geothermal countries. In these training programmes the training would be focused on the country, with the goal of increasing knowledge for the people working in the geothermal industry. The curricula would be based on the experience from UNU-GTP, and the teachers would be local or international, as required. Furthermore, local teachers would be trained during the first years of operation for such a training program.

Preliminary plans have thus been made to establish a training program in Tianjin, as a co-operation between the UNU-GTP in Iceland, TBGMED and Tianjin University (GRTC).

2. TARGET GROUPS AND TEACHERS

The target groups will be as follows:

1) System operating engineers from geothermal energy companies
2) Utilization designers and engineers from design institutes and energy companies
3) Geothermal field specialists from research institutes and energy companies
4) Management from geothermal energy companies.

The teachers should mainly be from the Chinese institutes. International teachers are planned for those parts of the teaching where they are needed, and at the same time Chinese teachers would be trained for these parts, so that the program would be taught by Chinese teachers in Chinese for Chinese students after the first few years of operation. International lecturers would then be used to strengthen new areas within the program, as considered necessary.

The training program will be good to prepare the students for further studies in the geothermal field in other countries.

3. THE PROGRAM

The intended program is a three week program, giving insight into the field, presenting the theoretical foundations as well as introducing new development in the area.

The first week of training as well as the last day will be common for all target groups. Lectures will be combined with exercises, setting time aside for discussion of the exercises.

3.1 The curriculum common for all target groups

The first week of the training will be common for all target groups. The training will start with an introduction to the field, introducing the state of the art in geothermal utilisation and research. An overview of the energy outlook will be given as well as a discussion of the role of geothermal energy in future development.

The basic concepts of geothermal utilization are then treated. The basic concepts of geothermal utilisation and exploration, and the foundations of reservoir engineering and management are presented. Key words such as thermal gradient and field productivity are explained. The effect on the environment and improvement of the sustainability of the reservoir by re-injection will also be treated.

The field utilization is treated, with concepts such as drawdown, well life without and with re-injection, which highlights the importance of reservoir management. Re-injection is treated, the theoretical foundations as well as common practical problems. Chemical considerations in the re-injection are studied, as well as the requirement of filtering solid particles from the re-injected fluid.

The utilisation in district heating is discussed. Heat load calculations are explained, as well as the load duration, both for tap water production and heating load. Different building heating methods are discussed, and their suitability for geothermal district heating. The well production, maximum well production and determination of required number of wells is treated. Peak load is analysed, and reasons for peaks in the load are explained.

The economics of geothermal utilisation are treated. Investment cost is the most important factor in ensuring economical operation, so investment cost and its relation to peak load is discussed.

Investment cost figures for the whole chain from the reservoir to the building radiator are presented, as well as peak load cost. The operating cost of geothermal district heating is covered. Determination of required income to cover investment and operation cost is treated, tariffs and their types, and the profitability in general.

This first common part of the program concludes with a summary, an exercise session and discussion of the exercises.

At the end of the program there is a common day. This part revolves more around project management of geothermal utilisation. In this part the following key words are treated:

- The project process in general
- Preliminary study
- Preliminary design
- Final design
- Tenders for work, material and equipment
- Requirements for contractors and vendors
- Quality control
- Communication, decision making
- Organization and division of responsibility

3.2 Curriculum special for system operating engineers from geothermal energy companies

Components and equipment for geothermal utilisation are discussed, electrical and non-electrical equipment. A further treatment of the installation of electrical systems, electrical grounding and safety in electrical systems is made.

Drilling, wells and casings are then treated. Piping for mud, temperature measurement and geological analysis as well as well engineering is covered. The operation of wells is covered, boiling in well, well pressure drop, well pumps and installation (non-return valves). The benefits and disadvantages of pump frequency control are covered.

Field piping system and transmission pipes are discussed. Nomograms for flow calculations are presented, and thermal expansion and forces in the piping system are explained. Welding and weld ability of different materials is covered. Piping system types (floating or fixed) is covered, and benefits and disadvantages discussed. Insulation and pipe connections, installation, pressure tests and operational requirements are discussed. The necessary system maintenance is covered.

The pumping stations are discussed, their purpose and equipment required. De-aerators for gas removal are discussed, as well as required sensors for flow and pressure control. Testing pumps and pumping systems is covered.

