Rödl & Partner

Follow-up benchmark study – geothermal power and heat generation in Hungary

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1 BACKGROUND AND IMPLEMENTATION

1.1 Project Background

Deep hydrothermal geothermics has experienced a significant boost in Germany during the last few years owing to the expansion of the Renewable Energy Sources Act (EEG) as well as a variety of other adjacent subsidy programs to geothermal energy.

The situation in Hungary is completely different. Although deep waters in the sandstone reservoirs of the Pannonian Basin have been used since decades primarily to heat greenhouses, there is no intensive use of geothermal energy for the purpose of supplying heat to households or industrial facilities.

The reasons for this are manifold. The results of the 2005/2006 benchmark study showed mainly that the investment environment was not ideal for investments into geothermal heat or even power generation projects.

Improvement of the investment climate would lead in the event of the implementation of combined heat and power as well as purely heat generation projects, among other things, to new or expanded investments in district heating networks. Where applicable, these projects could be implemented in cooperation with private and municipal investors (after the so called public-private partnership (PPP) model). This would result in the replacement of fossil fuels for heating buildings (also in combination with heat pumps) on the one hand and of the relatively poorly controlled use of biomass for heating purposes on the other hand.

The importance for Hungary can be assessed as immense since the use of geothermal energy finds high social acceptance. According to the Hungarian Energy Agency (MEH), biomass which is currently the focus of public attention as a means of the future energy supply in Hungary can only provide approximately 11.3% of the total gross energy consumption till 2020.[1]

The Hungarian authorities are currently faced with two landmark decisions:

a) Perpetuation of the obligation for reinjection of geothermal wells with depth down to 2500 m;

b) Tendering concessions for deep geothermal projects with depth of 2500 m and deeper.

The both issues will be decisive for the development of deep geothermal energy in Hungary. From the very beginning the authorities asked Germany to share its experience in that sphere and were always holding public consultations to stay close to the declared objectives of the development and ecologically optimized (sustainable) use of deep hydrothermal geothermal energy in Hungary.

The 2005/2006 study identified mainly the following obstacles to economically feasible implementation of projects:

[1] Presentation by Mr. Attila Bagi, Hungarian Energy Agency, 17 February 2011

a) Regulated district heating prices;

b) Security of investments in terms of power inputs;

c) Complexity of the licensing procedure under the mining law (lacking legal security) due to complex interaction between mining and water legislation.

These obstacles were examined again in detail during the follow-up study.

1.2 Project objectives

On the one hand the project objective is to establish the liaison between the relevant environmental authorities - Federal Ministry for the Environment/Federal Environment Agency on the German side and the Ministry for Rural Development and the Hungarian Mining and Geology Agency on the Hungarian side.

Furthermore the benchmark study of 2005/2006 had demonstrated significant investment obstacles. The relevant aspects were examined once again in terms of these identified barriers. The declared objective is therefore to facilitate the application in the Hungarian environment of the German experience with deep hydro-geothermal energy and to make possible the experience-sharing on ground-breaking issues.

Additionally the experts were supposed to share during a workshop the experience of overcoming the identified barriers which stand in the way of the development of geothermal resources in Hungary.

Based on the above, recommendations should be developed with consideration of the experience gained during the development of the German geothermal market regarding future actions to offer incentives and remove barriers where required.

1.3 Project implementation

The project implementation included the following steps:

1) Basic research: legal & economic framework conditions for the development of hydro-geothermal projects in Hungary;

2) Establishing contacts with the Hungarian authorities;

3) Trip to Budapest to interview representatives of the authorities, to discuss the results of Project Stage 1 and to complement the available information with own research findings;

4) Workshop – preparatory work (invitations, program, speakers, moderators);

5) Hosting of the workshop on 17 February 2011 on premises of Rödl & Partner Budapest;

6) Production of a report.

2 PROJECT RESULTS

2.1 Legal framework

2.1.1 Mining law

Most legal amendments made after the finalization of the 2005/2006 benchmark study in Hungary were in the field of mining law. The work of the expert government committees has resulted in the inclusion of important guaranties for investors into the **1993 Mining Act no. XLVIII**. These changes secure investors exclusive access to the resources in case of exploration, extraction and use of geothermal energy. The above changes were indispensable for further development of geothermal energy supply in view of the lacking investor protection.

Legal protection and guarantees (legal security) were already introduced by **Act CXXXIII on introduction of amendments to Mining Act XLVIII**. But the exclusivity intended to protect investors could not be enforced in practice and so the Supreme Court requested also the exclusive right to exploration activities.[2]

Another significant change came with the Amending Resolution no. 7/2008 issued by the Ministry for National Development and Economy on 05 June 2008; that resolution ranked geothermal energy eligible for subsidy funding as a renewable energy source within KEOP program.[3]

The **scope** of the amended Mining Act was expanded. As opposed to the prior version, the scope of the act was expanded to extraction and use in addition to exploration of geothermal energy as per § 1.1(h). The Mining Act (§ 3.1) says that geothermal energy, when in its natural area, is national patrimony. When geothermal energy is extracted from its natural area for energy supply purposes, the title goes to the extracting party.

[2] Presentation by Dr. Tamás Hámor, Hungarian Office for Mining and Geology, 15 December 2010

[3] Presentation by Dr. Tamás Hámor, Hungarian Office for Mining and Geology, 15 December 2010

The figure below shows the scope of the Mining Act:

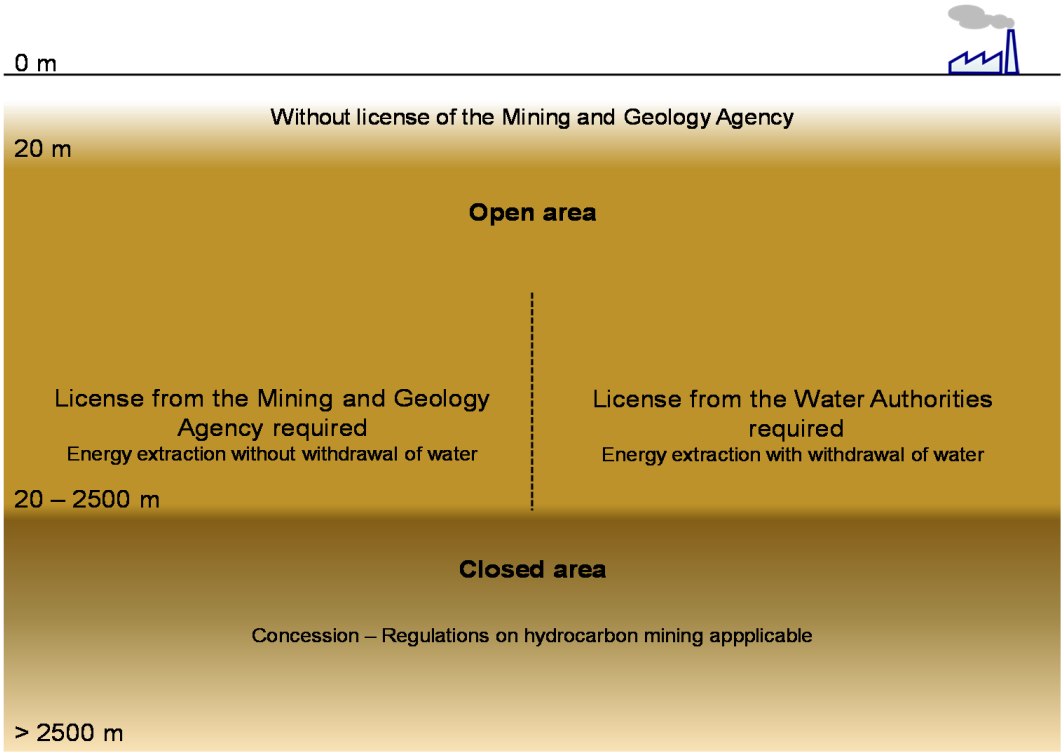

Figure 1: Scope of the Mining Act[4]

As shown above, projects with depths ranging **between the earth surface (0 m) and the depth of 20 m** are partially exempted from licensing. This means that investors can operate without a license from the Mining and Geology Agency; however a license from the Water Authority is required in case of groundwater withdrawal.

Depths between **20 and 2500 m** are classified as **"open area"**. According to § 48.20 (definitions of the terms used in the Mining Act), open area is any area not deemed to be a closed area for certain raw materials. Energy extraction in an open area is further subdivided into extraction with or without withdrawal of water. If energy is extracted in a closed system without withdrawal of water, a license of the Water Authority is not necessary. But if water is withdrawn during energy extraction, a Water Authority license should be applied for.

Areas **deeper than 2500 m** are classified as "closed areas". Under § 49.24 of the Mining Act, a closed area is any area intended for concession tendering and for allocation to exploration, extraction and exploitation purposes. Furthermore any area is categorized as closed area if a mining license has been granted in respect thereto, but only for the term specified in the license. For geothermal energy purposes, any area deeper than 2500 m is classified as closed area. The regulations on the licensing procedure are similar for these areas to the regulations on hydrocarbons (§ 22/A, § 22/B), provided no mining claim can be determined in respect of geothermal energy.

[4] Presentation by Dr. Tamás Hámor, Hungarian Office for Mining and Geology, 15 December 2010

The approval to carry out activities covered by the mining law is granted in case of open areas within the license for extraction and utilization – which is identical to the license for utilization of subsurface thermal water – and also within the concession in case of closed areas.

The regulations on the **obligation for concession** took effect on 01 January 2011 as part of Chapter 2 of the Mining Act. According to § 8 (a, b), the Minister can grant concessions for exploration, extraction and utilization to resident and non-resident legal entities, natural persons or their businesses that are not a legal entity under a concession contract. However, the subsequent regulations (§ 14 of the Mining Act) do not categorize utilization of geothermal energy as an activity subject to concession. According to the Hungarian Mining and Geology Agency, utilization of geothermal energy is regulated or restricted in the tender documents on the one hand and subsequently in the concession contract on the other hand.

The holder of rights of use has to pay a mining royalty. The royalty is regulated by Government Resolution 54/2008 and is HUF 1650 per GJ (approximately EUR 6 € per GJ[5]) in case of withdrawal of groundwater and HUF 320 per GJ (approximately EUR 1.2 per GJ[6]) in case of a closed system.

According to § 9.1, **the Minister** can determine closed areas based on the available data and information that suggest the existence of geothermal resources. Currently the responsible authority is the Ministry of National Development (NFM).

The **contents of the tender** for concession are regulated in § 10 of the Mining Act in conjunction with Act on Concessions XVI of 1991 and Implementing Regulation 203/1998 of 19 December 1998 on the Mining Act. According to § 11 the Minister is the ultimate decision-maker. Any company can file an application to the Mining and Geology Agency, seeking to be awarded a concession.[7] Nevertheless all concessions have to be awarded in an open tender. This implies however a significant risk for the investor who has already analyzed the initial geological data underlying his application for a concession.

According to § 8.2 of the Concessions Act, the tender documentation must include the criteria for evaluation of tender bids and furthermore specify the following:

- the activity subject to concession and other activities closely connected therewith;
- validity term of the invitation to tender for the concession;
- geographical and administrative unit where the concession activity will be exercised;
- legal and financial prerequisites for exercising the concession activity;
- grounds for early termination of the concession contract;
- information on the authority of the state (the community) to control compliance with the terms and conditions of the concession contract;

[5] Exchange rate: HUF 100 = approximately EUR 0.37 at 20 March 2011 (http://www.oanda.com)

[6] Exchange rate: HUF 100 = approximately EUR 0.37 at 20 March 2011 (http://www.oanda.com)

[7] http://www.mbfh.hu/home/html/index.asp?msid=1&sid=0&hkl=189&lng=1

- information on who is already entitled to exercise any activity subject to concession in the area concerned at the time of the tender, or whether the party issuing the invitation to tender expects to grant any other economic organization the right to exercise the activity subject to concession during the lifetime of the concession contract.

If required, the tender documentation must include furthermore the following information according to § 8.3 of the Concessions Act:

- qualification requirements;
- minimum charge for the concession;
- in the event the concession involves a transfer of state property (or community property), the terms and conditions for, as well as security of, its transfer and return;
- if the approval of the Parliament is required to conclude the concession contract;
- terms and conditions regarding concession charges and royalties for particular activity types; and
- other information which the party issuing the invitation to tender believes to be of importance.

However § 10 of the Mining Act has further requirements according to which the tender documentation has to contain the following information – in addition to the data mandatory under the Concessions Act:

- borders of the area covered by the tender and already existing third party rights;
- description of the activity subject to the concession;
- qualification requirements for the activity subject to concession;
- prerequisites for the activity subject to concession, which have been determined based on complex sensitivity and stability studies, and obligations to grant the concession subject to compliance with the prerequisites;
- requirements regarding the contents of the action plan;
- conditions prerequisite to participation (participation fee, information on the bidder's economic and financial situation);
- payment obligations arising after the concession is awarded (mining royalty) and other fees;
- re-cultivation obligations and adequate means to fund these – such as e.g. security, liability insurance;
- tender bid aspects to be evaluated (e.g. action plan, commitment to pay a higher mining royalty than the one specified in the tender documentation);
- information regarding the obligation to establish a concession company in case the concession is awarded;

- other requirements, e.g. the pre-emptive purchase right of the State to geothermal energy.

Governmental Resolution 203/1998 of 19 December 1998 on application of the Mining Act includes further provisions regarding the mining concession tendering procedures. According to § 2.2, consortiums have to name their legal representative when submitting the tender bid.

According to § 2.3, the President of the Mining and Geology Agency sets up a qualification committee to evaluate the bids. The committee shall include the Ministers of:

- Emergency Situations;
- health;
- cartography;
- mining;
- technical safety;
- environmental protection;
- national defense;
- research and technology innovations;
- state budget.

According to § 2.5, the right for exploration cannot be granted without a concession in an area allocated for the concession.

According to § 12 of the Mining Act the Minister concludes a **concession contract** for a term not to exceed 35 years with the winner awarded the tender. This contract can be extended once for to a half of the initial term. The work program (action plan) has to be defined in the concession contract. Furthermore guarantees must be provided in connection with the service provision. According to § 13 of the Mining Act, the winner awarded the tender must set up a concession company within 90 days of the Date of the concession contract. The concession company can be a resident company or a company with registered offices abroad according to Act CXXXII of 1997 on Hungarian Subsidiaries and Commercial Representative Offices of Foreign Companies (Subsidiaries Act)".

2.1.1.1 Mining concession

A concession can be granted for exploration, or for extraction and exploitation, or for the both, and the concession contract is concluded accordingly.[8]

According to § 22.1 of the Mining Act, the Minister can grant the exploration rights for the purpose of exploring geothermal resources in closed areas within the concession. The authority for open area is the Mining and Geology Agency.

Under § 22.2 of the Mining Act, mining companies have the exclusive right to apply for a work plan to explore geothermal resources and for an exploration license and

[8] http://www.mbfh.hu/home/html/index.asp?msid=1&sid=0&hkl=189&lng=1

to initiate the siting of a geothermal protection area in their area of exploration (see Chapter 2.1.1.2).

Exploration may only be started based on a work plan approved by the Mining and Geology Agency (§ 22.3).

If the right for exploration is granted for the whole area or a part of the area for which mining rights have already been granted to a third party, the party entitled to perform the exploration work must coordinate its activities with the holder of the mining rights; The relevant agreement has to be registered either in an official document or in a document duly authenticated by an attorney-at-law (§ 22.10). However, according to the Hungarian Mining and Geology Agency, the holder of the mining rights is not under an obligation to cooperate with the party entitled to perform exploration work.

The exploration of geothermal energy may not last longer than 4 years. This term can be extended twice, each time by half of the initial term (§ 14.1 of the Mining Act). Within one year of completion of the exploration phase, the mining company can apply for siting of the geothermal protection area to the Mining and Geology Agency (§14.2 of the Mining Act). The party granted the concession must start the extraction and utilization of the resource for energy purposes within 3 years of siting of the geothermal protection area, otherwise a penalty becomes payable according to § 15 of the Mining Act. This penalty is determined in the concession contract. If the penalty is not paid, the concession will be withdrawn.

2.1.1.2 Geothermal protection area

Geothermal resources found in a closed area can only be used for the purpose of energy extraction from a marked-off part of the underground (geothermal protection area as per § 22/B.2 ff.)

The geothermal protection area status is allocated by the Mining and Geology Agency.

No third party can be allowed to install any equipment intended for extraction of geothermal energy within a geothermal protection area without the concessionaire's approval in writing.

However, no closed areas and no geothermal protection areas have been allocated so far. According to the Mining and Geology Agency, 2-3 tenders can be held yet in 2011. Open tenders are scheduled for early autumn so the awards of the concession/signing of the concession contract can be expected by the end of 2011.

According to the Mining and Geology Agency, due attention will be paid during the allocation of geothermal protection areas to prevent the adverse impact between the marked-off areas. Eventual conflicts can be avoided that way. Thus the party entitled to extract geothermal energy has his security that he is the only one who is allowed to operate within his site (within the protection area). This means a new secure situation and the possibility to plan investments and investment projects. On the one hand this offers the possibility to secure the rights by means of a concession for a term of 35 years; the area for utilization is secured furthermore via allocation of a geothermal protection area. However it does not answer the question if the right for water use can also be guaranteed for the duration of the concession.

According to VITUKI[9], the right for water use cannot be guaranteed.

2.1.2 Water legislation

According to the expert unit (on environmental issues) in the Ministry for Rural Development, amendments and modifications to the **Mining Act (Act XLVIII of 1993)** have not affected either the powers of the Water Authority (the powers of the Water Authority are regulated in Act LVII of 1995 and in Government Resolution 72/1996 of 22 May 1992) or the procedure of licensing geothermal projects. The scope of the Mining Act covers all geothermal energy-related economic activities. Any involvement of underground water which contains geothermal energy is regulated in **Act LVII of 1995 on Water Management ('Water Act').** The powers of the Water Authority are detailed in §§ 28 ff of the Water Act.

The above act says till currently that any activity which might affect adversely underground or ground water is subject to approval (§ 1.1 (a) of the Water Act). The **powers of the Mining and Geology Agency** have changed insofar that the license issued according to water law for the utilization of geothermal energy extracted from a thermal reservoir not more than 2500 m deep is at the same time the license for the extraction and utilization of geothermal energy (§ 22/B.6 of the Mining Act). The Mining and Geology Agency is involved in the licensing procedure as an expert. The amendment also affects those who are already holding a valid license for commissioning and who are using thermal water. They have to pay a mining royalty and submit data and information to the authorities when using thermal water for the purposes of utilizing geothermal energy. This is for example the case for the hot springs with thermal water used for bathing and with geothermal energy used for heating. They also have to pay mining royalties.

Furthermore the **powers of the Water Authority** have not changed either in respect of projects for utilization of geothermal energy from levels below 2500 m deep in closed areas; but after 01 January 2011 the Mining Authorities must award concessions for these projects as the first step.

If the extraction of geothermal energy in a closed system takes place **without use of underground water** and therefore no impact can be expected on the underground water flows, then no license is required from the Water Authority.

If subsurface water/groundwater between 0 m and 20 m deep **is used** for the extraction of geothermal energy, a license is required for the interference and related activities.

If exploration, extraction and utilization of geothermal energy is performed in combination with water extraction (120-150°C), water flow will be affected by the production and reinjection drilling. For this reason the both drilling equipment types are classified as water equipment (**Act LVII of 1995**, Annex 1, Item 26) and therefore a license is required according to the water legislation. A concession company can only operate with a license granted in compliance with the water legislation. The obligation for reinjection is included in the Water Act. According to § 15.3.2 of the Water Act, thermal water extracted for utilization has to be re-injected. Under § 15.3.3 of the Water Act, the Water Authority is entitled - provided certain prerequisite conditions are met, as listed in § 78.4 (a-b) of **Government Resolution 147/2010** of 29 April 2010 - to exempt from the obligation to re-inject, if the li-

[9] VITUKI Environmental Protection and Water Management Research Institute

cense holder extracts thermal water solely for the purpose of energy utilization and provided:

- "water bodies" are categorized as weak or perishable in the water collection and development plans for the period till 22 December 2014; or
- "water bodies" are categorized as good in the water collection and development plans for the period till 22 December 2020; and
- the license holder was holding a valid license for commissioning for the purpose of energy utilization of thermal water on 30 September 2009.

According to § 15/C.1(a), no water fee should be paid on the re-injected quantities in case of reinjection.

Details on licenses required according to the water legislation can be found in **Government Decree 72/1996** of 22 May 1996 on the exercise of powers granted to the authorities in respect of water management.

The **basic license according to the water legislation** (§ 1 A - § 3) can be applied for before planning of the activity subject to licensing. The license covers general technical solution alternatives and requirements to be satisfied before achievement of the planned water management goal. The applicant can be the owner, the constructor or the asset manager. This license does not cover activities related to water utilization, installation of the relevant equipment ('water equipment' according to the law) and water utilization itself. Applications and documents necessary for the issuance of the above license are listed in Annex 1 to Decree 18/1996 of 13 June 1996 of the Ministry of Traffic, Telecommunications and Water Management.

The installation license according to the water legislation (§§ 3 ff.) can be applied for by the constructor, owner or asset manager for activities connected with water utilization and installation (also for introduction of modifications and close-down) of the relevant equipment.

The **operating license according to the water legislation** (§§ 5 ff.) has to be applied for by anyone who is directly affected by the utilization of water, commissioning of the water equipment and the related rights and duties.

The **licensing authority according to the water legislation** is the Controlling Authority for Environment Protection, Nature Conservation and Water Management (National Inspectorate for Environment Protection, Nature Conservation and Water Management). The Hungarian Mining and Geology Agency is involved in the licensing procedure as an expert according to Government Resolution 347/2006.

2.1.3 Licenses

2.1.3.1 Environmental Protection License

As the first step a geothermal project requires a license from the environmental protection authorities. The planned project is checked for possible impact on the environment and the nature. The results of this investigation are presented in the environmental impact study. The legal framework for the environmental protection license is **Act LIII of 1995** on general regulations on environment protection on the one hand and **Government Resolution 314/2005** of 25 December 2005 on the licensing procedure for environmental impact studies and use of the environmental (previously regulated by Government Resolution 20/2001 of 14 February 2001, cur-

rently revoked) on the other hand. The licensing procedure of the environmental protection authority takes place before initiation of the installation licensing procedure and before initiation of the licensing procedure for the construction of a heat or power plant.[10]

Licensing requirements depend on the project concept.

For example:

A**nnex 1 to** Government Resolution 314/2005 lists water extraction and water reinjection amounts that require an environmental impact study.

- Item **56** of Annex 1: if water reinjection in the aquifer is 3 million cubic meters per year or above;
- Item **34** of Annex 1: if the aquifer is used by means of a water extraction plant that takes 5 million cubic meters per year or above.

A**nnex** 3 to Government Resolution 314/2005 lists the activities for which the controlling authority (Környezetvédelmi, Természetvédelmi és VĚzügyi Felügyelség (KTVF) = National Inspectorate for Environment Protection, Nature Conservation and Water Management) decides on the necessity for an environmental impact study.

- Item **73** of Annex 3: in case of geothermal plants with the capacity of 20 MW.

- Item **80 of Annex 3**: in case of daily use of the following thermal water quantities by means of one or more water extraction plants:

    - Ground water: 1000 cubic meters,
    - Thermal karst water: 500 cubic meters (under Resolution 20/2001 previously 1000 cubic meters),
    - Strata water: 5000 cubic meters,
    - Cold karst water: 2500 cubic meters,
    - Filtered coast water: 5000 cubic meters,
    - Thermal strata water: 2000 cubic meters,
    - whenever the respective well extraction rate is higher than 33% or daily extraction is above 50 cubic meters (previously 100 cubic meters under Resolution 20/2001) (if not already regulated in Annex 1, see above).

- Item **134 of Annex 3**: in case of reinjection into the aquifer, if not already regulated by Annex 1. In this case the controlling authority can request a **preliminary consultation** (pre-study).

[10] Study of ENERGIAKLUB Climate Policy Institute and Methodology Center in collaboration with the law firm of Dr. Attila Lengyel and the Hungarian Energy Agency (MEH), page 47.

The objective of the **preliminary consultation** with the environment protection authority is to obtain its opinion as well as the opinion of other authorities with regard to the contents of the environmental impact study and of the application for a license to the environment protection authority. During the preliminary consultation the environment protection authority issues within 45 days of the filing day of the application an opinion regarding environment protection related aspects of the planned activities (e.g. names one of the alternatives described in the application, which is preferable in terms of environment protection; advises the applicant if there are grounds for rejecting the application, etc.).

As discussed in the above, there were certain amendments regarding water quantities. The requirements for environmentally friendly utilization and the respective licenses are regulated in § 66 of the Environment Act. The preliminary study and the preliminary consultation are regulated in § 67 of the Environment Act. The appraisal of impact on the environment is regulated in §§ 68 ff of the Environmental Act. The results of the appraisal are summarized in the environmental impact study.

Order **33/2005** of 27 December 2005 issued by **the Ministry of Environment and Water** regulates the obligation to involve authorized experts and to pay fees.

Individual licenses and licensing proceedings are regulated in detail in **Government Resolution 314/2005** of 25 December 2015:

- preliminary study - §§ 3-5,
- preliminary consultation - §§ 5/A ff,
- licensing procedure for environmental impact study - §§ 6-16,
- standardized licensing procedure for environmentally friendly use - §§ 17-23,
- the above two types of licensing procedures can be combined, the details are provided in §§ 24 ff.

Due to the complexity of the licensing procedures it is important to start the project with the environmental impact study which is a requirement or a prerequisite for the subsequent licensing procedures.

This study can detect risks not yet known to the project developer.

2.1.3.2 Construction and other licenses

According to § 5.1 of the **Mining Act (No. XLVIII of 1993),** the extraction and utilization of geothermal energy or the construction and commissioning of the equipment (plant) required for the purpose are subject to licensing by the Mining and Geology Agency, unless a construction license is required according to the water legislation.

A license must be obtained from the Mining and Geology Agency in certain situations described in **Order 96/2005** of 04 September 2005 issued by the Ministry for Economy and Transports: e.g. for deep drilling exploration installations (Annex 1 Item 1) or for buildings and structures within geothermal projects in which geothermal energy is utilized without discharging water (Annex 1 Item 4.1).

According to the above legal provisions and **Government Resolution 72/1996** of 22 May 1996, if a geothermal project is realized with extraction of water, it is obligatory to obtain a **license according to the water legislation** (construction and commissioning license according to the water legislation) which is issued by the environment protection authority.

Government Resolution 320/2010 of 27 December 2010 (§ 13.2 e), l) has a special provision to the effect that an additional license must be obtained from the Hungarian Trade Licensing Office (Magyar Kereskedelmi Engedélyezési Hivatal) for erecting those parts of the building that directly serve to protect heat production and heat supply facilities (e.g. boiler) of heat plants with a capacity above 0.5 MW_{th}. This regulation also applies to power lines.[11]

Furthermore a **license from the Hungarian Energy Agency** is required for the construction and operation of heat or power plants (please see § 4, Act XVIII of 2005 on District Heat Supply and § 4, Act LXXXVI of 2007 on Electric Energy).

2.1.4 Energy legislation

Act LXXXVI of 2007 on Electric Energy which is harmonized with the European law (further 'VET' = villamos energia törvény) has a totally different structure than its predecessor (Act CX of 2001). The new act has certain similarities with the German Renewable Energy Sources Act (EEG).

According to § 4.1 of VET, a small power plant with a capacity of 50 MW or more may produce electric energy solely on the basis of an **operating license** for power generation.

In case of small power plants with a capacity of 0.5 MW or more, a combined license is prerequisite for power production which comprises construction and operating license.

The producer obtains consideration for net power production, i.e. gross production minus in-house consumption (§ 4.4 of VET).

The regulations on energy from renewable energy sources, waste products and combined heat and power production can be found in Articles 9 to 13.

Article 10.1 c) of VET sets the criteria to determine purchase price, purchase quantities and purchase duration for power in the category of guaranteed energy purchases. These include:

- average amortization period of individual production technologies;
- efficient utilization of energy sources in the context of natural environment in the country,
- consumption capacity,
- improving efficiency as result of technology development,
- impact of individual production technologies on the power grid,
- technical performance characteristics.

Under § 11.1 of VET, the guaranteed purchases are either at market prices or at a fixed purchase price specified in this act or in other legislation.

[11] http://www.mkeh.gov.hu/muszaki/nemzeti/tavho_vezetekek

The obligations of transmission system operators, public utility suppliers (i.e. companies supplying power directly to end users) and electricity traders to purchase such energy are detailed in § 13 of VET.

Priority access to networks must be given to generating companies using renewable energy sources, as opposed to fossilized fuels (§ 35.3 of VET).

2.1.4.1 Price regulation

Pricing regulations can be found in Chapter XVI of VET (§§ 140-146). Consumers pay the price of electricity and the fee for the use of the power network as per electricity purchase contract and the network use agreement. Fees for the use of power network are fixed in the regulation; the price of electricity sold by electricity traders to end users is either the agreed purchase contract price or the electricity trader's standard rate fixed in its general terms of business. The price of energy sold for utility supply purposes is determined by the Minister in a ministerial order (regulated pricing).

The regulated price is stated in § 141.8 of VET. According to this law, the fee for the use of the power network (§ 142.1 of VET) and the network connection fee (§ 144.1 of VET) are the fees payable by the consumer to the distribution network operator and the community utility companies for their services (§ 142.11 and § 143.3 VET). The calculation is based on the actual consumption. These fees are the price for community services according to § 143.1 of VET.

2.1.4.2 KŔT-System (the Hungarian remuneration system)

The obligation to purchase energy from renewable sources, waste and combined heat and power generation as well as purchase prices are regulated in Government Resolution 389/2007 of 23 December 2007, which took effect on 01 January 2008. This Government Resolution is also called KŔT Resolution (Kötelezö Ŕtvételi Rendszer).

Purchase prices and prerequisites for purchases are regulated by the Government in the Government Resolution (§ 11.3.1 of KŔT). The energy quantities and the duration of the obligation to purchase are determined by the Hungarian Energy Agency (§ 11.3.2 of KŔT). The purchase prices can also be determined depending on energy carrier, generation process, intended use of the heat produced in a CHP process and the plant capacity (§ 11.3.3 of KŔT).

According to MEH, the prices used in the KŔT Scheme (the Hungarian remuneration scheme) are also regulated prices. The Hungarian Energy Agency is the authority in charge of fixing prices.

Price adjustments take place every 4 years.

Annex 1 to the KŔT Regulation presents the tariff rates of the KŔT Scheme in a table.

Further requirements concerning the purchasing obligation are detailed in § 4 of the KŔT Regulation.

Purchase prices are paid subject to the following **conditions**:[12]

- the capacity of the generation plant is above 50 KVA;
- the Hungarian Energy Agency stated the eligibility of the producer for the obligatory energy purchases scheme in a legally binding order before 01 January 2008;
- the Hungarian Energy Agency stated the eligibility of the producer for the obligatory energy purchases scheme in a legally binding order after 01 January 2008 because:
  - the producer produces energy solely from renewable energy sources, or waste, or a combination of both;
  - in case of a combination the portion of the renewable energy sources is at least 30%.

Further prerequisites for utilization in the obligatory purchase scheme (KŔT) according to § 6 of the KŔT Regulation:[13]

- The Hungarian Energy Agency (MEH) must determine in an order, how much energy (quantity/quota) can be paid/used and for how long.
- The producer is integrated into the KŔT accounting system, i.e. the technical and process-related prerequisites are in existence for such integration, such as: the connection point has been allocated, the necessary documents for the connection have been delivered when filing the application (investment subsidies, tax exemptions), and the administrative fees have been paid.
- There are no grounds for an exclusion from the purchase obligation. The grounds for such exclusion can be e.g. outstanding liabilities to public institutions, use of public subsidies without eligibility, or outstanding criminal proceedings against the applicant.

If the producer intends to sell his power under the KŔT scheme, he must file an application with the Hungarian Energy Agency (MEH) (§ 6.1). The application can be filed at the same time as an application for an operating license for a small or a large power plant, as defined in Chapter 2.1.4. In case of a small power plant not subject to an approval, the application must be filed with the Hungarian Energy Agency no later than 60 days before commissioning (§ 6.2).

The producer must enclose the following documents to the application:

- A confirmation on the drawdown of public subsidies;

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12 http://www.kormany.hu/download/d/61/10000/Magyarorsz%C3%A1g%20Meg%C3%BAjul%C3%B3%20Energia%20Hasznos%C3%ADt%C3%A1si%20Cselekv%C3%A9si%20Terve.pdf

13 http://www.kormany.hu/download/d/61/10000/Magyarorsz%C3%A1g%20Meg%C3%BAjul%C3%B3%20Energia%20Hasznos%C3%ADt%C3%A1si%20Cselekv%C3%A9si%20Terve.pdf

- A work plan for the power plant audited by an independent expert consultant and additionally by a financing institution where a loan is involved. The work plan must cover 15 years in case of power generation based on renewable energy sources and/or waste. A period of 10 years is sufficient in case of a CHP plant. The work plan must show the annual energy amounts to be sold under the KŔT scheme.
- Technical documentation of the generation plant.
- Declaration on the burden of proof of source (§ 8 of KŔT).
- Confirmation of the financial institution that statutory fees have been duly paid.

According to § 3.10.2 of KŔT, the net amount of power is used/paid under the KŔT scheme.

For each project the Hungarian Energy Agency issues an order that determines how much energy can be paid during which period. It is taken into account that an investment can entitle to payment until the investment is repaid (§ 6 ff.). According to MEH, it is planned to use in the future a benchmark matrix or benchmark analysis instead of the project-related system to determine the payment duration and energy amounts based on technology criteria rather than on individual projects.

According to Government Resolution 389/2007 of 23 December 2007, power plant operators can sell the **quotas/quantities determined** in the license of the Energy Agency. They are free to decide how much of it they sell during which year. Only an absolute cap is set on the total amount of energy that can be sold during a definite period of several years. After the producer sells that total amount, fixed prices do not apply any longer.[14]

It is planned to structure the KŔT scheme in a way that taken into account the generation technology and the size of the power plant because different technologies have different amortization periods and different renewable energy sources contribute differently to the achievement of social and economic objectives.[15]

2.1.4.3 CHP regulations on the entitlement to payment

The portion of power produced in CHP processes grew most significantly during the last 15 years. Before 31 December 2010 the power generated in such processes was paid under the KŔT scheme, but subsidies have expired in the meantime (§ 171.5 of VET). The expiry of the payment regulation affects 25% of the power generation units currently paid under the scheme. All other producers are still paid fixed purchase prices for their power till 2015.[16]

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14 http://www.kormany.hu/download/d/61/10000/Magyarorsz%C3%A1g%20Meg%C3%BAjul%C3%B3%20Energia%20Hasznos%C3%ADt%C3%A1si%20Cselekv%C3%A9si%20Terve.pdf

15 http://www.kormany.hu/download/d/61/10000/Magyarorsz%C3%A1g%20Meg%C3%BAjul%C3%B3%20Energia%20Hasznos%C3%ADt%C3%A1si%20Cselekv%C3%A9si%20Terve.pdf

16 http://www.mket.hu/alapanyagok/tanulmany_2010_vez_osszefog.pdf

According to § 171.5 of VET, a two-phase transit period rule applies according to which the generated power can still be paid at fixed prices if the heat generated in the CHP process is supplied to household customers and public institutions. As a prerequisite, the producer had to file an application with MEH before 31 January 2011. MEH will examine the submitted applications till 15 April 2011 (§ 171.5(b) of VET). Prerequisites for an extension of the entitlement to remuneration are detailed in § 171.5(a) (a-c) of VET, including the key ones detailed below:

- The portion of heat produced for the supply of household costumers and public institutions had to be 35% during the last two calendar years (before filing of the application).
- The producer continues to charge only the flat heat prices valid for the period 01 December 2010 to 30 June 2011.
- The portion of 35% must be achieved during each year of the extension period.

Nevertheless an additional reduction of the purchase prices applies to those producers who are affected by the transit rule and granted the extension of their entitlement to payment under the scheme. According to § 171.5 (c) of VET prices were reduced by 15% for the projects extended in Phase 1 and 2 at 01 January 2011. A further reduction of 15% will take place by 01 January 2012 for those who are granted the extension in the second phase.

In case of CHP projects an **alternative** exists for the producers to choose between statutory payment for the electricity under the regulations on renewable energy or on CHP. The possibility remains under the KŔT scheme to get paid for power generation from renewable energy sources.

2.1.4.4 Special taxes

Act XCIV of 18 October 2010 on Special Taxes for Certain Sectors introduced a **special tax** in Hungary in autumn 2010. 'Certain sectors' included the energy sector as well. This tax is payable in 2010, 2011 and 2012 and is based on the net revenue (turnover) for the respective fiscal year, irrespective whether the company achieves or does not achieve profit in the respective year. In 2010 an advance had to be paid for the tax payable for the current year based on the 2009 turnover.[17]

On 14 June 2010 the Hungarian Parliament enacted an amendment to freeze the electricity and natural gas prices for household customers and small consumers. The Ministry of National Development is currently the authority in charge of pricing for utility services. This situation will be maintained until a new regulation is developed jointly with the Hungarian Energy Agency.[18]

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[17] http://www.ahkungarn.hu/fileadmin/ahk_ungarn/Dokumente/Wirtschaftsinfos/HU/Regierungsdokumente/INFO_Sondersteuern_Ungarn.pdf

[18] http://index.hu/gazdasag/magyar/2010/06/15/visszaternek_a_hatosagi_arak/ and http://index.hu/gazdasag/magyar/2010/06/09/visszater_a_hatosagi_energiaar/

2.1.4.5 National Action Plan – NCST[19]

The Hungarian National Action Plan was developed in the wording based on the Commission Decision of 30 June 2009 that established a template for National Renewable Energy Action Plans under Directive 2009/28/EC of the European Parliament and of the Council (2009/548/EC). As a new target, a portion of **14.65%** (instead of 13%) of renewable energy was defined in the gross final energy consumption **till 2020**.

A few questions are listed below (in italics) that had to be answered by the Member States within their National Action Plans.

4.2.1 (e). Are there any unnecessary obstacles or non-proportionate requirements detected related to authorization, certification and licensing procedures applied to plants and associated transmission and distribution network infrastructure for the production of electricity, heating or cooling from renewable sources, and to the process of transformation of biomass into biofuels or other energy products? If so, what are they?

The complexity and complicated nature of the approval procedures, relatively high number of the involved authorizing authorities and the procedural deadlines can become **obstacles to investments.** Therefore a review is already underway aiming to simplify such procedures and to establish a **one-stop shop system**.

4.2.1 (f). What level of administration (local, regional and national) is responsible for authorizing, certifying and licensing renewable energy installations and for spatial planning? (If it depends on the type of installation, please specify.) If more than one level is involved, how is coordination between the different levels managed? How will coordination between different responsible authorities be improved in the future?

Licenses for the establishment, commissioning and operation at electricity and natural gas markets are issued by the Hungarian Energy Agency (MEH) as the national authority. The Ministry of the Interior is the authority in charge of issuing authorizations in connection with spatial planning. Mining and environmental permits are issued by the regional supervisory authorities.

Permits relating to construction are issued by the Hungarian Trade Licensing Office (HTLO) for electricity, gas and district heat supply.

Improved coordination is related to the findings of the review referred to in (e) (introduction of the one-stop shop system). The required measures can be determined based on the findings and conclusions of the completed study.

4.2.1 (h). How is horizontal coordination facilitated between different administrative bodies responsible for the different parts of the permit? How many procedural steps are needed to receive the final authorization/license/permit? Is there a one-stop shop for coordinating all steps? Are timetables for processing applications communicated in advance? What is the average time for obtaining a decision for the application?

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19 http://www.kormany.hu/download/d/61/10000/Magyarorsz%C3%A1g%20Meg%C3%BAjul%C3%B3%20Energia%20Hasznos%C3%ADt%C3%A1si%20Cselekv%C3%A9si%20Terve.pdf

Certain provisions of Act CXL of 2004 on the general rules of administrative proceedings and services already provide for data sharing and cooperation between the authorities as a general rule. A **one-stop shop system** does not exist at present. The introduction of a simplified one-stop shop system is a priority objective of the New Széchenyi Plan in line with the Government efforts to restructure public administration.

4.2.1 (i.) Do authorization procedures take into account the specificities of the different renewable energy technologies? If so, please describe how. If they do not, do you envisage taking them into account in the future?

The procedures take into account the differences of diverse energy sources only to a limited extent. The focus is primarily on the specifics of the field concerned (power, gas or heat). The review of the procedures intends to take into account the specifics of renewable energy sources. To this end, we are planning to issue evaluation and inspection guidelines for individual procedures as a part of the adjustments to the procedural framework with a view to facilitate the work of the authorities. The aim of these will be twofold: on the one hand, they will facilitate the work of the authorities and on the other hand they will also serve as guidelines for investors with regard to the aspects the authorities examine and evaluate during the procedure.

2.1.5 District heat pricing regulation

Provisions of Act XVIII of 2005 on District Heat Supply must be interpreted in conjunction with Act XLVIII of 1993 on Mining (please refer to section 2.1.1) and Act LVII of 1995 on Water Management (please refer to section 2.1.2) according to § 3.3 (b).

The following information was provided by Mr. Tibor Bartha of the Hungarian Energy Agency (MEH) regarding the current framework conditions on the Hungarian district heat market:

The district heat market participants are:

- gas traders,
- power plant operators,
- district heat suppliers,
- consumers: households and public institutions.

Examining the vertical pricing structure in the fossil district heat supply, one can notice the following: Gas is bought at market prices and the price of the produced heat is agreed directly between the plant operator and the district heat supplier and fixed in a contract.

The heat price payable to the district heat supplier by end consumers is determined as the regulated maximum price. This price is independent of the utilized energy source and is therefore also valid for geothermal district heat supply. The authority regulating the price is the municipal council.

The regulated price can be determined or adjusted in two ways. On the one hand the district heat supplier can file an application seeking a price adjustment. On the other hand, the municipal council can decide at its discretion.

After 01 July 2010 the Hungarian Energy Agency has been responsible within an administrative process to examine supplier applications seeking to amend prices. The application to amend prices is examined by the Hungarian Energy Agency based on a benchmark study.

District heat suppliers are categorized depending on the following criteria:

- number of households supplied district heat,
- heat production type (purely heat production or heat production in a CHP process).

The pricing systems must be comparable based on these categories applied by the Hungarian Energy Agency.

If a district heat supplier files an application to amend prices, the city council may only change the price of the district heat services after the Hungarian Energy Agency issues the relevant approving order.

Furthermore the Hungarian Pricing Act LXXXVII of 1990 entitles price regulators to change prices and the calculation method *ex officio*. In this case the Hungarian Energy Agency is not involved in the pricing regulation.

The pricing legislation has been changed by the Amending Act LXVII of 2008. However the final consumer price for district heat supply is still the regulated maximum price and the municipal council is the regulator.

Prior to the amendment and before 01 July 2009 the Minister had to express an opinion on the district heat prices. This authority (control over district heat prices) has been granted to the Hungarian Energy Agency as the central public authority. The objective is to harmonize and reduce the prices for district heat supply.

Powers of the Hungarian Energy Agency in respect of district heating

A district heat supplier has to file an application with the Hungarian Energy Agency if he intends to implement price changes. The authority examines the application in due course and issues an administrative decision within 30 days (§ 57/A.3 of the Act on District Heat Supply). Only based on this decision the district heat supplier is entitled to file an application with the price regulator (municipal council) (§ 57/A.5 of the Act on District Heat Supply).

The Hungarian Energy Agency has the following tasks:

- Price control based on applications of district heat suppliers (district heat connection fee and district heat prices for households).
- Supervision initiated at its sole discretion: Price control where the price is agreed in a contract between the district heat producer and the district heat supplier (§ 57/B.1 of the Act on District Heat Supply).

District heat prices depend on the district heat supplier and differ according to the following categories:

Consumption:

- household customer

- non-household customer

Purpose:

- heating
- warm water

Tariff rate:

- basic rate
- heat rate

General provisions on the licensing procedure according to § 12 ff. of the Act on District Heat Supply in conjunction with Government Resolution 157/2005 of 15 August 2005 on the Application of the Act on District Heat Supply:

Production and supply of district heat are activities subject to licensing. Construction and closedown of a district heat production plant with a capacity of 5 MW or more is also subject to approval. Construction comprises building, extension, rehabilitation, increase or decrease of the capacity as well as a switch to a different fuel.

If the total capacity of the district heat plant does not exceed 50 MW, a simplified licensing procedure is applied.

In case of a district heat plant with a capacity below 5 MW only an operating license must be applied for and obtained (§ 6.2 of Government Resolution 157/2005).

According to § 14.1 of the Act on District Heat Supply, the Hungarian Energy Agency and the notary of the respective community are the authorities in charge of licensing the construction and operation of heat production plants. If an environment permit or an integrative environment permit is required, the permit must be attached to the application.

According to § 16.1 the application for an operating license for district heat supply must be filed with the notary.

2.1.6 Company law

Company incorporation in Hungary

A Hungarian or a foreign natural or legal person as well as a company without a legal entity status may establish a company in Hungary. After 2006 several amendments were introduced to the Company law. A new Company Act and a new Company Registration Act came into effect on 01 July 2006 (Act IV of 2006 on companies - "Company Act" and Act V of 2006 on disclosures of company information, court and liquidation procedures - "Company Registration Act").[20]

The new Company Act (Act IV of 2006) provides for five possible legal statuses with which investors can operate in Hungary:

[20] http://de.itdhungary.com/?p=firmengrundung

- Kkt.[21] § 88-107 (unlimited partnership)
- Bt.[22] § 108-110 (limited partnership)
- Kft.[23] § 111-170 (limited liability company)
- Zrt.[24] § 171-183, § 184-284 (joint stock company - private)
- Nyrt.[25] § 171-183, § 285-315 (joint stock company - public)

After the new Company Act took effect (i.e. after 01 July 2006) companies with joint enterprise status could not be established any more. According to § 333.7 of the Company Act, the regulations of the former Company Act (Act CXLIV of 1997) are still applicable to already existing companies.

Regulations on joint stock companies also changed on 01 July 2006. The law differentiates between private (with shares offered to company founders) and public joint stock companies (with shares offered to the public). The difference must be evident in the company name.

According to § 4.1 of the Company Act a company can be established also with a "non-profit" status. The law can require that certain economic activities or business be allowed only to companies with a certain legal status (§ 2.4) or that a company be established solely after the relevant license is obtained from the authorities in due course (§ 6.1). At least two persons are required to establish a company, excluding companies with the Kft or Zrt status (§ 3.2).

The Hungarian legislation also covers the European corporate forms, such as *Societas Europaea* (SE), the European Economic Interest Grouping (EEIG)[26] and the European Cooperative Society (SCE).[27] The *Societas Europea* is regulated in Act XLV of 2004, the European Economic Interest Grouping in Act XLIX of 2003 and the European Cooperative Society in Act LXIX of 2006.

Foreign investors can operate in Hungary also in certain other legal statuses under the company law, such as a foreign private company (Act LXXII of 1998), trade agent (Act CXVII of 2000[28]), branch office of a foreign company, trade representative office or trade agent (Act CXXXII of 1997). Branch offices of foreign companies are covered in §§ 3-24 and trade agents of foreign companies are covered in §§ 25-31 of Act CXXXII of 1997.

The Hungarian company law distinguishes between two major groups – companies with and without legal entity status. Each of the five relevant company statuses is legally capable to acquire rights and accept obligations in its own name. The regis-

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[21] Közkereseti társaság

[22] Betéti társaság

[23] Korlátolt felelősségű társaság

[24] Zárt részvénytársaság

[25] Nyitott részvénytársaság

[26] http://www.ahkungarn.hu/fileadmin/ahk_ungarn/Dokumente/Bereich_RSI/Firmengruendung.pdf

[27] http://ec.europa.eu/youreurope/business/expanding-business/finding-business-partners/hungary/index_hu.htm

[28] http://de.itdhungary.com/?p=firmengrundung

tration process is however simpler and less expensive in case of Kkt. and Bt.[29] Companies without the legal entity status (partnerships) are the Bt. and the Kkt. The difference between the two statuses is the extent of the partners' liability.

According to § 108 of the Company Act at least one partner (general partner) in a Bt. has unlimited personal liability as well as joint and several liable with the other partners (limited partners) for the liabilities of the company, but the liability of the limited partners is limited to their capital contributions.[30]

According to § 88 of the Company Act, the liability of partners in a Kkt. for the liability of the company is unlimited and extends to their private property in the event the assets of the company are not sufficient to settle its the liabilities.[31]

Kft. (LLC), Zrt. (private JSC) and Nyrt. (public JSC) are companies with a legal entity status (corporations). The Kft. is established with registered share capital comprised of capital contributions in a pre-agreed amount. The liability of the company extends to all its assets.

Registered share capital

The changes in the requirements regarding the share capital after the 2005/2006 study were as follows:[32]

- Kft.: minimum required share capital reduced from HUF 3,000,000 (approx. EUR 10,964) to HUF 500,000 (approx. EUR 1,827) (§ 114.1 of the Company Act)
- Zrt.: minimum required share capital still HUF 5,000,000 (approx. EUR 18,274) (§ 207.1 of the Company Act)
- Nyrt.: minimum required share capital still HUF 20,000,000 (approx. EUR 73,094) (§ 288.1 of the Company Act); previously any Rt.[33] (JSC) had to have the minimum required share capital of HUF 20,000,000 (approx. EUR 73,094)

According to § 45 of Act XCIII of 1990, the current registration fees (fees of the company courts) are:[34]

- for Nyrt. and *Societas Europaea*: HUF 600,000 (approx. EUR 2193),
- for Bt. and Kkt.: HUF 50,000 (approx. EUR 183),
- for Zrt. and Kft.: HUF 100,000 (approx. EUR 365),

[29] http://de.itdhungary.com/?p=firmengrundung

[30] http://www.ahkungarn.hu/fileadmin/ahk_ungarn/Dokumente/Bereich_RSI/Firmengruendung.pdf

[31] http://www.ahkungarn.hu/fileadmin/ahk_ungarn/Dokumente/Bereich_RSI/Firmengruendung.pdf

[32] Exchange rate: HUF 100 = ca. EUR 0.37 at 20 March 2011 (http://www.oanda.com)

[33] Részvénytársaság

[34] Exchange rate: HUF 100 = ca. EUR 0.37 at 20 March 2011 (http://www.oanda.com)

- for a branch office: HUF 50,000 (approx. EUR 183),
- for a trade representative office of a foreign company: HUF 50,000[35] (approx. EUR 183).

The following fees are payable in addition to the above:[36]

- announcement fee of HUF 25,000 (approx. EUR 91),
- notarized sample signature card for the CEO - approx. HUF 10,000 (approx. EUR 37).

2.2 Economic framework conditions

2.2.1 Current situation at the Hungarian geothermal market

According to VITUKI estimates, only 500 of the existing 800 industrial wells are currently in operation to supply greenhouses due to the necessity of re-injection and waste water penalties in case of missing re-injection wells. It is estimated that **only** approximately 25 reinjection wells are on the total in existence.

As far as it is known, there is not a single power generation project currently in existence. One project that was developed by MOL (Hungarian Oil and Gas Company) with this objective failed due to insufficient flow rate of the production well. World Bank GeoFund provided insurance against the drilling exploration risk for this project and ultimately had to bear a considerable amount of the drilling costs due to the emergence of the insured event.[37]

Private geothermal project developing company "Pannergy" is particularly active at the Hungarian market. The business model provides for a PPP structure which is always based on collaboration with the municipal utility companies in heat supply. According to Pannergy, numerous projects are in the pipeline for the Pannonian Basin. However, the experts have not confirmed the existence of a single heat project that has entered into the operational stage.[38]

It is currently expected that more intensive utilization of geothermal energy will be possible if the municipalities become financially able to initiate and develop projects or if the economic framework conditions improve through new public subsidy concepts.

Please refer to Section "Recommendations" (2.3) for further information on the current situation.