Heat exchangers are treated, and their control and control valves. The maintenance of equipment is covered, care and preventive maintenance is discussed. Monitoring of the equipment is discussed, both as a general part in ensuring reliability and good economics of operation as well as part of a preventive maintenance system.

A large laboratory exercise is performed, covering pump and heat exchanger tests. Analysis of test data is done after the exercise, and a few days given for this work. During these days lectures will be held on heating of buildings.

There radiators, fan units, floor heating and air heating will be covered. Building connection stations are studied, and different principles analysed. Cost figures for the building systems are presented, effectiveness of the systems, and ”common practise” in the design and operation is covered.

The control of building systems is discussed. Hydraulic balancing of radiator systems, alternative control strategies and methods is treated. One line systems are compared to supply/return systems (serial versus parallel radiator coupling). Heat pumps and heat pump systems are briefly introduced.

Then the results of the pump and heat exchanger test exercise are presented and evaluated. The student reports are discussed.

This concludes the special part of the program for the system operating engineers.

3.3 Curriculum special for utilization designers and engineers from design institutes and energy companies

The specialised part starts by focusing on design of geothermal wells. The design in general, casings and wellheads are discussed. Well pumps and pump control, filters, sensors and sensor locations, as well as re-injection is covered.

Geothermal field piping design, pressure drop and system layout and location for collection and heat exchanger stations is covered. Heat exchangers, parallel flow and counter-flow, shell and tube versus plate heat exchangers are covered. The control required is discussed, as well as material required and its cost.

Design of pumping stations is the next item. Pumps and equipment needed, air bleeding, speed control, theory and practical experience is covered. The system pressure control, including supply and return pressure control in order to keep required consumer pressure difference is treated.

Duration and load duration curves are explained, for flow, building heat load, pumping station load and distribution network loss. The concept of network transmission effectiveness is introduced, and an exercise is done on the system heat loss.

A similar laboratory exercise as for the system engineers is performed. It involves pumps, heat exchangers, control valves and, data analysis of the results.

Thermodynamic analysis of the systems is included. Thermal analysis regarding supply and return temperature, and the building, water and radiator equations are presented and solved. Constant and variable supply temperature is analysed as well as its influence on the return temperature. Equipment required for different supply temperature strategies is discussed, and its benefits and disadvantages.

Heat pumps and heat pump systems are discussed. Their feasibility and profitability is studied, and an exercise made comparing two different system layouts.

The design aspects of electrical and control systems is covered. Pump motors, control valve actuators, electrical installations, power and signal lines are treated.

Design for operational system safety, involving safety valves and circuit breakers are then covered.

This specialised part concludes with presentation and discussion of the results and reports from the laboratory exercise.

3.4 Curriculum special for geothermal field specialists from research institutes and energy companies

The specialised part will start with an introduction, covering the nature of geothermal resources; general background and classification. Then geothermal exploration, geology, geophysics, and geochemistry will be covered. An exercise will be done.

Geothermal drilling is the next subject, as well as geothermal well stimulation and basics of geothermal reservoir physics. This concludes with an exercise.

Geothermal logging is covered, lithological logging as well as pressure and temperature logging. This concludes with an exercise.

A full day is then taken in discussion of exercises for the previously mentioned exercises.

Geothermal well testing and analysis, geothermal system monitoring during utilization and geothermal resource assessment is covered, concluding with an exercise.

Simple modelling of geothermal systems, numerical modelling of geothermal systems, geothermal re-injection and geothermal tracer tests are covered, concluding with an exercise.

Finally geothermal resource management and environmental aspects are covered, concluding this specialised part with discussion of the exercises.

3.5 Curriculum special for management from geothermal energy companies

Presently the curriculum has not been as well defined as for the two previous groups. It will at least include load and load duration analysis, analysis of investment cost for geothermal utilisation and economic feasibility studies.

Risk assessment and risk modelling in the economic and feasibility studies will be included, as well as decision trees for decision making under risk.

Tariffs, tariff policy and income modelling will be covered in more detail than what is done in the common part of the program.

Discussion with Chinese energy companies active in the geothermal field will be necessary to define the curricula for this target group in more detail.

4. CONCLUSION

The training program described here has been discussed with the Chinese co-operation partners. Some further work in defining the curriculum is needed, especially for the management target group. Division of teaching between the partners has been discussed, with the main goal to have this program entirely in Chinese with a few international guest lecturers after the first few years of operation.

Earliest possible start of the program is in 2009 or 2010, depending on further discussions between the partners.