2.2.2 Economic feasibility study

The new economic feasibility calculations did not yield any fundamental changes regarding deep geothermal projects in Hungary as compared to the 2005/2006

[35] http://de.itdhungary.com/?p=firmengrundung und http://www.ahkungarn.hu/fileadmin/ahk_ungarn/Dokumente/Bereich_RSI/Firmengruendung.pdf

[36] Exchange rate: HUF 100 = ca. EUR 0.37 at 20 March 2011 (http://www.oanda.com)

[37] Proceedings from World Bank GeoFund – IGA International Geothermal Workshop, February 16-19, 2009 - Istanbul, Turkey

[38] http://www.pannergy.hu/alap_eng.php?inc=dsp&menu_id=17

study and the original results were re-confirmed. Similar to the original calculations, the following project types were analyzed for an operation period of 20 years based on the assumptions defined at a prior stage.

- CHP heat-led,
- CHP current-led,
- Only power generation,
- Power generation with tested well,
- Heat production without existing district heating net,
- Heat production with existing district heating net.

Investment costs as well as expenses and heat revenues were recomputed applying the general inflation growth rate in Hungary[39] during 2005 to 2011. Prices published for Hungary by Eurostat and the European Commission were used for electricity[40] and oil[41]. The interest rate of 4.5% was applied to funding.

However, the both power generation models (without CHP) are still not feasible economically. As opposed to high investment costs, the feed-in tariff is not sufficiently high to ensure a rate of return for the investor which could even roughly reflect the risk.

Heat projects must be studied on case by case basis. Depending on the existing net, the quality and the need of net rehabilitation, the need to extend the net and the existing consumption capacity, certain projects can be economically feasible. Of relevance is furthermore the question what heat prices can be charged by the project developer (please refer to chapter 2.1.5).

The alternative scenario calculation has demonstrated the impact of the above aspects on the profitability of heat projects. Only the scenario with existing district heating net has yielded a positive ROE in the event the price increase is driven by the general inflation rate in Hungary. The scenario "no existing heating net" was also assessed, assuming the price increase driven by the average gas price escalation for industrial consumers in Hungary (published for 2002 to 2009) [42] and yielded a distinctively positive ROE (12.17%). This illustrates the dependence of the project profitability on realizable heat prices.

In feasibility terms and based on the assumption that the feed-in tariff is maintained for 20 years, CHP projects are the most likely project type to be realized in Hungary. The appropriate free cash flows can be generated due to higher operation time (as opposed to only heat generation which is usually limited to the heating period) and therefore better resource utilization rate combined with higher added value. Based on higher efficiency of heat production as opposed to power generation a heat-led plant is preferable to a current-led CHP plant.

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[39] Eurostat: Inflation rate of the annual average as at 31 January 2011

[40] Eurostat: Power prices for industrial consumers, without taxes, at 15 April 2011 (the last available price information for 2009 Hungary was inflated based on the average price increase 1999 to 2009 for 2011)

[41] European Commission, Directorate-General for Energy, Oil Bulletin, consumer prices for petroleum products excluding duties and taxes, as at 11 April 2011

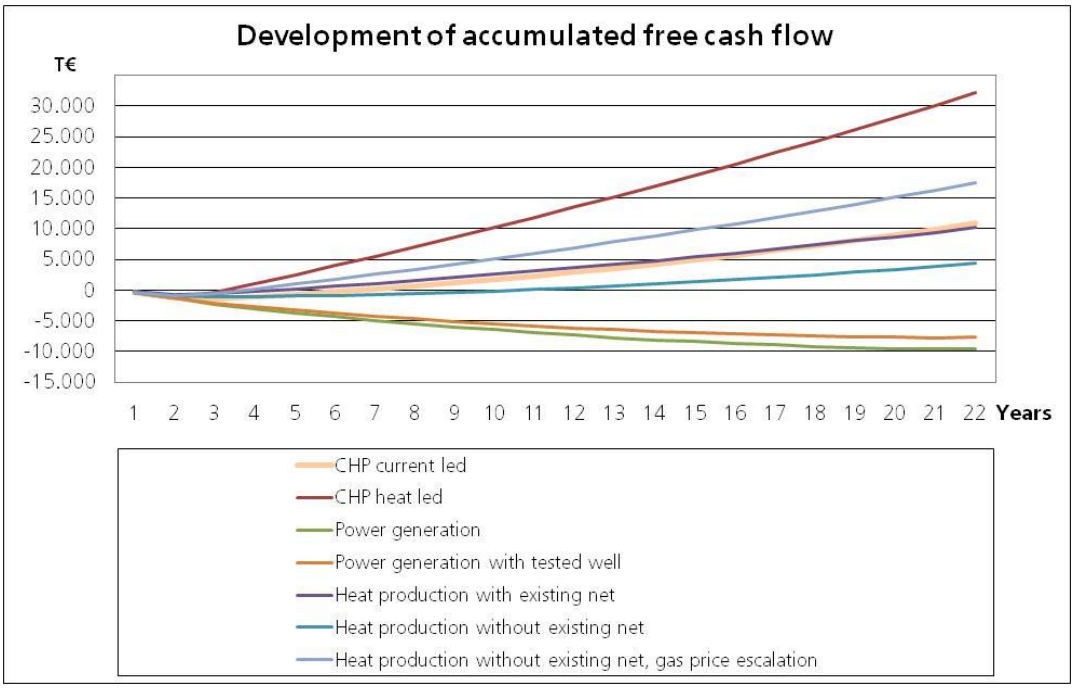
[42] Eurostat: Gas prices for industrial consumers as at 15 April 2011

It must be remembered in case of CHP projects that the barriers are combined with risks existing in Hungary in connection with power and heat remuneration. Therefore the feed-in tariff cannot be assumed as legally secure for the examined operation period of 20 years for this kind of projects. In addition project developers must accept the risk that heat price increases cannot – as it is e.g. the case in Germany – be transferred directly to the final customers.

The table below shows the calculated ROE for each individual project scenario. From our experience we noted that ROE of no less than 10 % for only electricity projects and of no less than 8% for heat or CHP-projects would have to be achieved to attract capital from private investors, e.g. within PPP projects.

Project type	**ROE**
CHP heat-led	16.19%
CHP current-led	3.73%
Power generation	negative
Power generation with tested well	negative
Heat production without existing district heating net	negative
Heat production with existing district heating net	8.69%
Heat production without existing heating net and gas price escalation	12.17%

The chart below gives an idea of the development of accumulated free cash flows from diverse project scenarios.



2.2.3 Subsidies

Subsidies to geothermal projects are possible within KEOP program (Environmental and Energy Operational Program) - one of the six operational programs under the New Hungarian Development Plan (NHDP) with the lifetime of 2007 to 2013. During this period Hungary will receive approximately EUR 4.2 billion from the EU, including EUR 215 million intended for the support of renewable energy projects. Combined with the Hungarian co-funding of EUR 38 million (15%), the total budget of EUR 253 million is available for renewable energy projects.

However subsidies do not apply to investment costs for drilling or plant installation; they are intended only to support the costs of preparatory steps, such as feasibility studies, seismic and geophysical studies, as well as project management costs.

The total of 16 projects applied for funding during 2007 to 2010. Applications of 12 projects were approved and 3 projects were rejected. One project is currently under examination. The 12 subsidized projects received on the total approximately EUR 10.3 million (HUF 2809 million[43]).[44] Therefore each project received approximately EUR 800,000 on the average.

[43] Exchange rate: EUR 1 = approx. HUF 273 as at 24 February 2011 (http://www.oanda.com)

[44] E-mail from Mr. Jozsef Bánfi, Energia Központ Nonprofit Kft., of 24 February 2011

2.3 Recommendations

2.3.1 Mining law

A positive development worth mention is that the mining authorities will announce tenders for two mining concessions already in 2011. The process has not started yet, so no further information is available so far regarding the location, type of the reservoir or intended use of geothermal energy.

However it is clear from the discussion on the mining law (Section 2.1.1) that the reservoirs must be located in deeper layers (> 2500 m), which makes them a possible source for power production depending on the actual temperatures. A cascade or CHP utilization is therefore also within the realms of possible.

The approach to find a company for exploration and utilization based on the awards of the concession tender is basically "historically" inherent to the Hungarian mining law (see Section 2.1.1).[45]

The advantages and disadvantages of such an approach practiced by the authorities were discussed during the workshop. As opposed to the German mining law, the most striking thing is that concessions do not comply with the German legal framework. The German system basically allows any legal person to apply for an exploration permit and only subsequently the authorities determine the area of the licensed territory, so exploration permits can be granted very quickly. Thus the enormous administrative efforts are avoided to hold a concession tender.

The investment-friendly climate in Germany resulted in the granting of numerous exploration licenses and ultimately in the implementation of numerous projects. An efficient administrative procedure seems hard to implement within the Hungarian system.

Furthermore the criteria underlying the selection process are quite complex, therefore a transparent process must be ensured to all bidders from the very beginning. In Hungary the panel (the "qualification committee") with the authority to grant mining concessions is comprised of politicians rather than experts on mining law or geology. Therefore an lobbying influence cannot be excluded and it is not certain that the concession will be necessarily awarded to the best bidder with the best chances to succeed (in terms of optimized utilization of the available resource).

2.3.2 Water legislation

The Hungarian water law gives the Water Authorities a relatively strong position in case of drilling (with re-injection) to the depth of max. 2500 m.

According to Vituki, this category covers approximately 800 wells which are used in the agricultural sector to supply greenhouses. Allegedly approximately 500 wells of those 800 were still in operation in 2011. According to the workshop attendees, the obligation to re-inject (dating back to 2006) was fulfilled in case of only 25 reinjection wells.

This situation creates an enormous threat of differences between economic and environmental interests. Although the obligation to re-inject was introduced in 2006 and has been in existence since then to protect the aquifer and to ensure sustainable use (reservoir pressure) and it has been promoted with economic tools (increased

[45] According to the Hungarian Mining and Geology Agency

waste water fees for the discharge of thermal water into surface water), the number of reinjection wells is quite disillusioning.

The new water regulations (2010) granted an exemption from the obligation to reinject. Therefore the operators have postponed their investments into reinjection wells.

The exemption from the obligation to re-inject is still in existence due to economic interests. From our point of view, the requirement for sustainable operation can only be implemented via subsidies to make possible the required investments in reinjection wells. The compliant operation of water installations can hardly be monitored due to their high number. Furthermore operators should be aware of the consequences of using the aquifers without reinjection. The discussion between the Hungarian and German experts during the workshop on 17 February 2011 (please refer to Section 3.4) has demonstrated the basic feasibility of reinjection from technical or geo-technical point of view.

The Mining Agency is only consulted for the purpose of quality control in case of wells less than 2500 m deep. It seems that the Water Authority and the Mining and Geology Agency have no shared data bases, thus preventing a consistent approach. The issue of geothermal utilization requires close cooperation between the mining and water authorities.

2.3.3 Feed-in tariffs

In Germany the Renewable Energy Sources Act (EEG) has enabled rapid expansion of renewable energy since 2000. The key reason is the stable and legally secure framework conditions for feed-in tariffs for electricity from the renewable energy sources. The transparency and calculability of the projects has resulted in billions of Euros of investments, which caused the increase in the portion of renewable energy in the total electricity generation in Germany up to almost 17% during 2010. Even geothermal energy as a very young technology already yields currently on the total 6.7 MW_{el} of installed capacity.

In Hungary the legal framework for investments in geothermal power generation does not remove the uncertainty. The feed-in tariff is actually fixed in the regulations but because the duration of payment and the total quantity of electricity to be paid is determined for each project individually according to benchmarks (by the Hungarian Energy Agency), the required transparency level is not ensured for the investments in renewable energy sources.

Therefore the environment is not sufficiently investment-friendly. due to the following reasons, among others:

- The administrative effort is huge; it could be reduced considerably via cross-project determination of tariffs.
- The transparent determination of tariffs - at least for each year - would give the investors a legally secure basis for revenue estimates - especially so, because investments in a plant that uses renewable energy require a relatively long project phase preparatory to commissioning. In case of geothermal electricity generation the preparatory phase before feed-in can be 2-3 years.
- Purchase prices are only fixed for a certain period of time and therefore the investor cannot be certain about the future after the guaranteed purchase period.

The parliament is **currently** discussing new payment regulations. It is possible to create a more investment-friendly climate by setting long-term and diversified tariffs depending on the technology and capacity. Furthermore the tariffs should not be determined for each project independently; they should be based on the benchmarks for the respective technology.

The tenders for mining concessions will show if any investors can be found who invest into geothermal power generation based on the new regulations.

If Hungary is politically committed to geothermal power production, it is very likely that feed-in tariffs will be increased to ensure the appropriate risk-to-award ratio for the investments.

2.3.4 Determination of district heating prices

No amendments were introduced to the regulations for determination of district heating prices after the basic 2005/2006 study. Only the duties were re-allocated between the Hungarian Energy Agency and the responsible Minister (currently the Ministry of National Development).

In Germany any district heating net operator is basically free to set prices at its discretion as long as the "Regulation on general terms and conditions for the supply with district heating" ('AVBFernwärmeV') of 20 June 1980 is complied with. The pricing development must be in line with the pricing trend, as determined in the heat supply contract according to AVBFernwärmeV. On the one hand the investor or operator of the district heat net is in competition with alternative heat sources and at the same time it is restricted in the exercise of its market power. This approach is generally acceptable to operators and customers.

In Hungary the law requires that district heat prices must always be determined by the counsel of the municipality where the supply takes place (please refer to Section 2.1.5). For this reason economic operation driven by the development of the heat market on the one hand and the fuel market on the other hand is not possible.

This regulation applies to all renewable energy projects.

In Hungary investments into new or existing nets can be realized as PPP (public-private-partnership). The existing regulations prevent such investments and do not ensure the investment-friendly climate - especially for foreign investments.

3 PROJECT CONCLUSIONS

3.1 Measures to secure a long-lasting impact of the project

An exchange of experts on water legislation (water protection) is currently planned between the German Environment Agency and the Hungarian Ministry for Rural Development within the framework of the German-Hungarian Environmental Cooperation. It would be helpful for the environment-friendly extension of deep geothermal energy in Hungary to discuss the water legislation in conjunction with the requirements on geothermal energy extraction.

Furthermore contacts were established with Mr. Rainer Zimmer, Mining Director (Department "Mining, Mineral Raw Material, Mining Supervision", Bavarian State Ministry of Economic Affairs, Infrastructure, Transport and Technology). In Bavaria he is in charge of examining applications and granting exploration and extraction licenses for geothermal use license areas. In this position he is acquainted best with the critical issues arising in Germany in connection with the successful project implementation. Mr. Zimmer has expressed his willingness to cooperate with the Hungarian colleagues in the Mining and Geology Agency within the framework of the experience sharing between the authorities (in Munich or in Budapest).[46]

Upon inquiry the Bavarian State Ministry of Economic Affairs, Infrastructure, Transport and Technology has made available the following information sheets:

- Recommendations to applicants for licenses to explore geothermal energy of 01 May 2007;
- Recommendations to applicants for licenses to extract geothermal energy (hydrothermal geothermal energy) of 01 December 2010;
- Development of deep geothermal energy in Bavaria;
- Information sheet "Geothermal Energy" of December 2010.

Rödl & Partner made all information sheets available to the workshop participants via download server.

Furthermore certain workshop participants expressed their interest to receive the 2005/2006 benchmark study. The study can only be made available in the long version.

3.2 Project assessment by the project contractor

When updating the 2005/2006 study, the Hungarian experts on mining, water and energy legislation were contacted to obtain information on the current developments in Hungary and in particular on the existing political plans to introduce amendments to the law. Generally the contacted experts showed great interest and were very cooperative. Due to the high workload in connection with the currently mandatory calculation of the feed-in tariff for each single case and the expected

[46] Acceptance by phone, 23 February 2011

amendments to the law on feed-in tariffs, the energy experts found it especially difficult to provide more detailed information. Owing to the cooperation of the Hungarian experts, a perspective could be included into the report on possible future developments in addition to the current applicable legal framework.

Very informative discussions were held with representatives of the Hungarian Mining and Geology Agency, Vituki and MEH during the preparatory trip to Budapest (25-27 January 2011).

Despite the relatively short project duration, a body of experts could be gathered for the workshop to cover a broad range of topics pertaining to the utilization of geothermal energy.

Unfortunately Mr. József Bánfi had to cancel his participation at the workshop on short notice due to another appointment, but he still provided further information concerning subsidy possibilities for deep-seated geothermal projects.

In preparation of the workshop, presentations were directly coordinated between the two geological experts Dr. Jörn Bartels, GTN (Germany) and Dr. János Szanyi, Geothermal Coordinating and Innovation Foundation (Hungary) on issues connected with reinjection.

The speakers made available all presentations for further distribution.

The project objective "Capacity Building" included in the project application was achieved via dissemination of the study results and experience sharing with the Hungarian institutions during the workshop. The Hungarian experts (in particular those on mining and water legislation) are very interested to use the German experience as a reference point and the basis for comparison during the further development of the legal framework in Hungary. The legal framework on mining and water is currently at a turning point. The existing norms must be complied with although they are partly very bureaucratic and extremely complex. An attempt was made to ensure maximum transparency via close coordination with the Hungarian Mining and Geology Agency.

3.3 Project assessment by the beneficiary

During the expert workshop, animated discussions took place among the participants concerning the differing legal framework in Hungary and in Germany. Many participants expressed their interest to obtain the original 2005/2006 benchmark study. Also interest was expressed to continue experience sharing between the involved authorities.

Ms. Gabriella Jelinek, Ministry of Rural Development, who unfortunately had to cancel her participation at the workshop, has mentioned out in the follow-up that the experience-sharing between the authorities is planned currently on water legislation within the framework of the German-Hungarian Environmental Cooperation.

Furthermore many participants were interested in the information sheets of the Bavarian State Ministry of Economic Affairs, Infrastructure, Transport and Technology on the allocation of exploration and extraction fields as a reference point for comparison of the current development of tender award criteria for granting of concessions.

3.4 Project documentation

3.4.1 Workshop Agenda on 17 February 2011

Workshop "Geothermal energy in Hungary - update barriers and solution statements"			
From	**To**	**Agenda**	**Speaker**
09:00	**09:05**	Address of welcome by Hungarian Office for Mining and Geology	Dr. József Molnár, Hungarian Office for Mining and Geology
09:05	**09:10**	Address of welcome by German Federal Environment Agency	Ms. Christiane Lohse, German Federal Environment Agency
09:10	**09:20**	Address of welcome and presentation of workshop program	Mr. Kai Imolauer, Rödl & Partner
09:20	**09:30**	Round of introductions	All
09:30	**11:10**	Topic: Award of geothermal concession/license	
		10 min Presentation of situation in Germany	Mr. Kai Imolauer, Rödl & Partner
		10 min Geophysical modeling	Dr. Jörn Bartels, Geothermie Neubrandenburg GmbH
		20 min Presentation of situation in Hungary	Dr. Tamás Hámor, Hungarian Office for Mining and Geology
		60 min Discussion	All
11:10	**11:30**	*Coffee break*	
11:30	**13:10**	Topic: Reinjection	
		20 min Presentation of experiences in Germany	Dr. Jörn Bartels, Geothermie Neubrandenburg GmbH
		20 min Presentation of experiences in Hungary	Dr. János Szanyi, Geothermal Coordinating and Innovation Foundation
		60 min Discussion	All
13:10	**14:00**	*Lunch break*	
14:00	**15:30**	Topic: Feed-in-tariffs regarding geothermal energy	
		15 min Presentation of German Renewable Energy Act	Mr. Kai Imolauer, Rödl & Partner
		15 min Presentation of planned new feed-in-tariff structure in Hungary	Mr. Attila Bagi, Hungarian Energy Office (MEH)
		60 min Discussion	All
15:30	**15:45**	*Coffee break*	
15:45	**16:45**	Topic: District heating / price regulations	
		15 min Presentation of situation in Germany	Mr. Kai Imolauer, Rödl & Partner
		15 min Presentation of situation in Hungary	Ms. Zsuzsanna Serra - Rödl & Partner
		30 min Discussion	All
16:45	**17:15**	Discussion and conclusion	Ms. Christiane Lohse, German Federal Environment Agency / All

3.4.2 List of workshop participants, 17 February 2011

No.	Name	Company/Authority	Title
1.	Dr. József Molnár	MBFH Hungarian Mining and Geology Agency	Vice president
2.	Dr. Tamás Hámor	MBFH Hungarian Mining and Geology Agency	Head of section
3.	Krisztián Klima	MBFH Hungarian Mining and Geology Agency	Consultant
4.	Hámorné Dr. Mária Vidó	ELGI Eötvös Lorand Geophysical Institute of Hungary	Vice president
5.	Dr. Annamária Nádor	MŔFI Geological Institute of Hungary	Vice president
6.	Attila Bagi	MEH	Strategy advisor
7.	Dr. János Szanyi	Geothermal Coordinating and Innovation Foundation	President
8.	Christiane Lohse	Federal Environment Agency	Scientific Advisor for Geothermal Energy of German Ministry for Environment
9.	Dr. Jörn Bartels	GTN Geothermie Neubrandenburg GmbH	Geophysicist
10.	Stefan Sieferer	Rödl & Partner	Attorney Partner
11.	Kai Imolauer	Rödl & Partner	Economic Engineer Associate partner
12.	Zsuzsanna Serra	Rödl & Partner	Lawyer

Furthermore the following persons were invited to the workshop but could not attend:

- Ms. Gabrielle Jelinek, Head of Section, Ministry of Rural Development
- Mr. József Bánfi, Energia Központ Nonprofit Kft.

3.4.3 Workshop presentations, 17 February 2011

No.	Topic	Speaker	Company/Authority
1.	Introduction - Advisory Assistance Program for Environmental Protection in Central and Eastern Europe, the Caucasus and Central Asia	Christiane Lohse	German Federal Environment Agency
2.	Geothermal Energy Mining Law in Germany	Kai Imolauer	Rödl & Partner
3.	Dimensioning of geothermal concession areas by means of hydraulic and thermal stimulation	Dr. Jörn Bartels	Geothermie Neubrandenburg GmbH
4.	Update on the geothermal regulatory framework in Hungary: the mining legislation development	Tamás Hámor	MBFH - Hungarian Mining Office
5.	Reinjection into sandstone: German experience	Dr. Jörn Bartels	Geothermie Neubrandenburg GmbH
6.	History of reinjection into porous geothermal reservoirs in Hungary	Dr. János Szanyi	Geothermal Coordinating and Innovation Foundation
7.	Feed-in-tariffs on geothermal energy - German Renewable Energy Act	Kai Imolauer	Rödl & Partner
8.	Feed-in-tariff structure in Hungary	Attila Bagi	MEH – Hungarian Energy Agency
9.	German regulations & heat pricing model	Kai Imolauer	Rödl & Partner
10.	District heating/price regulation in Hungary	Zsuzsanna Serra	Rödl & Partner

4 APPENDICES

4.1 Appendix 1: Presentations of the workshop on 17 February 2011

4.1.1 Introduction - Advisory Assistance Program for Environmental Protection in Central and Eastern Europe, the Caucasus and Central Asia

4.1.2 Geothermal Energy Mining Law in Germany

4.1.3 Dimensioning of geothermal concession areas by means of hydraulic and thermal stimulation

4.1.4 Update on the geothermal regulatory framework in Hungary: the mining legislation development

4.1.5 Reinjection into sandstone: German experience

4.1.6 History of reinjection into porous geothermal reservoirs in Hungary

4.1.7 Feed-in-tariffs regarding geothermal energy - German Renewable Energy Act

4.1.8 Feed-in-tariff structure in Hungary

4.1.9 German regulations & heat price modeling

4.1.10 District heating / price regulation in Hungary

4.2 Anhang 2: Merkblätter des Bayerischen Staatsministeriums für Wirtschaft, Infrastruktur, Verkehr und Technologie

4.2.1 Hinweise zur Antragstellung bei Erlaubnissen zur Aufsuchung von Erdwärme vom 01.05.2007

4.2.2 Hinweise zur Antragstellung bei Bewilligungen zur Gewinnung von Erdwärme (hydrothermale Geothermie) vom 01.12.2010

4.2.3 Ausbau der Tiefengeothermie in Bayern

4.2.4 Merkblatt Geothermie von 12/2010

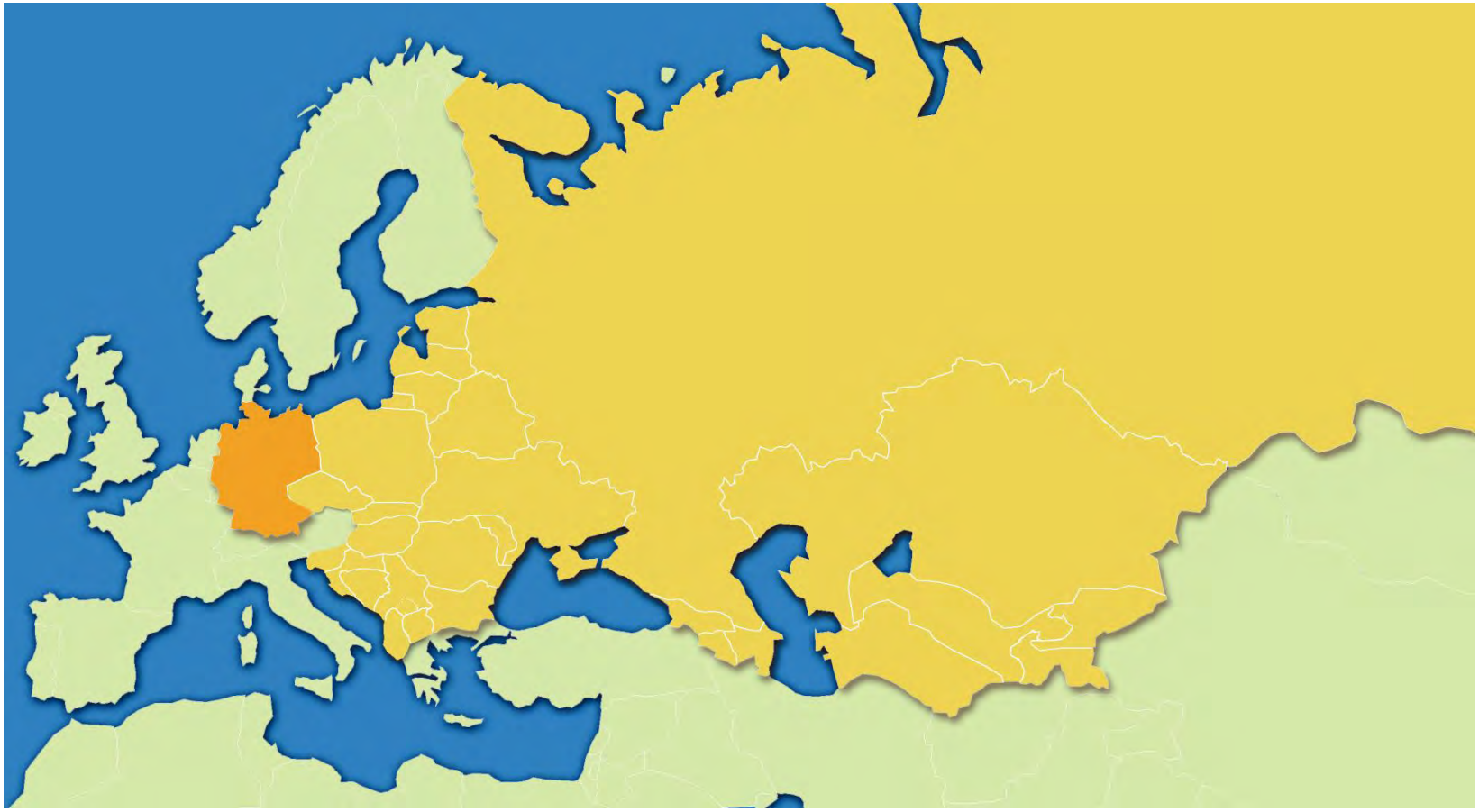
Umwelt Bundes Amt
for our Environment

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Advisory Assistance Programme for Environmental Protection in Central and Eastern Europe, the Caucasus and Central Asia

Christiane Lohse
Federal Environment Agency
Renewable Energy – Geothermal Energy

Environmental Protection in Central and Eastern Europe, the Caucasus and Central Asia



Advisory Assistance Programme – how does it work?

Consultation projects

- in cooperation with regional and German partners
- on relevant environmental issues
- aiming to adopt EU environmental standards
- aiming to realize climate protection targets

  (20 / 20 / 20 by 2020)

The deep well drilling tower in Unterhaching, Germany

Advisory Assistance Programme – rough figures

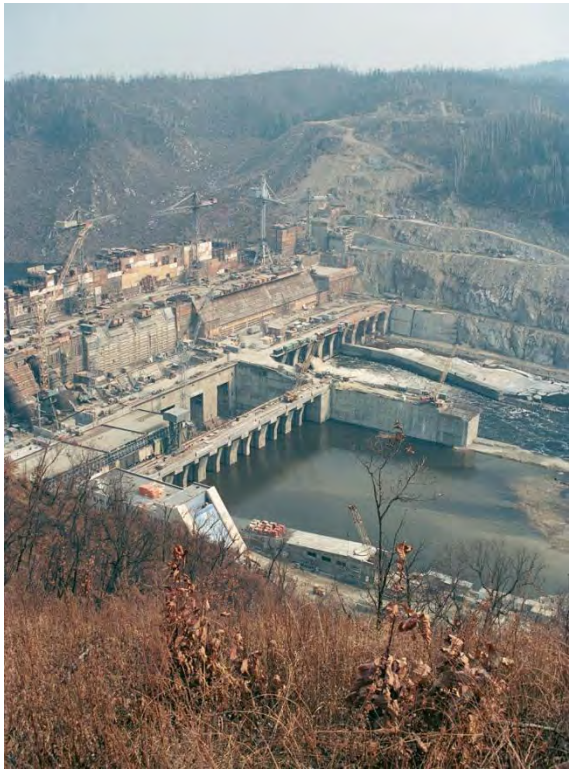
Start of the programme: 2000

Budget: 2.74 Mio. EUR / year (from 2010 on)

Number of ongoing projects / year:

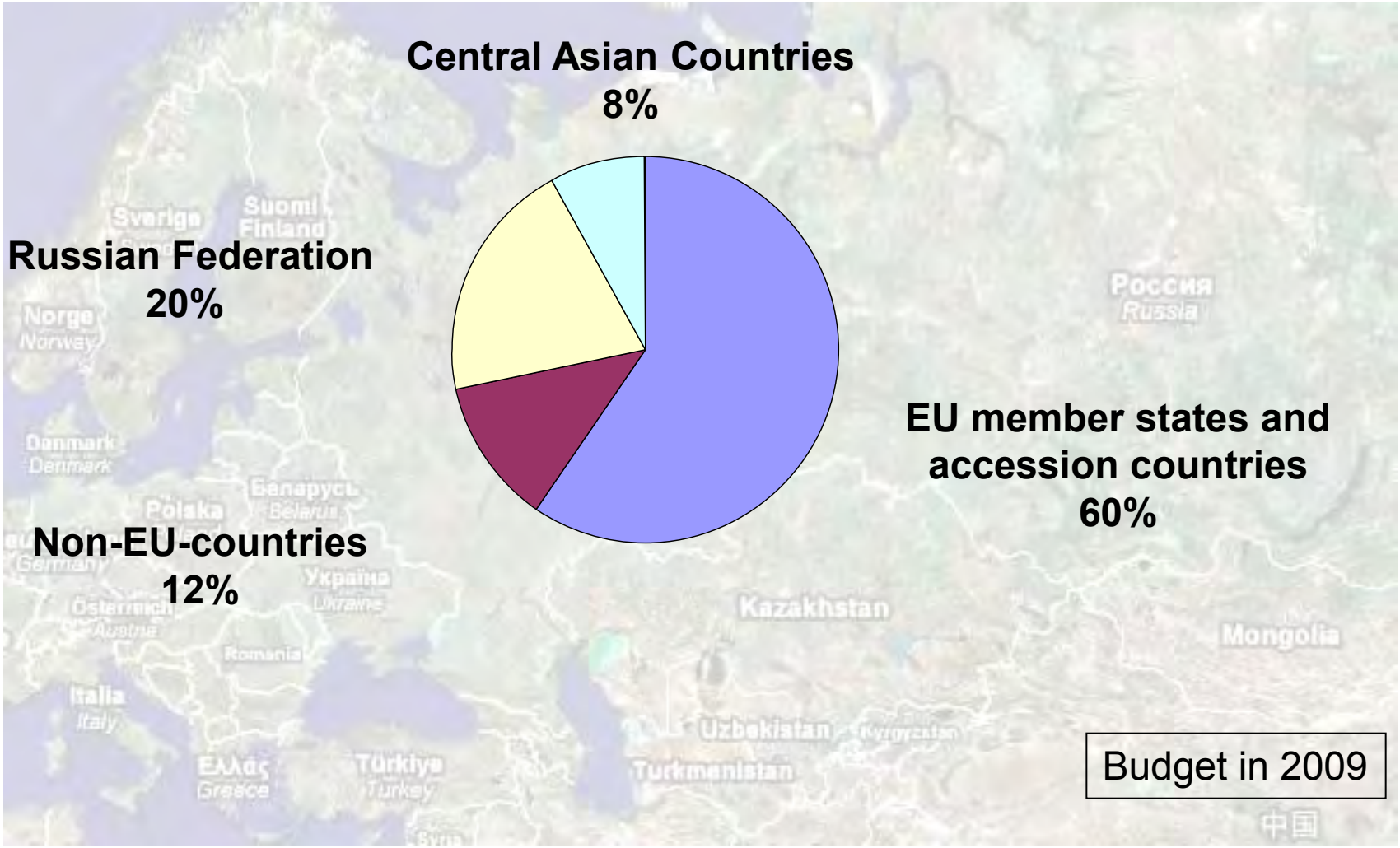
approx. 45

Budget per project: about 50,000 EUR



Bureyskaya hydropower project in Russia

Regional focus



Advisory Assistance Programme – measures and characteristics

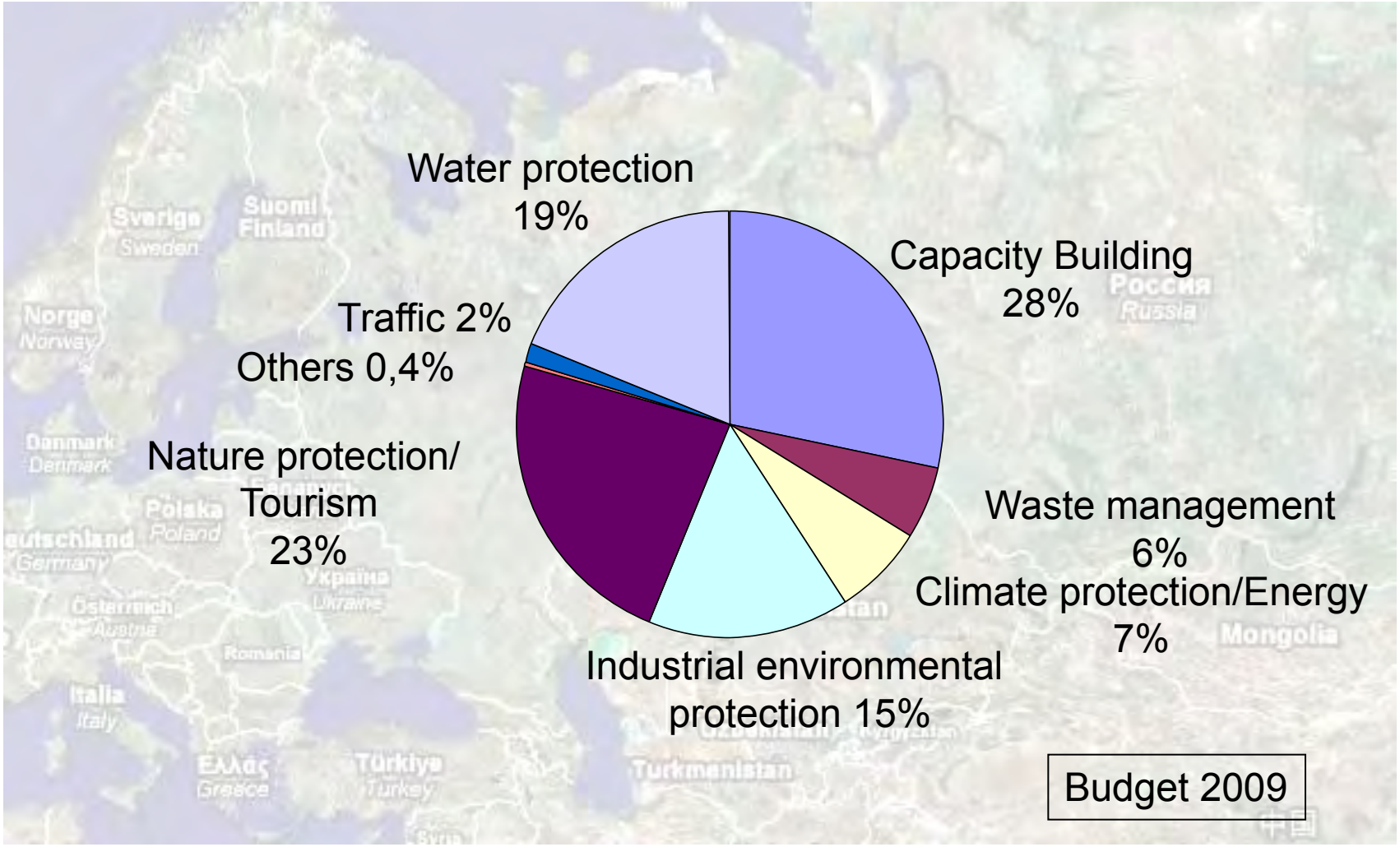
Measures:

- Knowledge transfer
- Raising awareness
- Institution building
- Preparation of investment projects

Project characteristics:

- Improve environmental situation
- Serve as models
- Initiate ongoing activities in the project region
- Support cross-border cooperation

Thematic focus



Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

Umwelt Bundes Amt
Für Mensch und Umwelt

BfN Bundesamt für Naturschutz

Rödl & Partner

Geothermal Energy

Mining Law in Germany

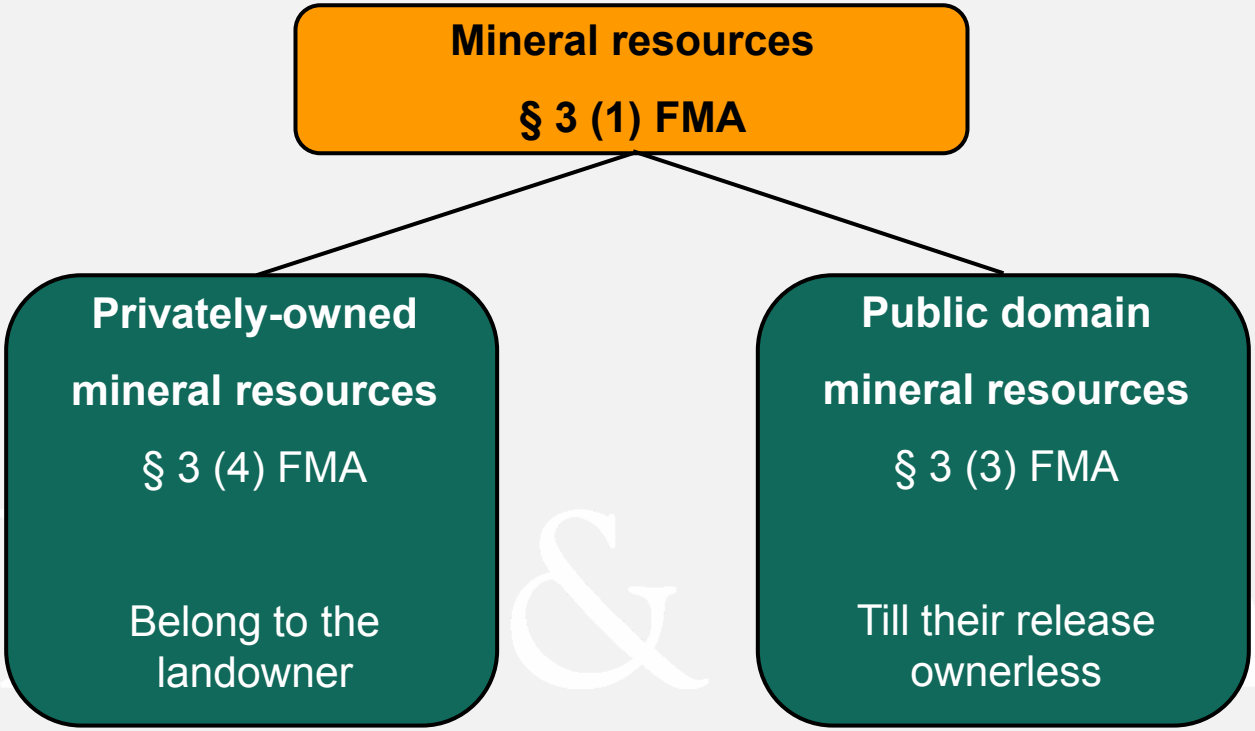
Budapest, 17 February 2011

Attorneys
Auditors
Tax Consultants
Business Consultants

Mining Act

According to the Federal Mining Act (FMA), geothermal energy is a **public domain mineral resource**, i.e. it does not depend on the real property and is ownerless till release.

A mining entitlement is necessary for the legally effective appropriation.



Mining Act

Exploration & Exploitation

Rödl & Partner

Exploration, § 4 (1) FMA:

Exploration is the activity directly or indirectly aimed at discovering or determining the expansion of mineral resources.

Exploitation, § 4 (2) FMA:

Exploitation is the dismantling or releasing of mineral resources including the connected preparatory, accompanying and succeeding activities.

Mining Act

Exploration & Exploitation permit

Rödl & Partner

Policy § 6 (1) FMA:

Those who want to explore public domain mineral resources need a permission. Those who want to recover public domain mineral resources need the exploration & exploitation permit.

- The exploration permit confers the exclusive right to prospect for the mineral resources specified therein within a “area”. Prospecting means activities aimed at exploring mineral resources or determining the extent of the deposit, which can involve prospecting and/or exploration (§ 7 FMA).
- Those who wish to exploit mineral resources require an exploitation permit. An exploitation permit grants the exclusive right to extract specific public domain mineral resources within specified area. The license holder may also exploit mineral resources which are not listed in the license where these are necessarily obtained for technical and safety reasons (§ 8 FMA).

Mining Act
Premises

Rödl & Partner

Application has to be submitted formal in written form to the responsible authority (§ 10 (2) FMA), which is determined according the competence regulation of the federal states.

§§ 11 & 12 FMA regulate the cause of denying the grant of exploration and exploitation permit.

There is no administrative tolerance for the authority.

Main causes of denying:

- No precise definition of the mineral resources
- No exact information of the exploration area
- No sufficient information of the working program
- No sufficient capital proof
- No sufficient proof for responsibility of the liable person

Mining Act
Respites

Rödl & Partner

Exploration:

- Limited to a period of three years; extendable to a maximum of 8 years
- Extended by three years in each case, as far as the permit field in spite of scheduled exploration coordinated with the responsible authority could not be examined yet enough (§ 16 (4) FMA)

Exploitation permit:

- Adequate time period has to be determined
- As a rule 50 years should not be exceeded
- Excess and extension is possible under the conditions of § 16 (5) FMA

Mining Act

Transferability of the exploration & exploitation permit

Rödl & Partner

§ 22 (1) FMA:

The transference of the permission on a third or the participation of third is allowed only with approval of the responsible authority. The approval of the authority may be refused only because of reasons counting to the permission and approval procedure.

→ Hamper speculation & passing to other companies

Mining Act

Exploration & exploitation permit

Rödl & Partner

Exploration and exploitation permit regulate that a project may be carried out.

Operation plans regulate how a project may be carried out, e.g., drilling operation plan, drilling site construction plan, operation plan for the thermal water pipeline.

Mining authority:

- All activities connected to mining are regulated by the mining authority
- Is entitled to demand all required information as well as presentation of the business and operational documents
- Is entitled to enter company properties, offices and facilities and to conduct investigations as well as to take probes charging the company

Mining Act

Competition of several applications

Rödl & Partner

Exploration – Exploitation permit:

Principle of priority § 14 (2) FMA

The applicant who has already applied for a exploration permit receives the exploration permit with priority.

Several applications for explorations permit:

No principle of priority!

Precedence of the best application according to a sensible and scheduled process.

Mining Act

Demand for investor's view

Rödl & Partner

Exclusive usage of the permit field

Requirements for permission area:

- Sufficient size (Germany approx. 36 km²)
- Suitable shape for future utilization
- Valid for sufficiently long period (approx. 4 years) to assure project development
- Application possible for all legal persons
- Proof of financial ability & expert knowledge
- First come, first served or tender procedure

Mining Act

Critical acclaim of German regulations

Rödl & Partner

- **Distance** between exploration and exploitation fields not determined
- **Speculation:** as there is always the possibility to lodge an appeal, the holder of an exploration concession can lengthen the period from 3 up to 8 years
- **Approval of financial ability:** is not regulated on national level, therefore executed in different manner in regions; also unclear how to be treated in administrative process
- **General "conflict" between water and mining law:** Water aims to protect as much as possible to reduce any impact; Mining Law aims to enable a maximum use of resources
- **Size of exploration areas:** firstly fixed by investor (applicant); exploitation areas usually as large as exploration or smaller

Mining Act

Critical acclaim of German regulations

Rödl & Partner

- **Conflict situation with neighboring exploitation areas:** an impact in general – e.g. higher electricity effort for pumping could be accepted if compensated by the originator; nevertheless a stronger impact has to be avoided (if project becomes not realizable – e.g. larger pump not available)
- **§ 9 FMA "Mining property"** – ideal instrument to assure the utilization of geothermal resources; even possible to charge on land of the mine owner. Not known, if already established for a geothermal project.
- Concession fee established, but so far not charged by authorities, due to ecological purpose of geothermal energy production (BUT: can amount to 10% of turn over, at the moment the project company realizes a taxable profit).

Thank you for your attention…

Kai Imolauer
Economic Engineer
Associate Partner

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Fax: +49 (9 11) 9193-35 49

kai.imolauer@roedl.de

Dimensioning of geothermal concession areas by means of hydraulic and thermal simulation

Jörn Bartels

Geothermie Neubrandenburg GmbH

Workshop “Geothermal energy in Hungary – update barriers and solution statements”;
Budapest 17 February 2011

GTN INGENIEURE & GEOLOGEN

1. Criteria on the claim outline

2. Demands on the heat mining prognosis
    a. Geophysical determination of the input parameters
    b. Model size, model structure and verification

3. Examples of thermo-hydraulic simulations

Content

GTN INGENIEURE & GEOLOGEN

Dimensioning of geothermal concession areas

The concession area should protect the operation of the geothermal installation and the investment .

but also

Its spatial limitation should enable further reasonable, economic utilization of geothermal heat within an acceptable distance, i.e. outside the mining claim

General principle

GTN INGENIEURE & GEOLOGEN

Criteria on claim outline

Vertically:

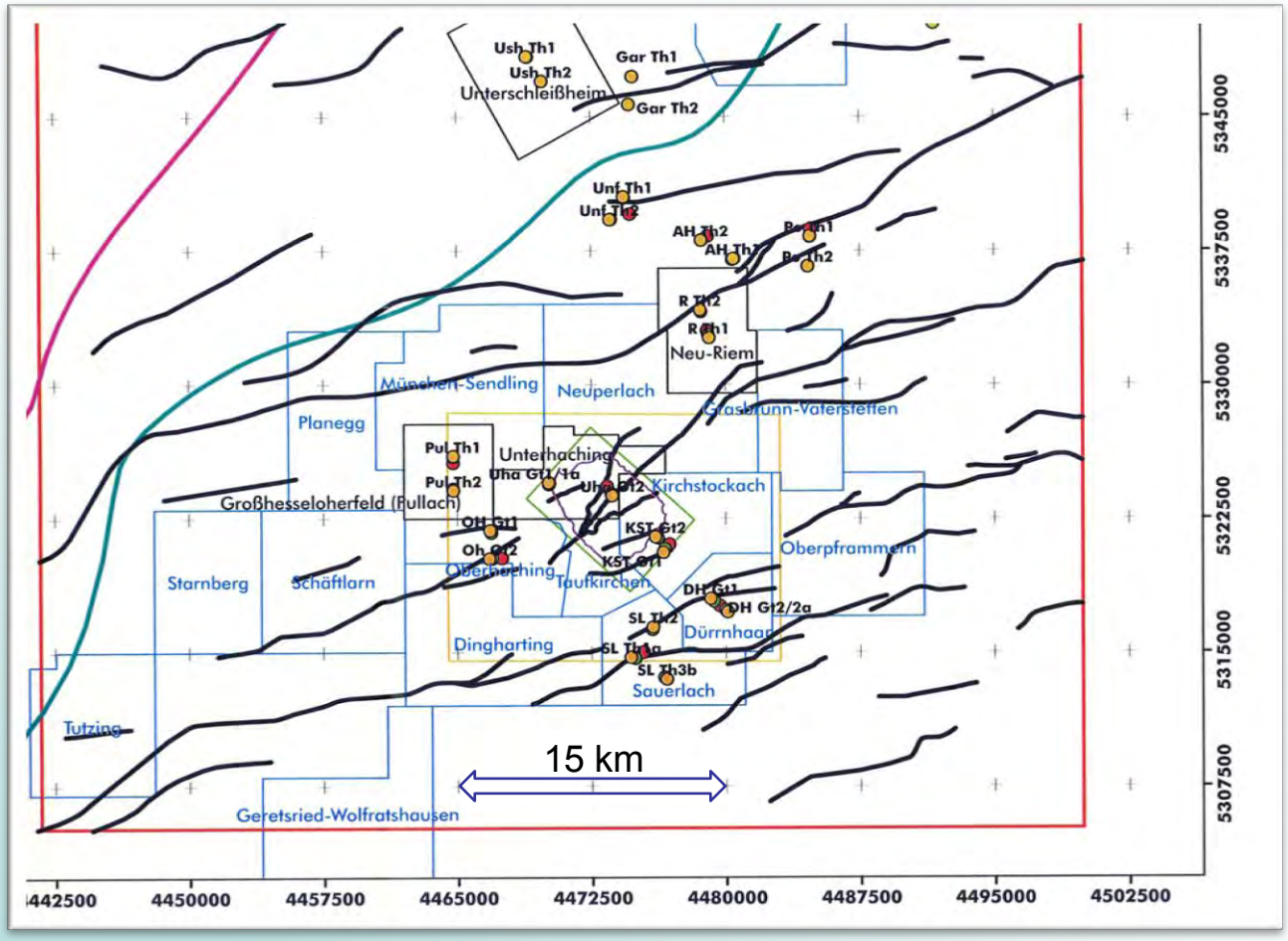
1. The licensee owns the exclusive heat exploitation right from surface to the middle of the earth

Horizontally:

1. Generally, a new concession area has to be large enough to ensure that the hydraulic and thermal impact of the geothermal well operation at its boundaries is lower than a certain value, i.e. the influence **on and of** neighbouring geothermal wells is limited.
2. This impact has to be predicted in some way. Prediction period is equal to the concession period.
3. The limiting values for maximum induced pressure and temperature change at the claim boundary and application are not the same in the individual Federal States.
4. Limits and criteria are still changing.

GTN INGENIEURE & GEOLOGEN

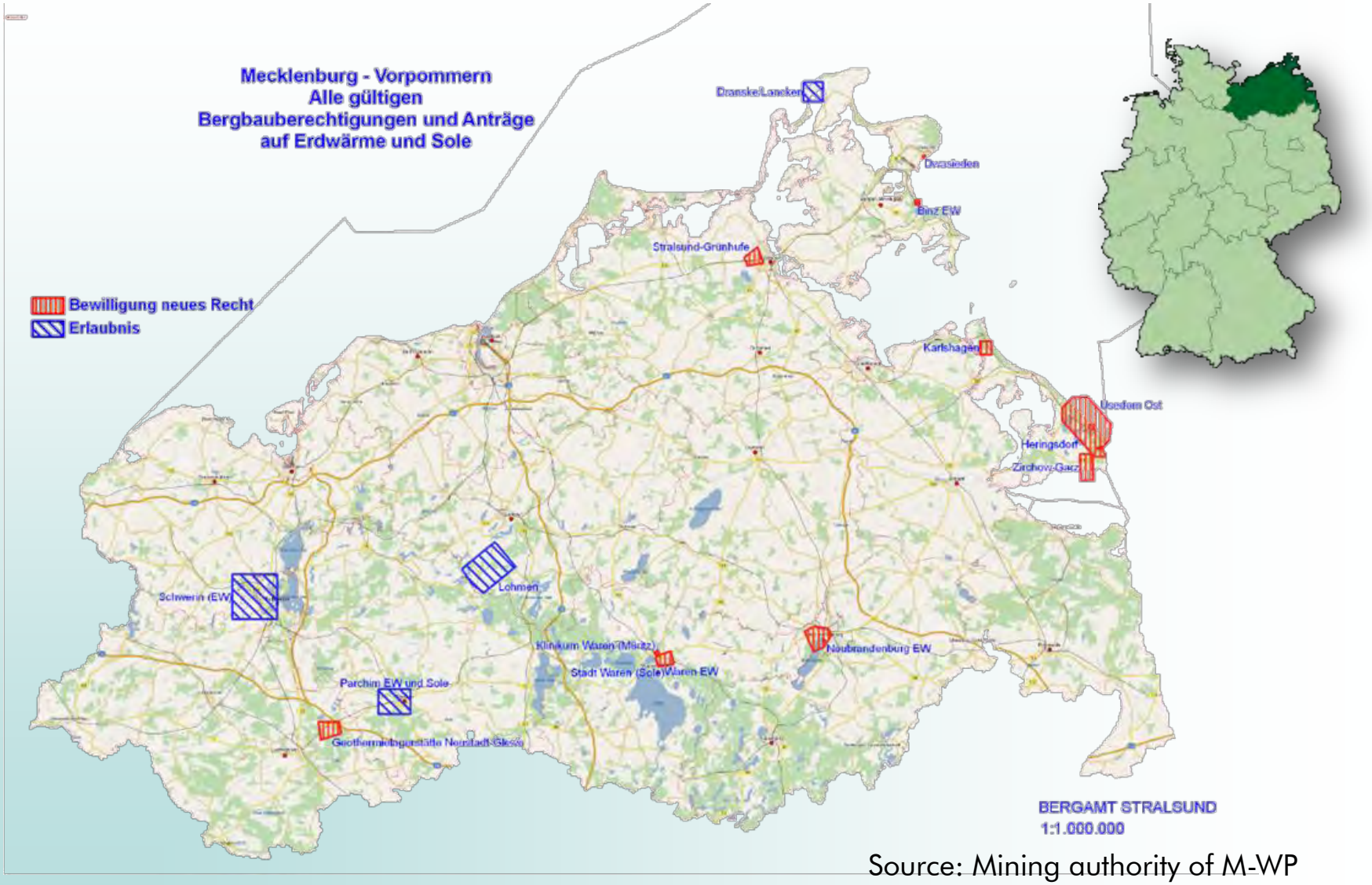
Criteria on claim outline



Situation 1:
Many neighbouring exploration claims around Munich

GTN INGENIEURE & GEOLOGEN

Criteria to claim outline



Source: Mining authority of M-WP (2011)

Situation 2: Concession areas in Mecklenburg-West Pommerania (NE-Germany)

GTN INGENIEURE & GEOLOGEN

Criteria to claim outline

e.g. Bavaria, Mecklenburg-West Pommerania, Brandenburg,..:

a. ±0,1** to±1-bar pressure change isobar around the wells *
b. 1-Kelvin-cooling isotherm around the injection well***
c. Existing claim boundaries

- at the end of the concession period (30 -50 years)
- determined by means of a calibrated groundwater simulation model
- !! permitted production rate can be further limited in the water law licensing procedure
- strict first-come first-served policy, if technical and financial quality of the applicant is sufficient

* in Bavaria guideline only, "no production or injection restriction at existing neighbouring geothermal wells are acceptable"

** in Brandenburg 0,1 bar only

*** the cooled zone is always smaller than the pressure-affected zone

Typical outline criteria

GTN INGENIEURE & GEOLOGEN

Criteria on claim outline

The protective function is more and more transferred from the concession area to a proof, that operation of existing and licensed wells won't be restricted by the applicant.

This proof has to be part of the application documents: Heat mining prognosis

Presented criteria are still important for new exploration claims without neighbours.

GTN
INGENIEURE
& GEOLOGEN

Demands on the heat mining prognosis

Bavaria (other Federal States similar or less):

- evaluation of available seismic data
- current drilling results
- results of the hydraulic tests incl. reaction measurements in neighbouring wells (Note: reaction measurement is compulsory for neighbours with a concession for exploration or exploitation and at his own cost)
  - short term productivity tests (days)
  - long term circulation test (weeks)
- state of knowledge in the geologic and mining authorities of the Federal State concerned

Required exploration basis

GTN INGENIEURE & GEOLOGEN

Demands on the heat mining prognosis

Consistent set of models, i.e.

1. Structure model
   - Layer structure
   - Fault zones
2. Hydrogeological model which explains
   - main production sections of the wells
   - hydraulic test results incl. reaction measurements (model verification)
3. Temperature model
   - based on temperature measurement at top aquifer & bottom hole
   - "undisturbed" temperature log measured directly before installing submersible pump

Model area: by far larger than the concession area, but at least covering the neighbouring mining claims

Required exploration basis of the simulation model

GTN INGENIEURE & GEOLOGEN

Demands on the heat mining prognosis

- Software package for modeling fluid flow, transport of dissolved constituents and heat transfer in the subsurface

- Completely integrated system from simulation engine to graphical user interface

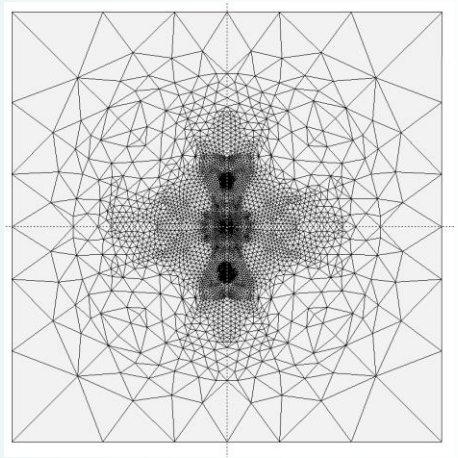
- Public programming interface for user code

- Strength (jb): real time simulation control, productivity

- **Accepted by German mining authorities**

GTN standard tool:

FE-Simulator FEFLOW (DHI-WASY GmbH Berlin, v. 6.0)



Optimized mesh for a geothermal doublet

Simulator example

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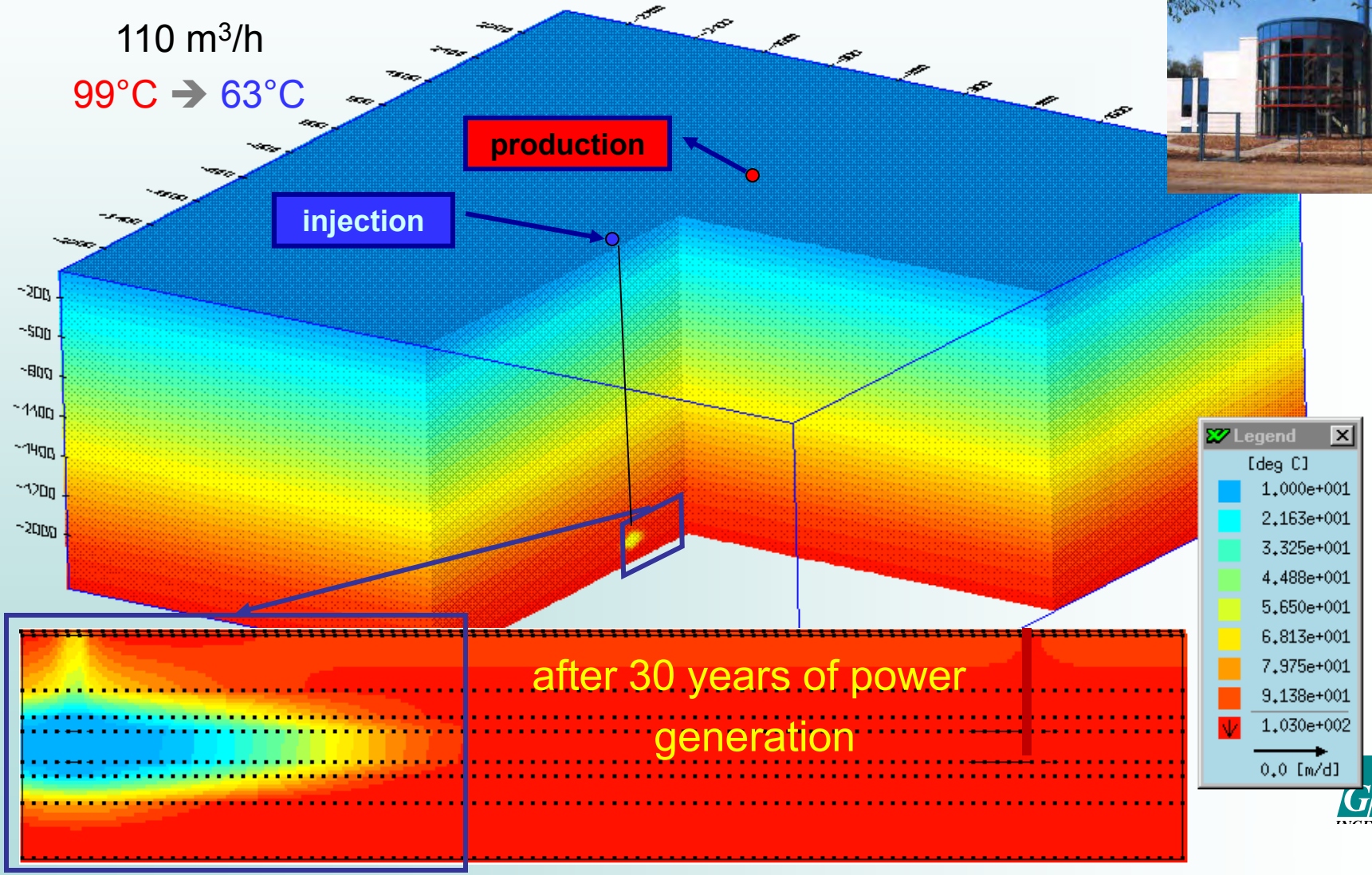
Demands on the heat mining prognosis

110 m³/h

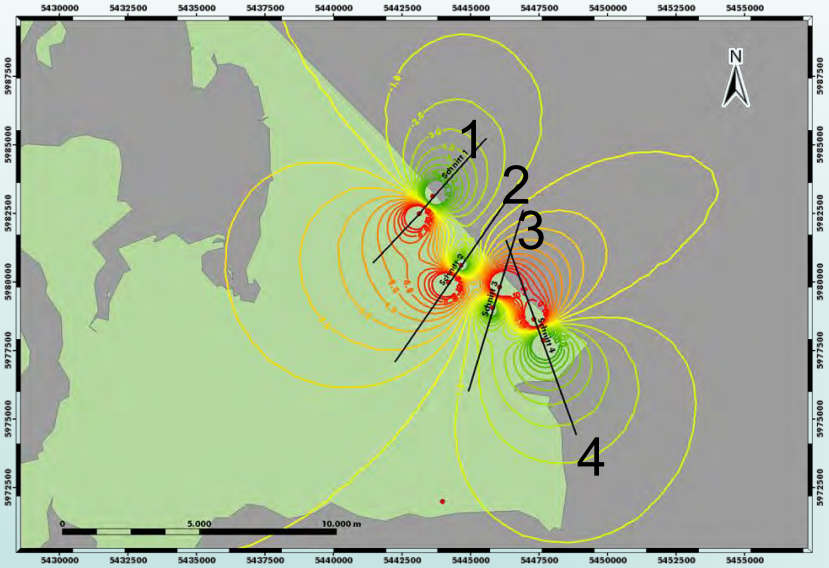
99°C ➔ 63°C

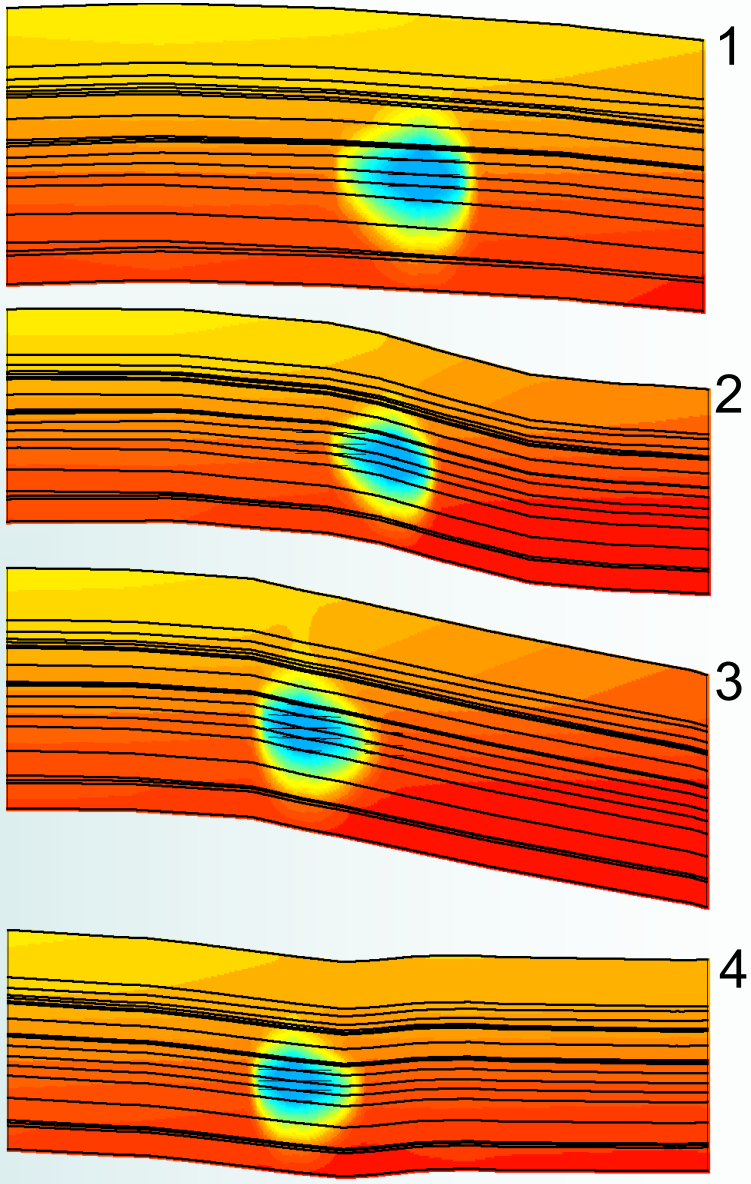


Demands on the heat mining prognosis

Four doublets
in a 1-layer sandstone reservoir

Reservoir pressure distribution





Temperature after 30 years
along cross sections

Simulation example

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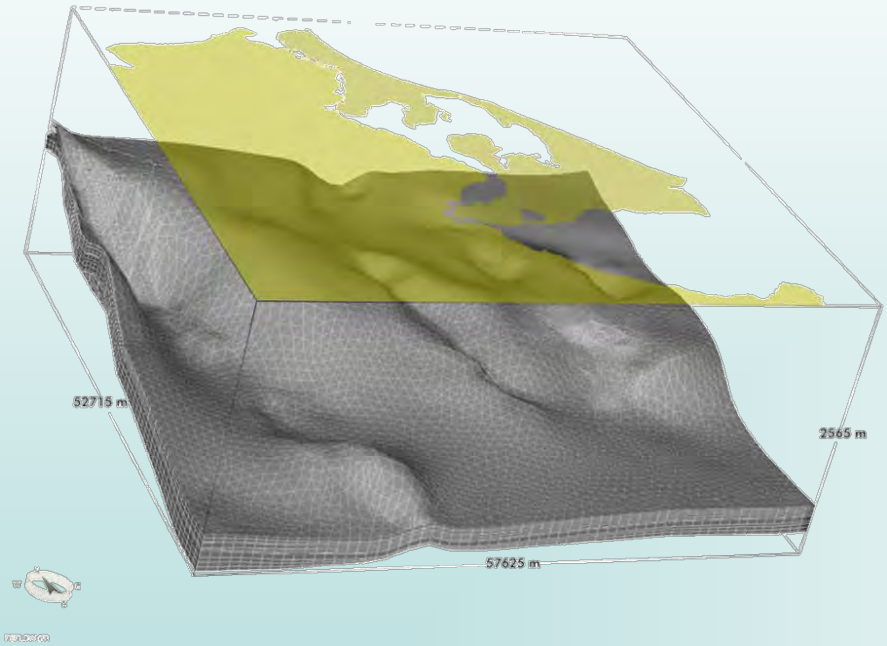
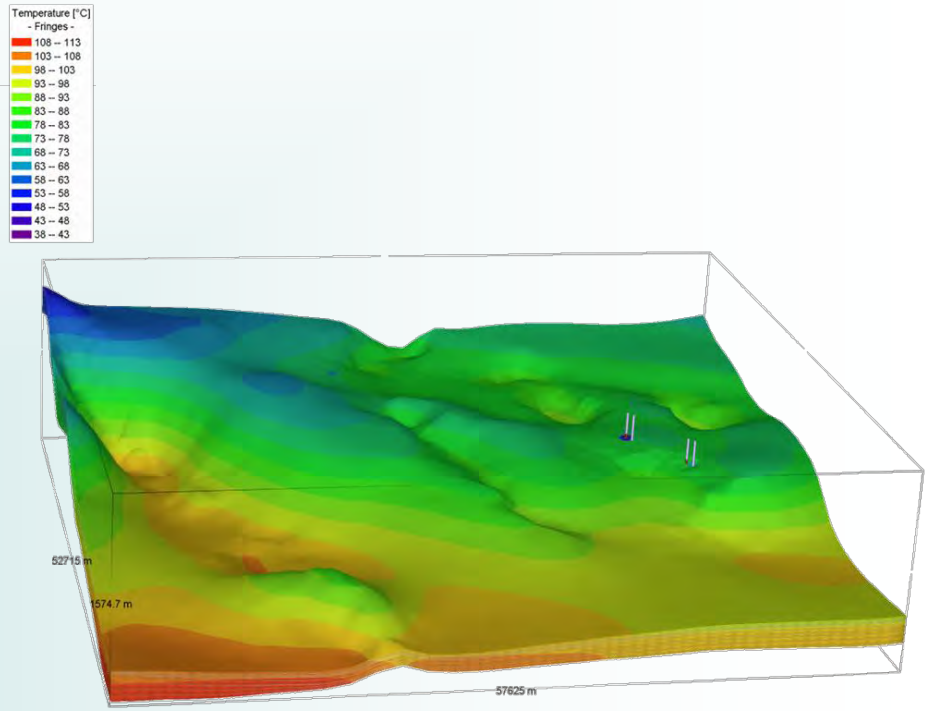
Example of a thermo-hydraulic simulation



Model layers and horizontal grid



Initial temperature distribution
at reservoir depth

Layer model and temperature model

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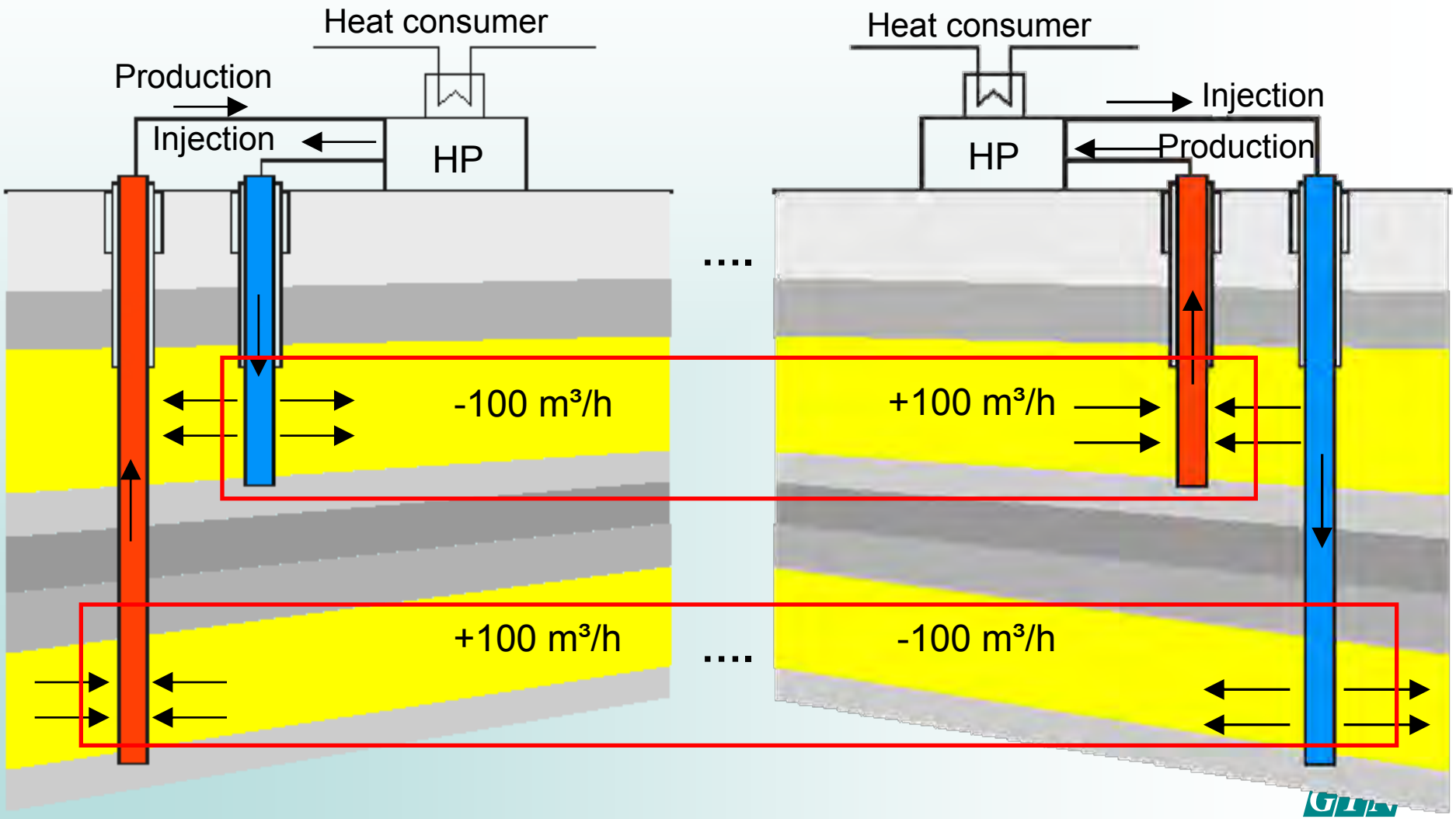
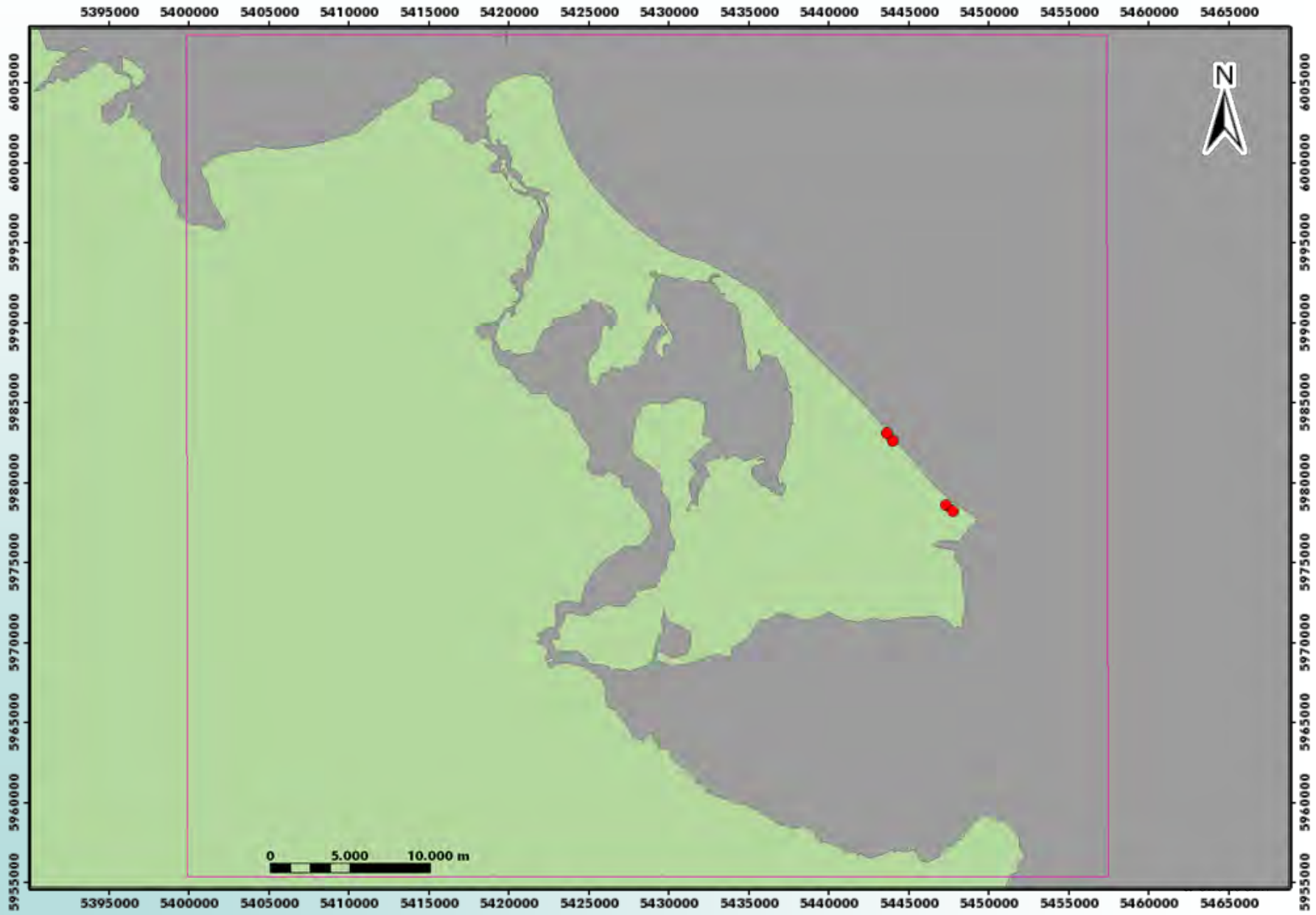
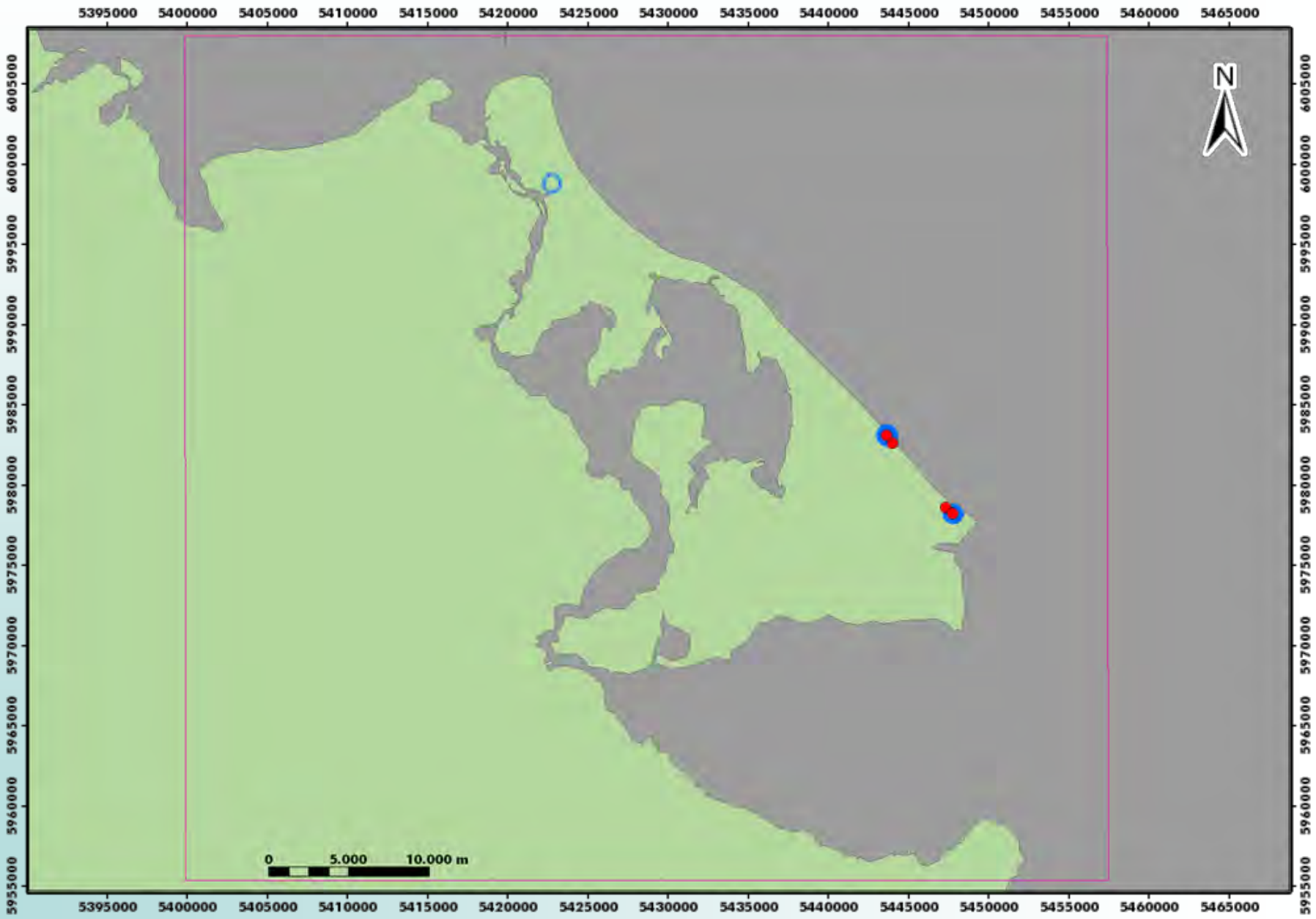
Examples of dimensioning: 2 layers 4 wells



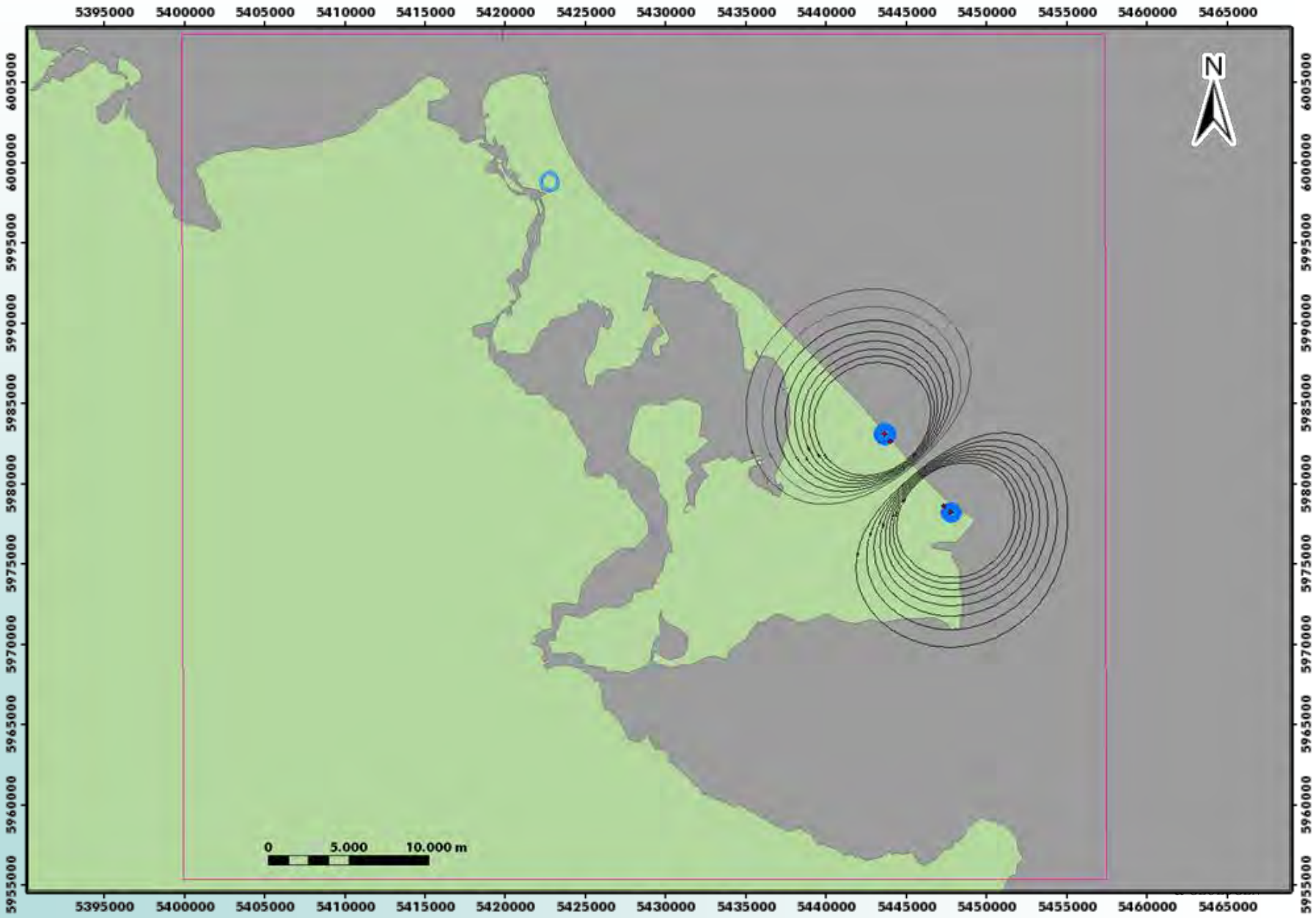
Examples of dimensioning: 2 layers 4 wells

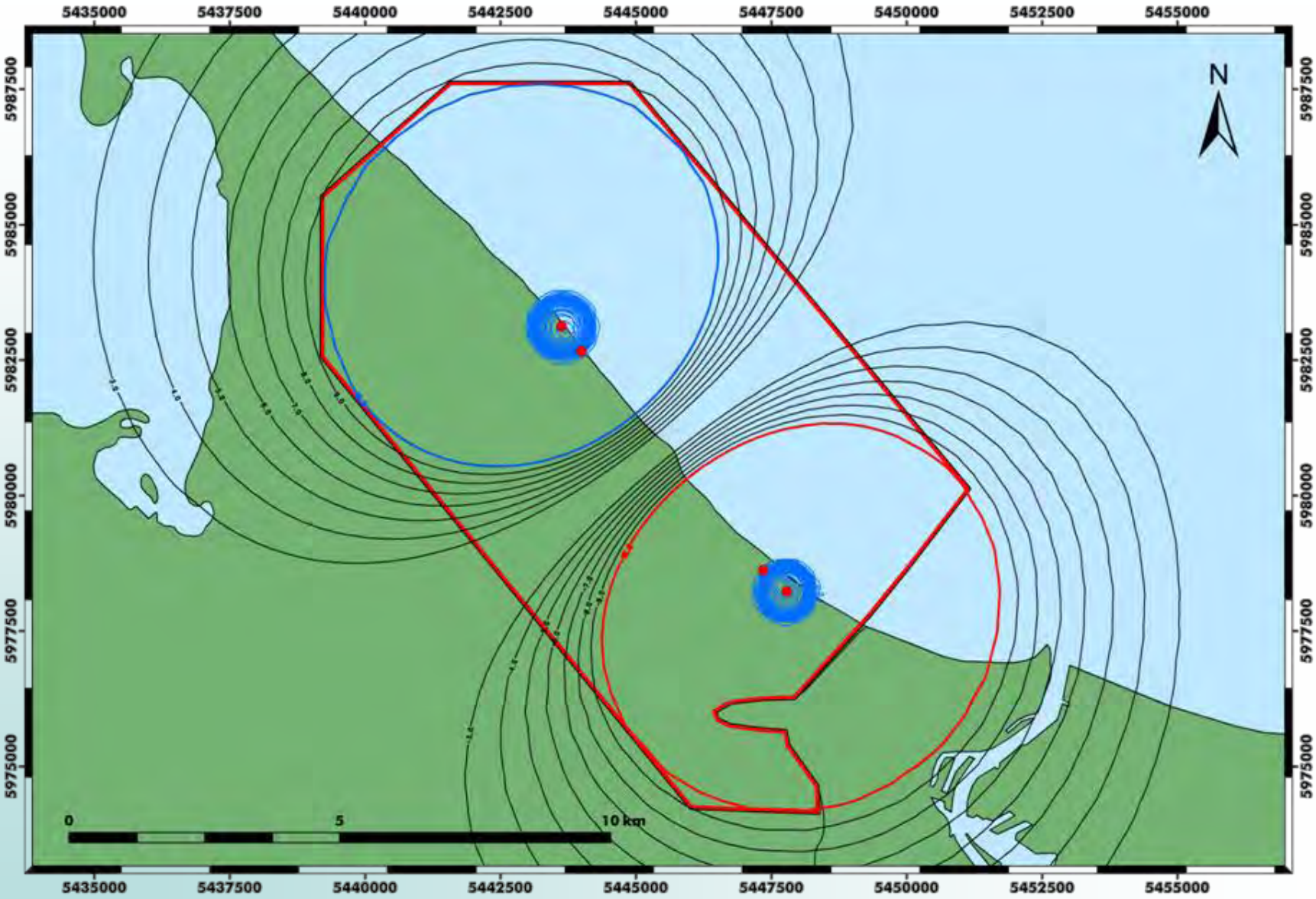


Examples of dimensioning: 2 layers 4 wells



Examples of dimensioning: 2 layers 4 wells





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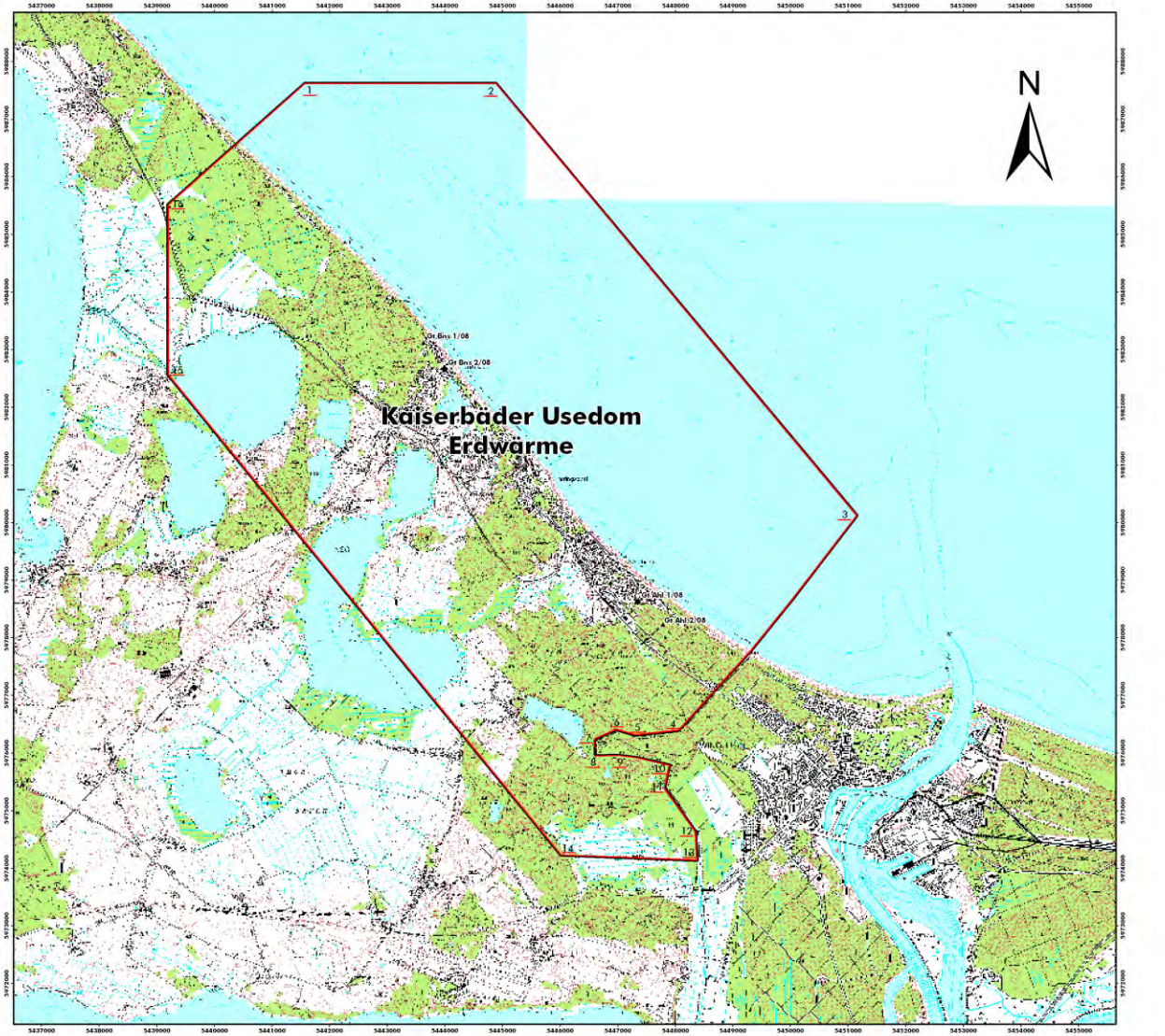


Lageriss

Maßstab 1:25000

für das Bewilligungsfeld	Kaiserbäder Usedom
zur Gewinnung von	Erdwärme
Land:	Mecklenburg-Vorpommern
Kreis:	Ostvorpommern
Gemeinde:	Kaiserbäder Usedom

Koordinaten der Feldeseckpunkte			
lfd. Nr.	Rechtswert	Hochwert	Höhe (NN)
1	5441568.64	5987646.99	-
2	5444898.66	5987650.99	-
3	5451178.56	5986127.73	-
4	5448063.37	5976381.96	-
5	5447306.08	5976306.73	-
6	5446977.44	5976401.76	-
7	5446609.2	5976231.5	-
8	5446601.28	5975986	-
9	5447028.91	5975993.93	-
10	5447911.9	5975803.87	-
11	5447832.71	5975407.91	-
12	5448363.29	5974659.54	-
13	5448394.97	5974132.92	-
14	5446007.34	5974227.95	-
15	5439169.13	5982558.92	-
16	5435173.09	5985532.57	-
1	5441568.64	5987646.99	-
Koordinaten der Bohrungsansatzpunkte			
Gt Bns 01/08	5443634	5983125	25
Gt Bns 02/08	5443634	5983125	25
Gt Ahl 01/08	54473535.41	5978624.31	5
Gt Ahl 02/08	54473535.41	5978624.31	5
Koordinaten der Bohrungsaufschlagpunkte			
Gt Bns 01/08	5443634	5983125	
Gt Bns 02/08	5443999.47	5982661.99	
Gt Ahl 01/08	54473535.41	5978624.31	
Gt Ahl 02/08	5447789.15	5978232.71	

Koordinatensystem: Gauß-Krüger-Bessel, Maßstab 1:25000

Flächeninhalt des Feldes: 94.2 km²

Angefertigt: Neubrandenburg, den 06.11.2007 durch

Dr. M. Wolfgramm
Geothermie Neubrandenburg GmbH
Seestrasse 7a
17033 Neubrandenburg

für die DISA GmbH.

Zur Erteilung der Bewilligung

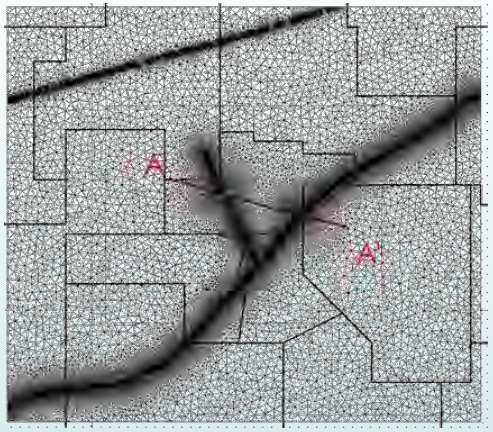
vom Az. gehörend.

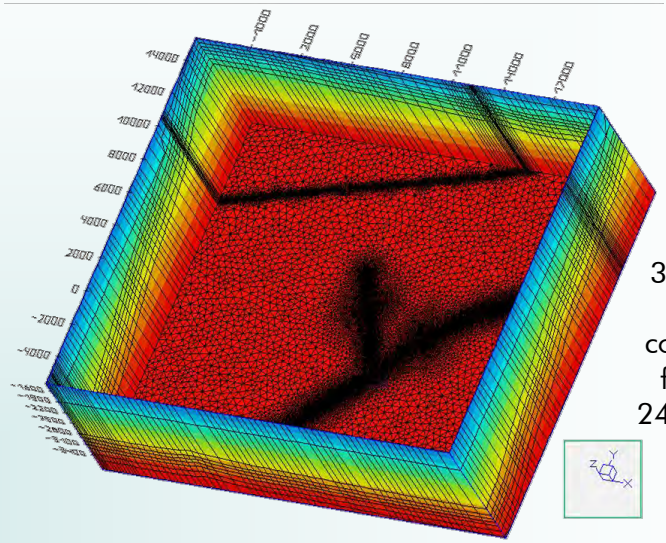
Stralsund, den
Bergamt Stralsund

Example of a thermo-hydraulic simulation

Project: Heat mining prediction for the Unterhaching geothermal power & heat plant
Client: Geothermie Unterhaching GmbH

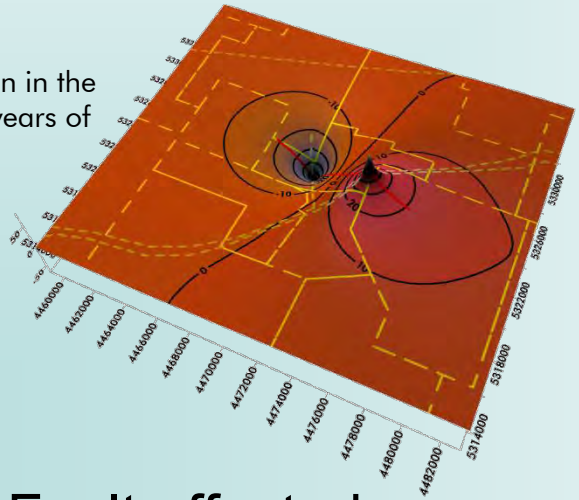
Model area with horizontal grid and refinement along fault zones in relation to the surrounding concession areas

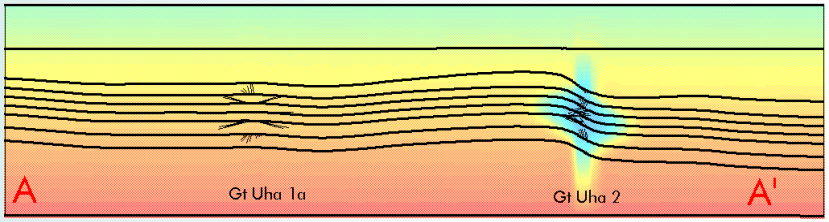




3-dimensional model structure (without cover) with layers and fault zones; extend ≈ 24 x 21 km; coloured: initial temperature; Axis in m

Pressure distribution in the reservoir after 30 years of circulation





Temperature distribution along cross section A-A' (9400 m) through both wells after 30 years of circulation

Example: Fault affected pressure cones

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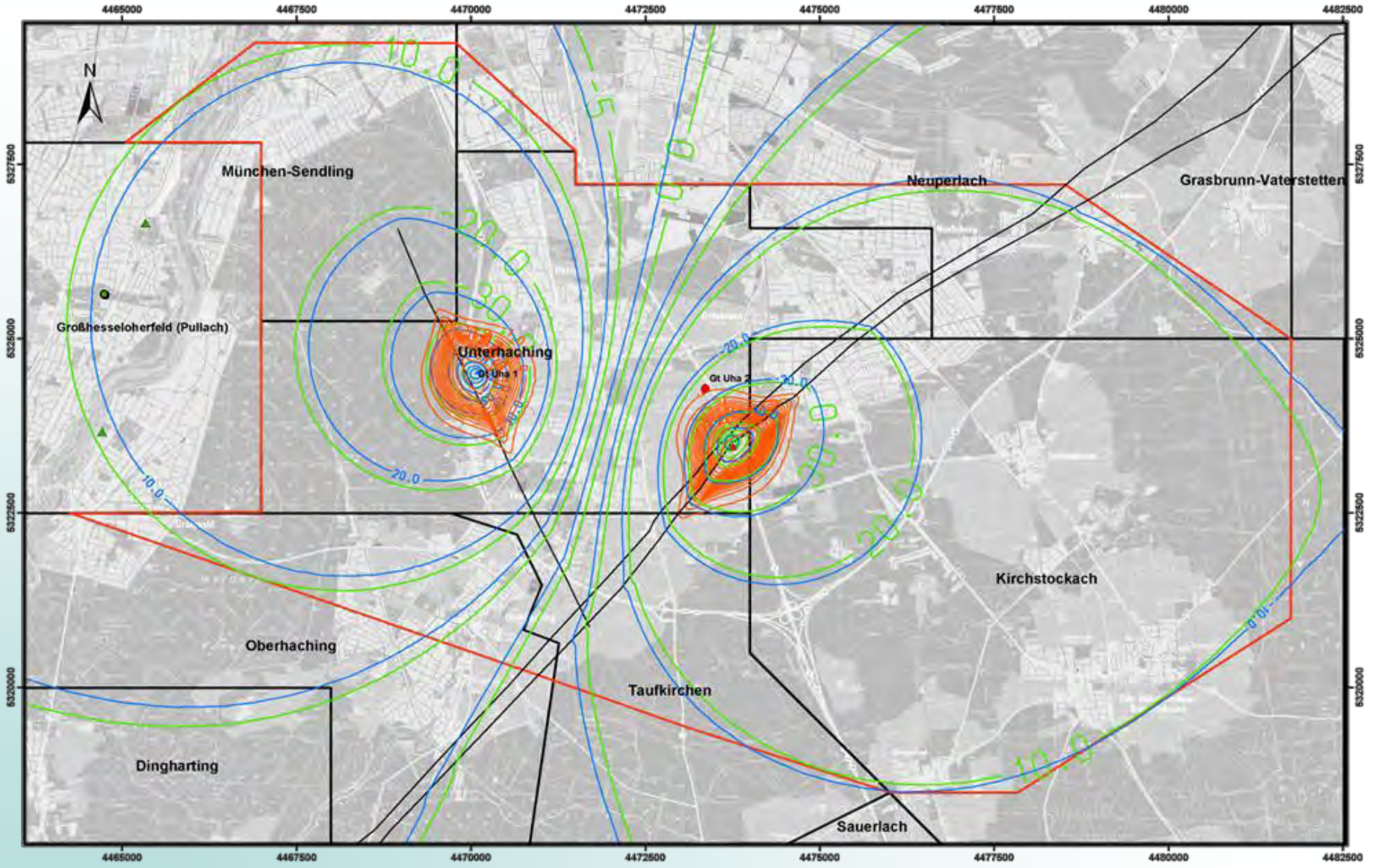

Legende

Bohrungen Unterhaching
- Ansatzpunkt
- Aufschlagpunkt

- thermisch beeinflusster Bereich Gt Uha 1
- thermisch beeinflusster Bereich Gt Uha 2 mit Injektionstemperatur von 40 °C
- Druckdifferenz Förderbohrung Gt Uha 2 (m)
- Druckdifferenz Förderbohrung Gt Uha 1 (m)

Bewilligungsfeld

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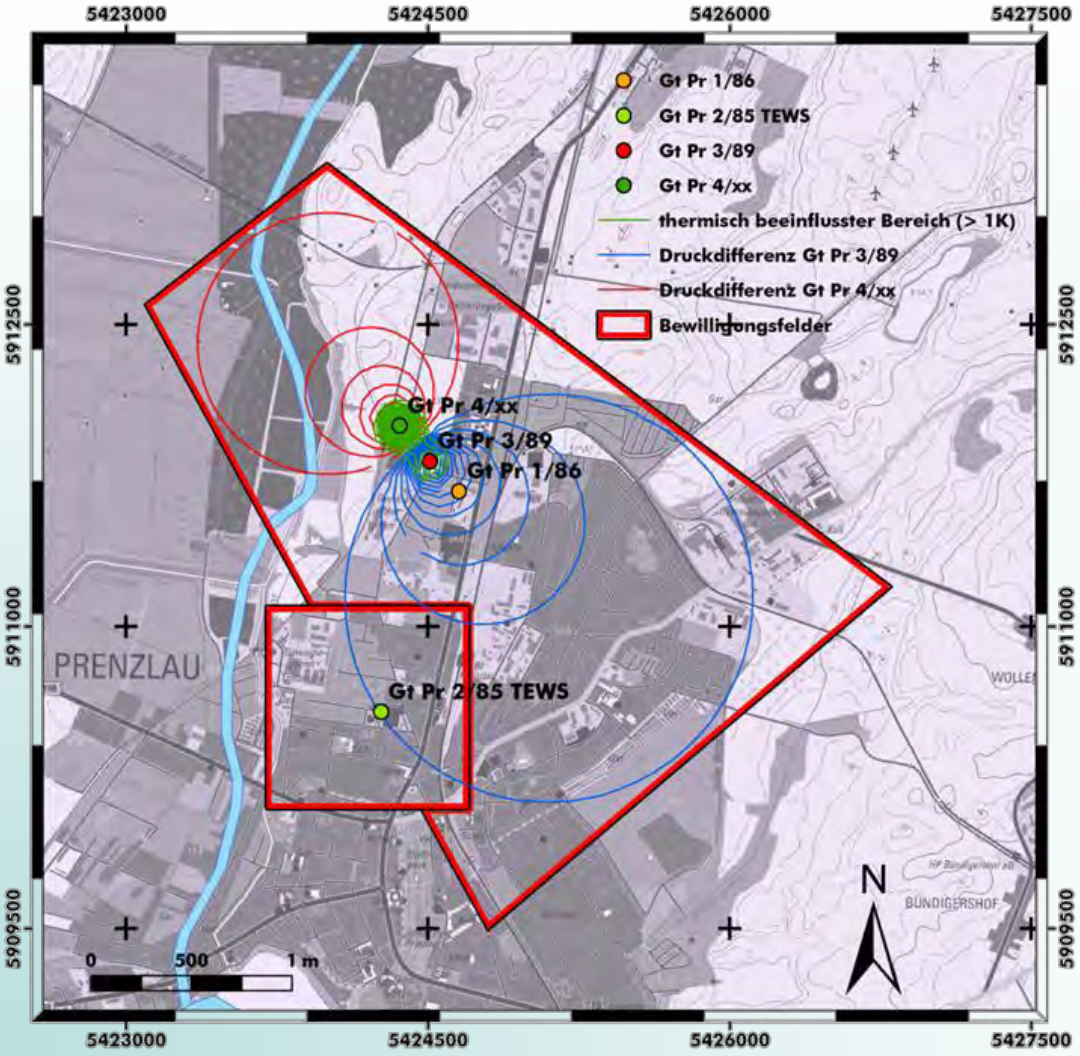
Dimensioning example



Example: Existing claim in the pressure-influence zone

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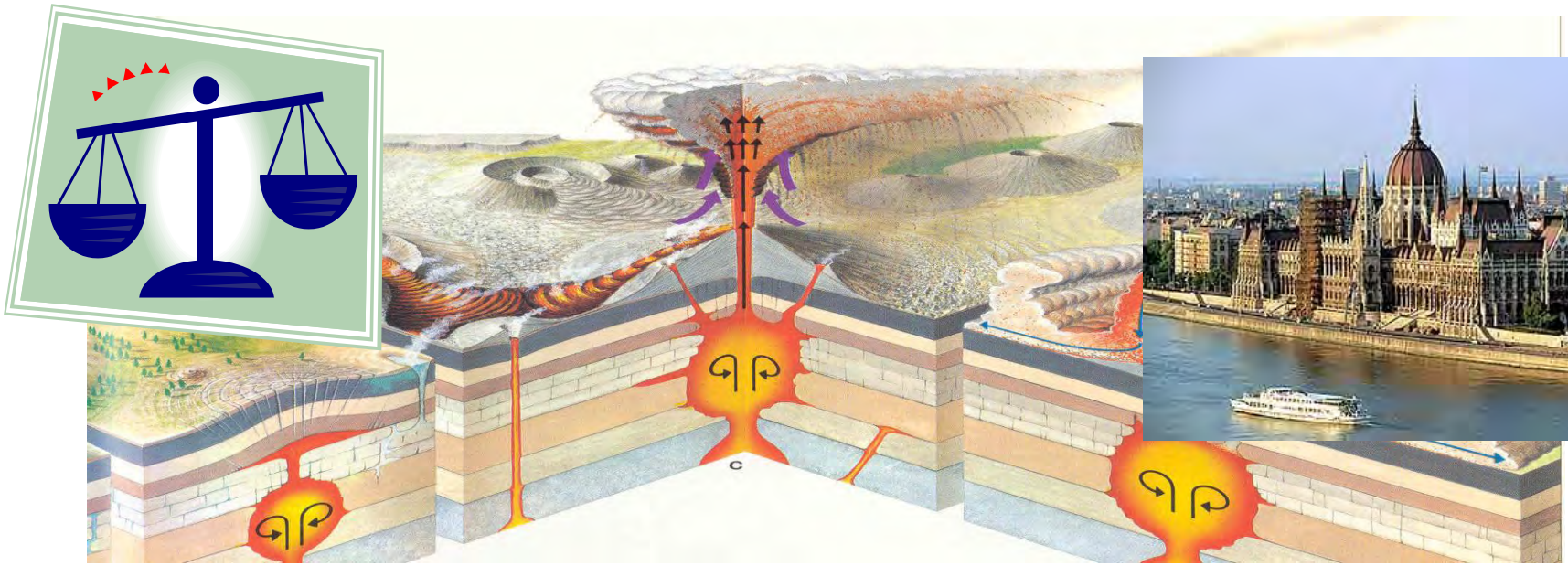
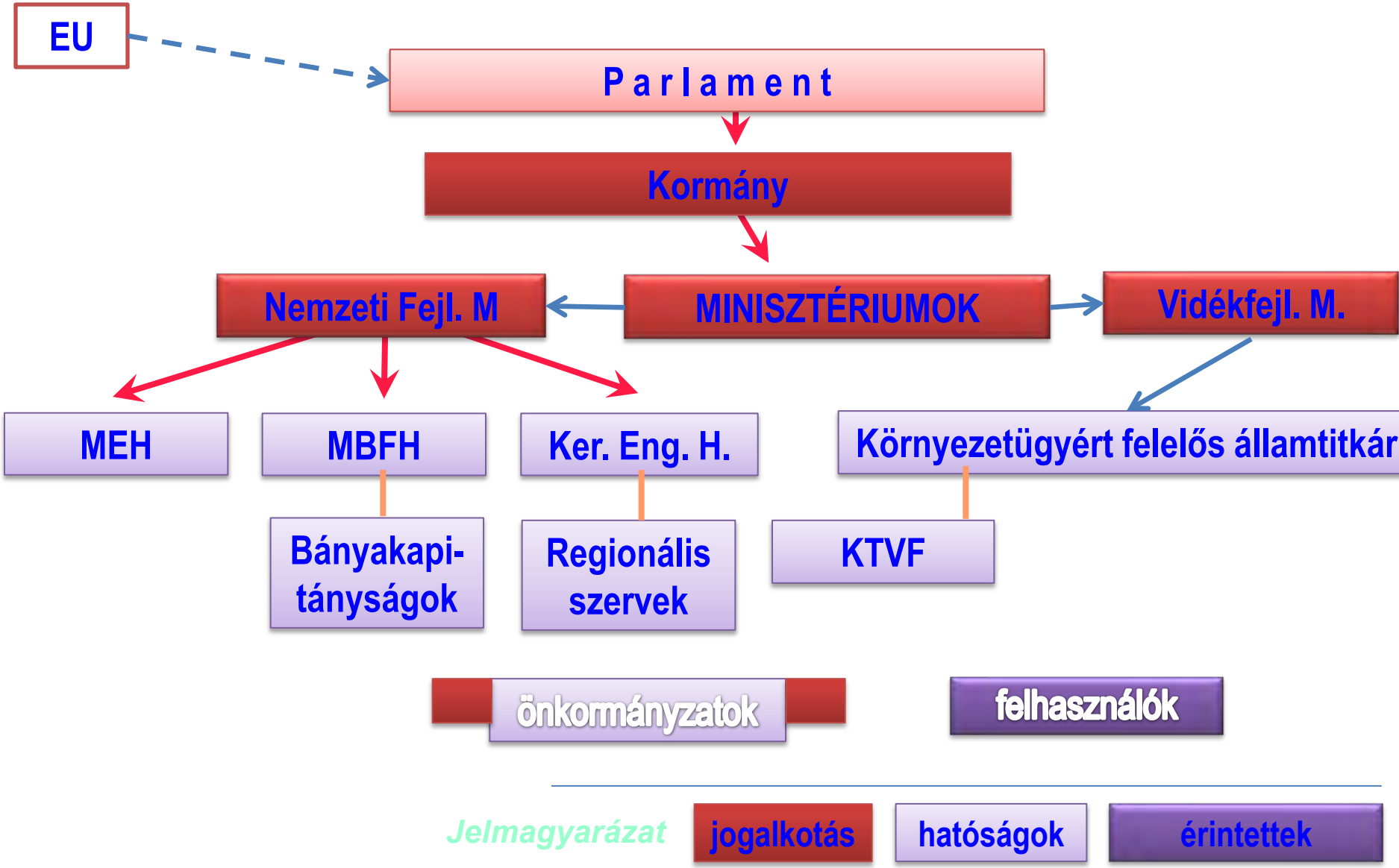
UPDATE ON THE GEOTHERMAL REGULATORY FRAMEWORK IN HUNGARY: THE MINING LEGISLATION DEVELOPMENT

TAMÁS HÁMOR

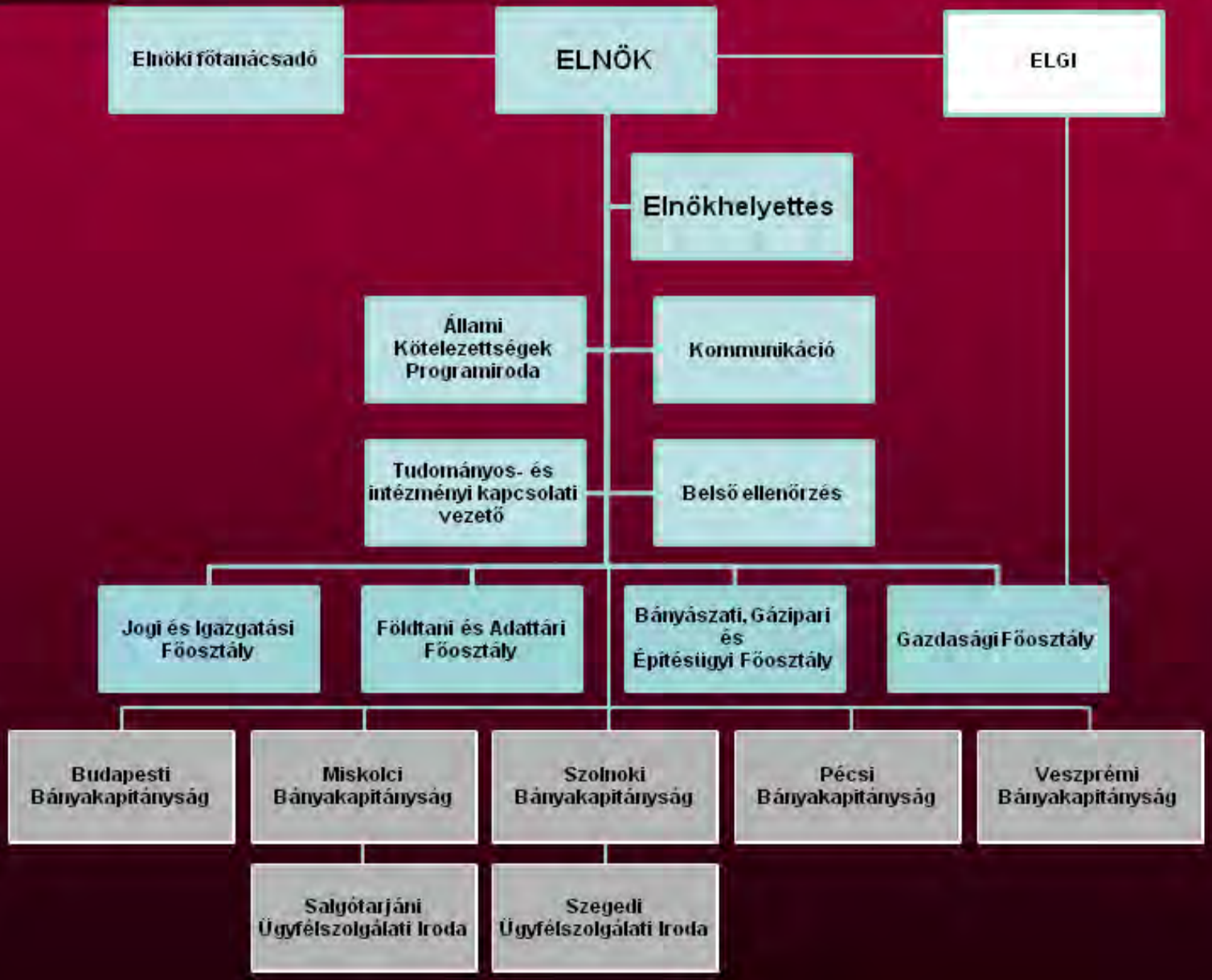
HUNGARIAN OFFICE FOR MINING AND GEOLOGY



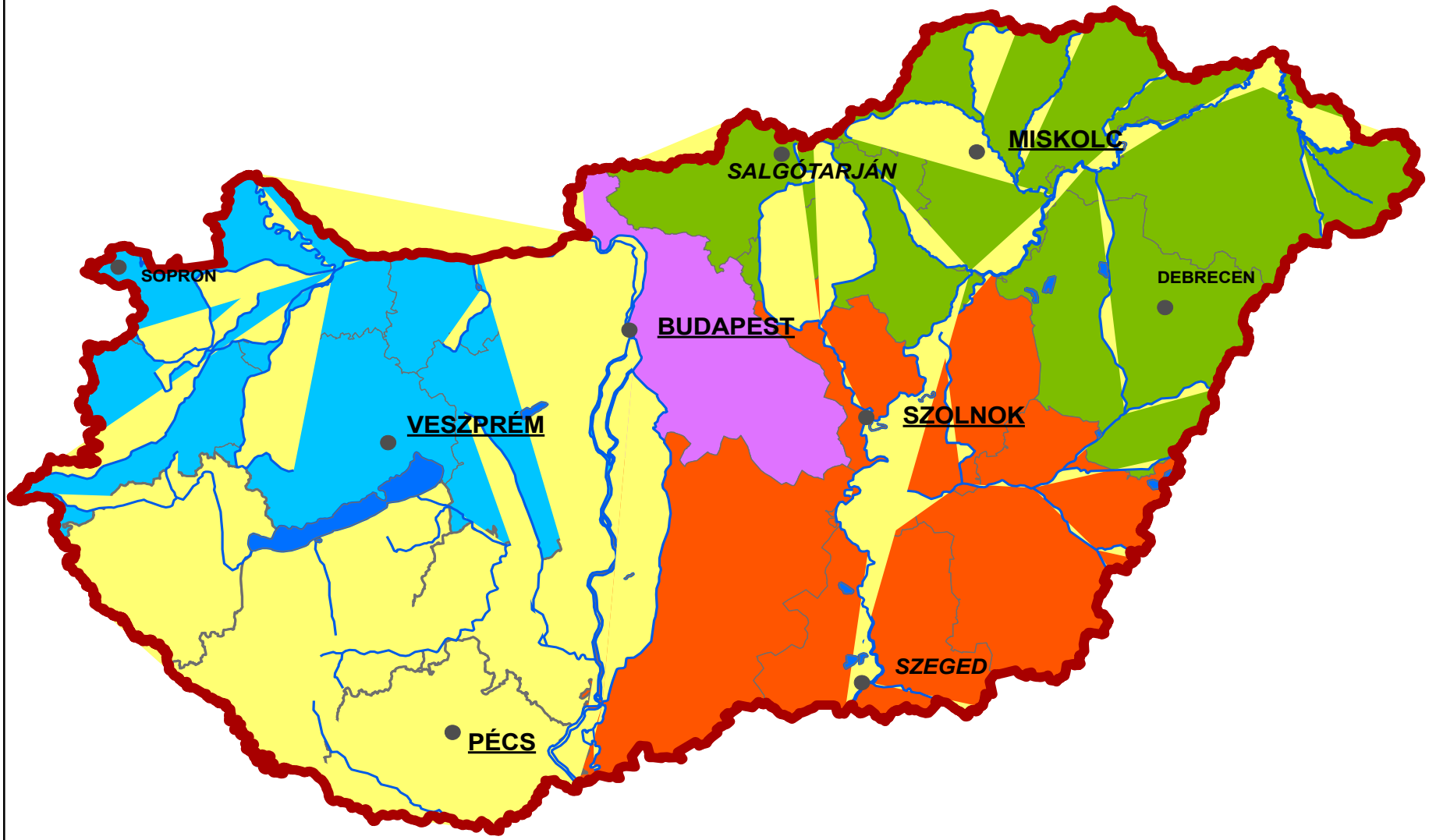
RÖDLworkshop, Budapest, 17th February 2011


EU
Parlament
Kormány
Nemzeti Fejl. M
MINISZTÉRIUMOK
Vidékfejl. M.
MEH
MBFH
Ker. Eng. H.
Környezetügyért felelős államtitkár
Bányakapi-tányságok
Regionális szervek
KTVF
önkormányzatok
felhasználók
Jelmagyarázat
jogalkotás
hatóságok
érintettek

Magyar Bányászati és Földtani Hivatal



Bányakapitányságok illetékességi területei



Legislative changes in Hungary 2006-2009

2007 January: **Regulatory merger**

The Act No. CIX of 2006 stipulated merging of Hungarian Geological Survey into Hungarian Bureau of Mines, and re-name it to „Hungarian Office for Mining and Geology" (MBFH).

2007 June: **The concept of the geothermal protective pillar**

Meeting of 20 experts was organized by MBFH to present the first concept on the introduction of the "geothermal protective pillar", a legal instrument similar to the mineral exploitation plot , in order to ensure both the sustainable exploitation of geothermal energy and the safety of investors.

2007 July: **New act on electric energy**

Act No. LXXXVI. of 2007 introduced, inter alia, a set of legal instruments for renewables (definitions, obligatory trade-in, green certificate, etc.). The implementing Government Decree No. 273/2007. (V. 19.), and GKM ministerial Decree No. 110/2007. (XII. 23.) were also published.

2007 July: **A deficient regulation on EU funding eligibility**

MeHVM Decrees No.19/2007. (VII. 30.) and 23/2007. (VIII. 29.) on the rules of the financial support of regional development, environmental and energy projects were published. Geothermal heating projects and heat pump installations appeared but geothermal electricity power plants were excluded.

2007 November: **Amendment of the Mining Act**

The Act No. CXXXIII. of 2007 amended the Mining Act: *„22/B. § (1) For licensing and supervising exploration of geothermal energy, rules of licensing and official supervision of geological exploration shall be appropriately applied.*

(2) Exploitation of geothermal energy shall only be from the part of earth's crust designated for this purpose (protective pillar).

Legislative changes in Hungary 2006-2009

(3) The protective pillar is designated by mining supervision.
(4) Within the protective pillar establishment for exploitation of geothermal energy cannot be permitted for another entity without the written agreement of the licensee.
(5) Geothermic protective pillar is registered by mining supervision."

The amendment also authorized the Government to issue a decree to regulate the technical and licensing details of the establishment of the geothermal protective pillar.

2007 December: **New decrees on thermal water extraction**

Government Decree No. 379/2007. (XII. 23.), and the Decrees No. 94/2007. (XII. 23.), 101/2007. (XII. 23.) of the minister for environment and water (KvVM) regulate thermal wells drilling, design, data. These generated legal collision and left niche in the field. An indication of this was a gas outburst of a thermal well during drilling licensed without mining inspectorate's involvement.

2007 December: **Trade-in tariffs for renewables**

Government Decree No. 389/2007. (XII. 23.) set preferential prices for geothermal power plants.

2008 March: **Simple mining royalty rules**

Government Decree No. 54/2008. (III. 20.) on the calculation of mining royalty of minerals and geothermal energy annulated the previous regulation , made the calculation for geothermal energy more simple and easy by setting the nominal value 1650 HUF/GJ (ca. 6€/GJ) for installations with groundwater extraction, and 320 HUF/GJ (ca. 1.5 €/GJ) for closed circuit systems.

2008 March: **Proposal for licensing geothermal facilities**

Proposal to amend the ministerial decree No. 96/2005. (XI. 4.) GKM on specific construction licensing by mining authority to include geothermal installations.

Legislative changes in Hungary 2006-2009

2008 April - : **Negotiations started between MBFH and Ministry for Environment and Water on geothermal issues**

Talks focused on geothermal protective pillar, a new legal term introduced by the Mining Act in January 2008. Major argument was if existing water licenses function properly for exploration and exploitation of geothermal energy.

2008 Spring: **Numerous applications submitted for geothermal projects on basis of Mining Act**

Submitted both to the mining and to the water authorities for geothermal energy and/or thermal water exploration or exploitation license. Mining inspectorates issued geological prospect permits not ensuring exclusive access. Water authorities issue preliminary water exploitation permit (1+1 years).

2008 June: **Geothermal plants became eligible for funding**

NFGM ministerial decree No. 7/2008. (VI. 5.) amended the MeHVM decree No. 23/2007. (VIII. 29.) by inserting the electricity generating geothermal power plants as eligible.

2008 October: **Renewables strategy published (12 PJ/year by 2020 for geothermal!)**

Government Decision No. 2148/2008. (X. 31.) on the renewable energy strategy 2008-2020.

2009 February: **Preferential electricity prices for heat pumps**

Heat Pump Association set agreement with electricity companies on supply price for heat pump users.

Legislative changes in Hungary 2006-2009

2009 April: **First-instance Court jurisdiction on interpretation of "geothermal exploration"**

Court ruled out that mineral exploration terms shall be used for geothermal energy.

2009 June: **First attempt for a waiver for re-injection failed**

An amendment of the Act No. LVII. of 1995 on water management was approved by the Parliament that made possible the authorization of the exclusion from the general obligation of re-injecting groundwater extracted for energy exploitation purposes. However, the President of the Republic of Hungary vetoed the amendment and sent it back to the Parliament for further re-conciliation.

2009 June: **Amendment of the Mining Act submitted**

Due to growing political and economic pressure from lobbyists, and unsuccessful conciliation talks in the subject an amendment of Mining Act was submitted to Parliament. Bill proposed a clear and exclusive licensing scheme for all geothermal projects by MBFH. It prescribed a licensing scheme similar to hydrocarbons, with an exclusive right for the licensee already at the prospection phase. Discussion of bill was postponed to the 2009 fall semester….

and it goes on …

Hatályos 1993. évi XLVIII. törvény

2010. évi IV. törvény a bányászatról szóló 1993. évi XLVIII. törvény módosításáról

- A módosítást – alapvetően – a hazai geotermikus energia energetikai célú hasznosításához szükséges nagy volumenű befektetések védelme kényszeríttette ki, mivel *védelmi-garanciális* jogintézményt a Bt. nem tartalmazott.
- A Bt. 1., 3., 5., 8., 9., 14., 15., 20., 22., 22/B., 44., 45., 49. § szabályozza alapvetően a geotermikus energia kutatását, kinyerését és hasznosítását.
- 1. § (1) h) E törvény hatálya alá tartozik: a geotermikus energia kutatása, kinyerése és hasznosítása;
- 3. § (1) Az ásványi nyersanyagok és a geotermikus energia természetes előfordulási helyükön állami tulajdonban vannak.

Hatályos 1993. évi XLVIII. törvény

5. § (1) A bányafelügyelet engedélyezi:

g) a geotermikus energia kinyerését és hasznosítását, valamint az ehhez szükséges - külön jogszabályban meghatározott – föld alatti és felszíni létesítmények megépítését és használatba vételét, ha a tevékenység nem vízjogi engedély köteles.

8. § A miniszter belföldi vagy külföldi jogi és természetes személyekkel, valamint ezek jogi személyiség nélküli társaságaival kötött *koncessziós szerződéssel* meghatározott időre átengedheti: a) *zárt területen* ab) a geotermikus energia kutatását, kinyerését és hasznosítását,

9. § (1) A miniszter a rendelkezésre álló földtani adatok, valamint a vállalkozói kezdeményezések alapján azokat a koncesszióra kijelölhető zárt területeket veszi számításba…(2011. 01. 01-től)

14. § (1) A koncesszió időtartamán belül a tervezett ásványi nyersanyag-kutatási, illetve geotermikusenergia-kutatási időszak 4 évnél hosszabb nem lehet (+2x2 év).

(2) A bányavállalkozó a kutatás befejezésétől számított 1 éves időtartamon belül kezdeményezheti a geotermikus védőidom kijelölését.

Hatályos 1993. évi XLVIII. törvény

15. § Ha a koncesszió jogosultja a szerződésben meghatározott határidőn belül, legkésőbb azonban a geotermikus védőidom kijelölésétől számított 3 éven belül a kitermelést, az energetikai célú hasznosítást nem kezdi meg, a szerződésben meghatározott *térítést köteles megfizetni*. Ha a térítésfizetési kötelezettségnek nem tesz eleget, a koncesszió megszűnik.

22. § (1) Zárt területen koncesszió keretében meghatározott ásványi nyersanyag vagy geotermikus energia kutatására a miniszter a koncessziós szerződésben *kutatási jogot adományoz*.

(2) A kutatási jog a kutatási területen a bányavállalkozónak *kizárólagos jogot* ad az ásványi nyersanyag-, illetve geotermikus energia-kutatási műszaki üzemi terv benyújtására.

49. § E törvény alkalmazásában:

24. „Zárt terület”: a geotermikus energia vonatkozásában zárt területnek minősül az ország egész területén a természetes felszíntől mért *2500 m alatti* földkéreg-rész.

Hatályos Bányatörvény

22/B. § (1) Zárt területen a geotermikus energia kutatásának, kinyerésének és hasznosításának engedélyezésére a *szénhidrogén-bányászat* engedélyezésére vonatkozó sajátos szabályokat kell megfelelően alkalmazni azzal, hogy geotermikus energiára bányatelket megállapítani nem lehet.

(2) Zárt területen geotermikus energiát kinyerni csak a földkéreg e célra elhatárolt részéből (*geotermikus védőidom*) szabad.

(3) A geotermikus védőidomot a bányafelügyelet jelöli ki.

(4) A geotermikus védőidomon belül a jogosult írásbeli hozzájáruló nyilatkozata nélkül geotermikus energia kinyerését szolgáló létesítmény más részére nem engedélyezhető.

(5) A geotermikusenergia-hasznosító létesítményekről, a kitermelt és hasznosított geotermikus energia mennyiségéről, valamint a megállapított geotermikus védőidomokról a bányafelügyelet *nyilvántartást* vezet

Hatályos Bányatörvény

22/B. § (6) Geotermikus energia szempontjából nyílt területen, a felszín alatti vízkészletből termálvíz használatára adott *vízjogi engedély egyidejűleg geotermikus energia kinyerési- és hasznosítási engedélynek* is minősül. A geotermikus energia vízjogi engedély alapján történő hasznosítására e törvény 3. §-ának, 20. §-ának, 22/B. § (5) bekezdésének, 25. § (2) bekezdése *b)* pontjának és 41. §-ának rendelkezéseit megfelelően alkalmazni kell, egyebekben a vízügyi és környezetvédelmi jogszabályok az irányadók.

(8) A természetes felszíntől mért *20 méteres* mélységet el nem érő földkéreg részből történő geotermikus energia kinyerés és hasznosítás nem engedélyköteles. E rendelkezés nem mentesíti a tevékenységet végzőt a más jogszabályban előírt engedély megszerzése alól.

Hatályos 1993. évi XLVIII. törvény

44. § (1) A bányafelügyelet hatáskörébe tartozik - figyelemmel a 43. § (3) bekezdésében foglaltakra (*A bányafelügyelet a hatósági felügyelete keretében - az e törvényben és a külön jogszabályokban meghatározott - műszaki-biztonsági, munkavédelmi, építésügyi hatósági, építésfelügyeleti, ásványvagyon-gazdálkodási, piacfelügyeleti és földtani hatásköröket gyakorol.*):

d) a geotermikus energia kutatása, energetikai célra történő kinyerése és hasznosítása, az ehhez szükséges létesítmények és berendezések építése, használatbavétele és üzemeltetése.

45. § (1) A bányafelügyelet látja el a mélységi vizek felszínre hozatalára irányuló, bányászati technológiával végzett munkálatok *hatósági biztonságtechnikai felügyeletét*. A hatósági felügyelet keretében a bányafelügyelet a munkálatok és az üzemben tartás biztonságára és szakszerűségére vonatkozó kérdésekben közvetlenül intézkedik, a vízvagyon védelmére szolgáló intézkedések megtételét pedig a környezetvédelmi és a vízügyi hatóságnál kezdeményezi.

A geotermikus engedélyezés a Bt. szerint

a bányafelügyelet engedélye nélkül

20 m

NYÍLT TERÜLET

bányafelügyelet engedélyével, ha
vízkivétellel nem járó zárt hurkú szondakutak engedélyezése

KTVF engedélyével, ha
vízkivétellel jár a geotermális energia hasznosítása

20 - 2500 m

ZÁRT TERÜLET

koncesszió - CH-bányászat engedélyezésére vonatkozó sajátos szabályok

>2500 m

Építésügyi hatósági eljárások

Bt. 22/B. § (7) Nyílt területen geotermikus energia *nem vízjogi engedély alapján végzett* kinyerésének és hasznosításának engedélyezésére a bányafelügyelet hatáskörébe tartozó, sajátos építményfajtákra vonatkozó külön jogszabály rendelkezéseit kell alkalmazni.

96/2005. (XI. 4.) GKM rendelet

A bányafelügyelet építésügyi hatósági engedélyéhez kötött létesítmények

1. számú melléklet

4. Egyéb létesítmények:

4.1. a geotermikus energia felszín alatti víz kitermelését nem igénylő kinyerésének és energetikai célú hasznosításának létesítményei az épületgépészeti berendezések kivételével.

Geothermal licensing actions by MBFH

¤	2006¤	2007¤	2008¤	2009· (extrapolated)¤	¤
thermal· water· co-authority· consents¤	20¤	37¤	38¤	51¤	¤
geothermal· project· and· heat· pump· applications¤	114¤	133¤	324¤	612¤	¤
TOTAL¤	134¤	170¤	362¤	663¤	¤

GEOTHERMAL CONFLICT FIELD

agriculture
+

mining
+/-

healthcare, tourism
+

GEOTHERMAL
ENERGY

regional development
+

energy
+/-

environmental protection
+/-

water management
-

Reinjection into sandstone: German experience

Jörn Bartels, Peter Seibt & Markus Wolfgramm
Geothermie Neubrandenburg GmbH

Workshop "Geothermal energy in Hungary – update barriers and solution statements";
Budapest 17 February 2011

GTN INGENIEURE & GEOLOGEN

1. Reinjection as a necessity
2. Characteristic aquifer parameters in Germany
3. Risks & problems
4. Technical design
5. Project example and operational experience

Outline

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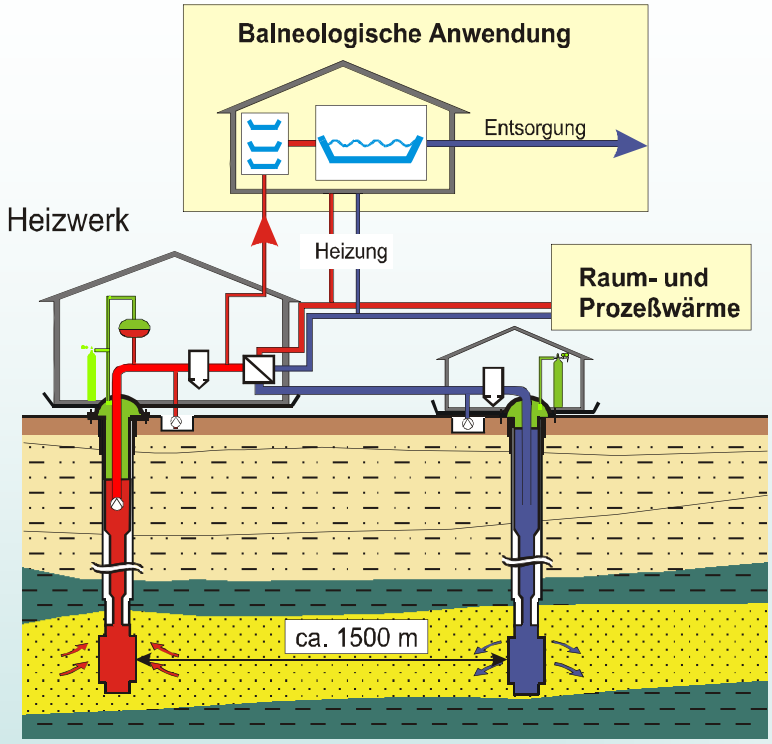
Reinjection in Germany



1. Within this context, reinjection means that the produced and cooled thermal water is injected back into the host sandstone aquifer (completely)
2. Huge amounts of water as required for direct heating or power production reinjected (other than quantities typically used in a spa)

Definition

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Necessity of reinjection

Reinjection proves to be necessary
at most sites due to the following reasons:

1. Permanent production (without reinjection) of large quantities of water results in the reduction of the reservoir pressure, thus endangering the sustainable use of the reservoir.
2. The disposal of the cooled thermal water causes thermic and material contamination of the surface water bodies or shallow groundwater-bearing beds.
3. (Long term) Pressure influence zone (depression) around the production well has to be kept small (claim size)
4. In Germany, reinjection is an obligation according to the Federal Mining Code.

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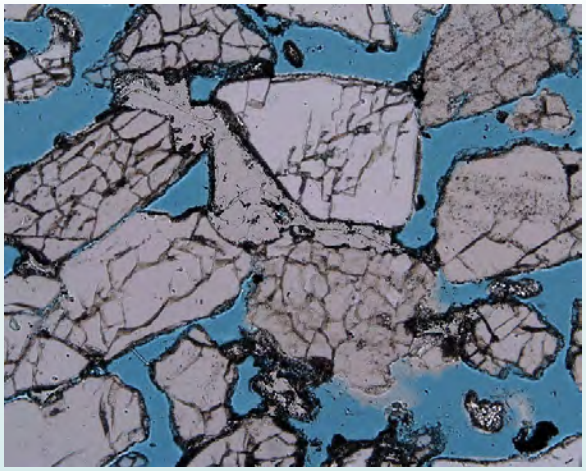
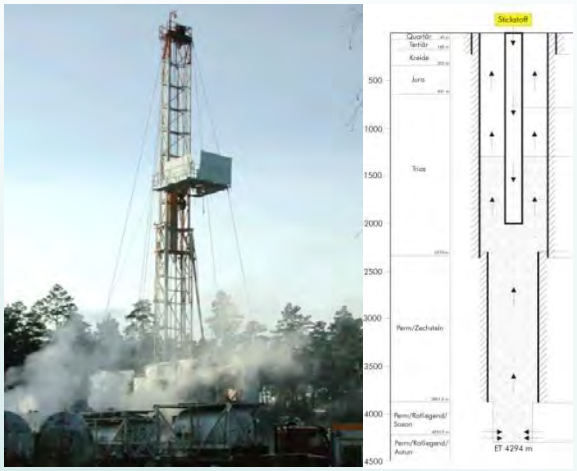
Characteristic aquifer parameters in Germany

Microscopic scale



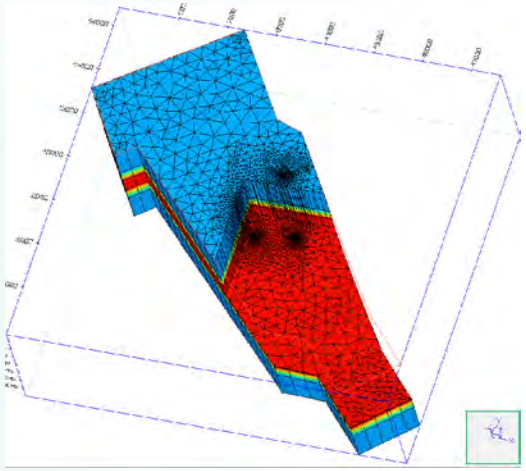
e.g., porosity, pore radii & grain size distribution

Well scale



e.g., short term hydraulic test results, local layer structure

Reservoir scale



e.g., vertical and lateral extension, faults

The comprehensive target parameter of reservoir evaluation is long term injectivity (flow rate related to the pressure increase in the well)

Note: Direct injection tests with cold water are not recommended anymore by GTN.

General overview

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Characteristic aquifer parameters in Germany

Consolidated sandstones in the North German Basin:

50 -100 m^3/h or 15-30 l/s

(partly fractured) Carbonates in the Bavarian Molasse Basin:

200 – 450 m^3/h or 60-130 l/s

Typical injection rates

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Characteristic aquifer parameters in Germany

Reinjection parameter (direct heating):

50 – 100 m³/h *45-70 °C* *100-220 g/l* *300-2500 m*

For the injection of 50 – 100 m³/h (i.e. 15 – 30 l/s) per well according to our experience gained in the North German Basin, a sandstone aquifer should provide minimum:

Effective porosity	> 20 %
Permeability	> 0.5 μm² (Darcy)
Reservoir thickness	> 20 m

in order to achieve an injectivity > 50 (m³/h)/MPa or 1.4 (l/s)/bar.

Suitability criteria for sandstone aquifers I

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Characteristic aquifer parameters in Germany

and have to be characterised additionally by

- a percentage of large pores (radius > 5,000 nm) >60 % or of small and medium pores < 50 % of the pore volume

Note! Knowing in detail the above parameters it is possible to give very reliable prognoses for initial productivity or injectivity.

- < 0.063 mm fine grain (silt and clay) percentage < 10 – 12 %
- average content of binding agents and cement not exceeding 8 – 10 %

Suitability criteria II: Pore and grain size distribution

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Characteristic aquifer parameters in Germany

- Chemical composition
- Gas content
- Temperature at the well head

Fluid parameters

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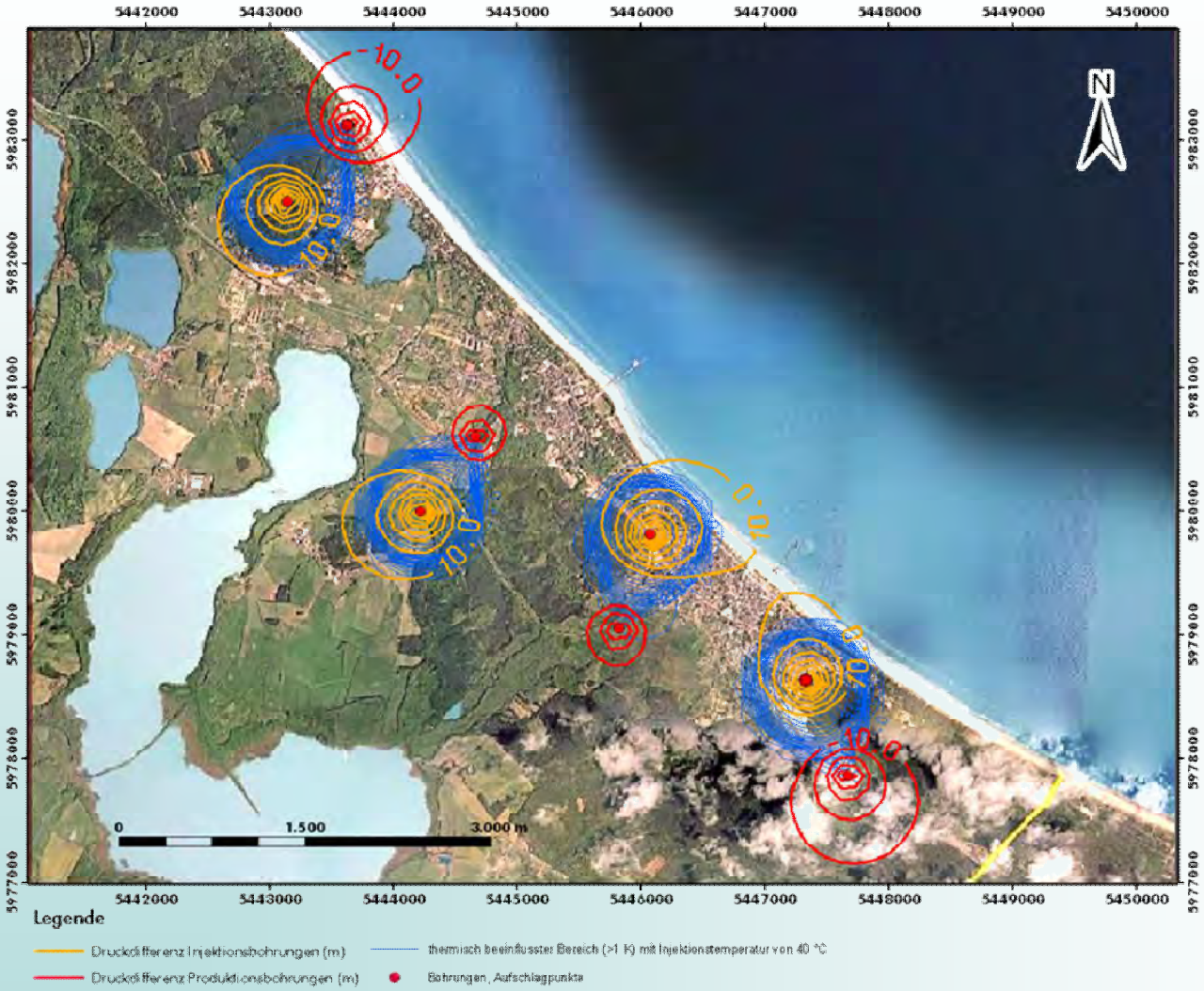
Risks & problems



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Thermal breakthrough; blue: cold water zone

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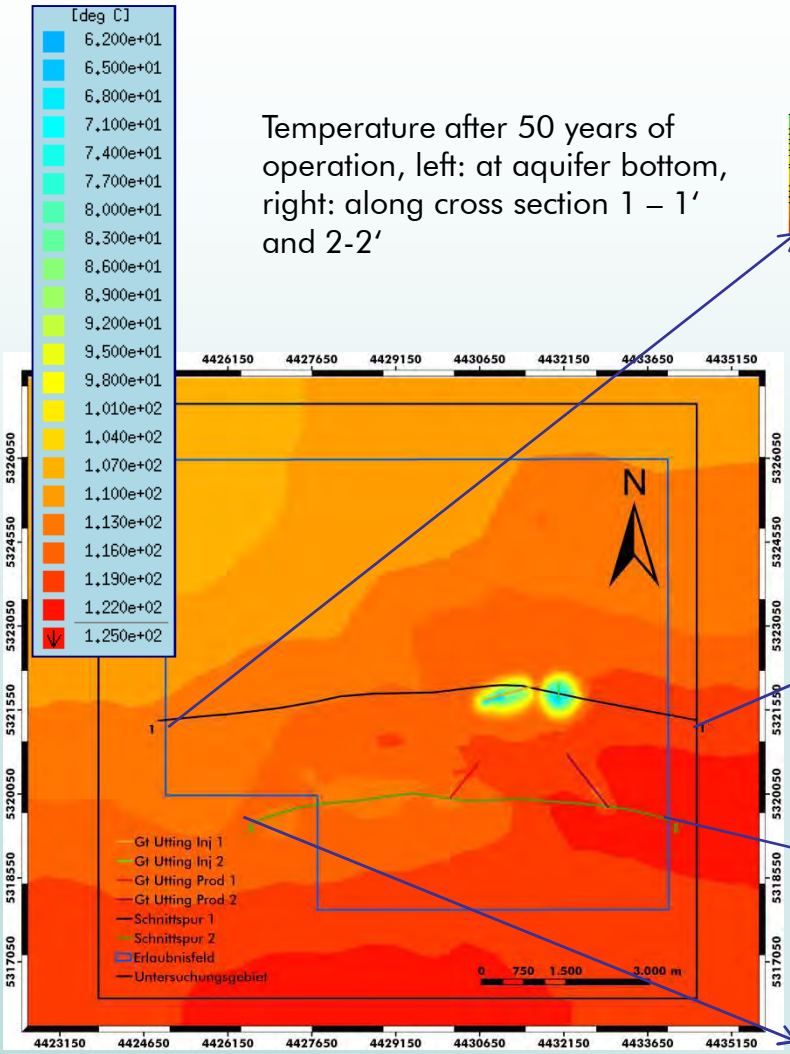
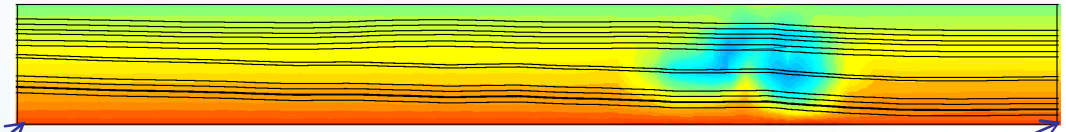
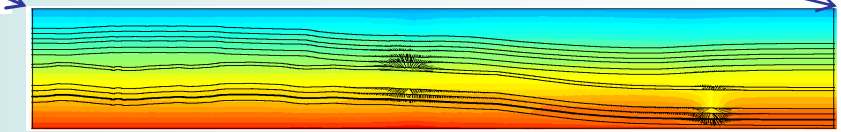
Risks & problems



Temperature after 50 years of operation, left: at aquifer bottom, right: along cross section 1 – 1' and 2-2'





Prevention:

1. Exploration of fault zones which could serve as preferential flow paths
2. Determination of the required minimum well distance by means of numerical simulation

Thermal breakthrough

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Risks & problems

1. Mobilisation of particles from the reservoir
2. Precipitation of chemical products
3. Clogging of the pores by corrosion products
4. Bacterial activities
5. Fluid/matrix interactions
6. Clay swelling
7. Technical inadequacy of the installation

Potential causes of injectivity reduction

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Risks & problems

Potential reason for injectivity decrease	Location	Neuruppin (NE-Germany)	Neustadt-Glewe (NE-Germany)	Neubrandenburg (NE-Germany)	Klaipeda (Lithuania)	Skierniewice (Poland)
Aquifer	Structure, Conductivity	+	+	+	o	o
	Reservoir boundaries	+	+	+	+	+
Well	Technical realization	-	+	+	+	+
	Adaption of screen (filter) construction to aquifer properties	+	+	+	-	-
Scaling/ Corrosion	Supersaturation induced scaling	+	-	+	o	+
	O_2-Entry	+	-	+	+	+
	Microbiology	o	+	-	+	+
	Finest migration	-	+	+	-	-
	Swelling clay	+	+	+	+	+
Surface	Filter dimension	+	o	+	+	+
Gas	Two-phase flow (gas – fluid surface tension)	+	+	+	+	+
	Degassing induced scaling	+	+	+	+	+

+ no relevance o minor relevance - main reason

Analyzed reasons for reinjection problems

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Risks & problems

1. Analysis
    a. GTN has developed a comprehensive geological, geophysical & technical analysis scheme recently which can be adopted/reduced site specifically
2. Elimination

    A number of possible measures : soft acidizing (good experiences); mechanical cleaning; hydraulic stimulation; …; well screen reconstruction; side track drilling; new reinjection well
3. Prevention
    a. Construction phase: proper design and technical & geological supervision
    b. Operation phase:
        - Use of scaling inhibitors
        - Monitoring (incl. extensive determination of initial conditions at start; required key parameters and technical realization already described in a recently completed R&D project (GTN))

Summary “Reinjection problems”

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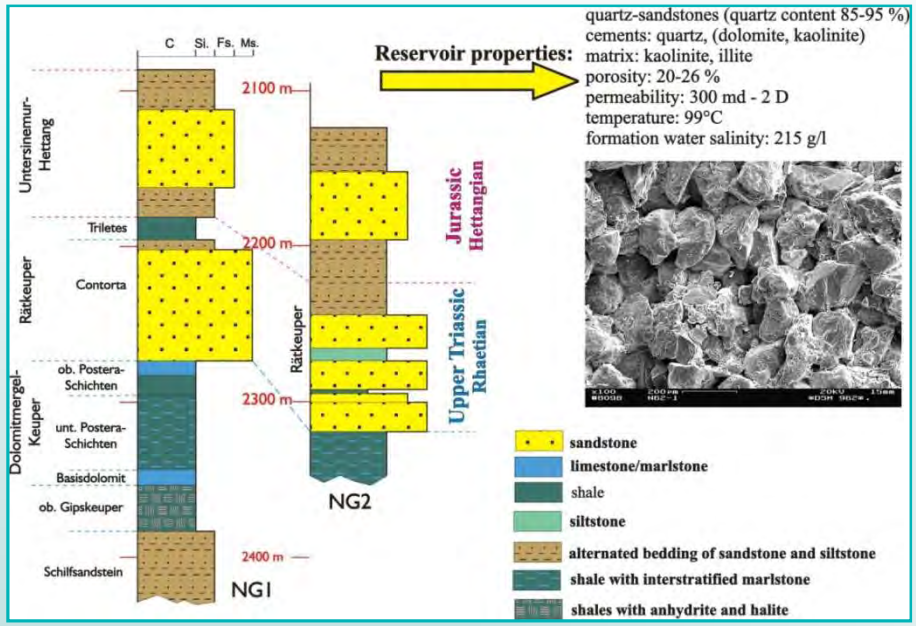
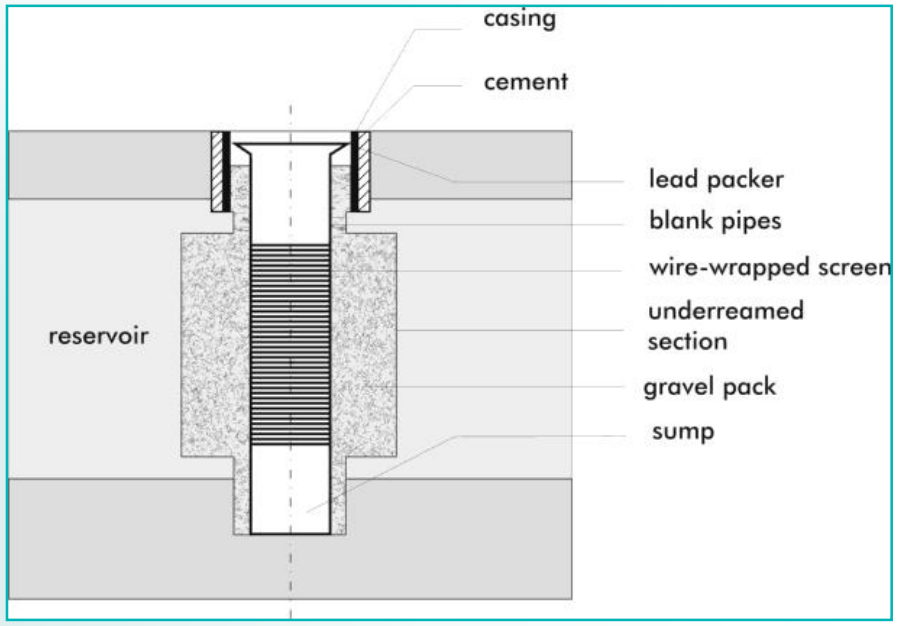
Technical design

Reinjection without injection pumps can be achieved by a well construction adapted to the geological/reservoir conditions





Selection of the injection horizons and locking of the clay layers (blanks)

Screen completion with gravel pack (preferred variant)

Well construction I

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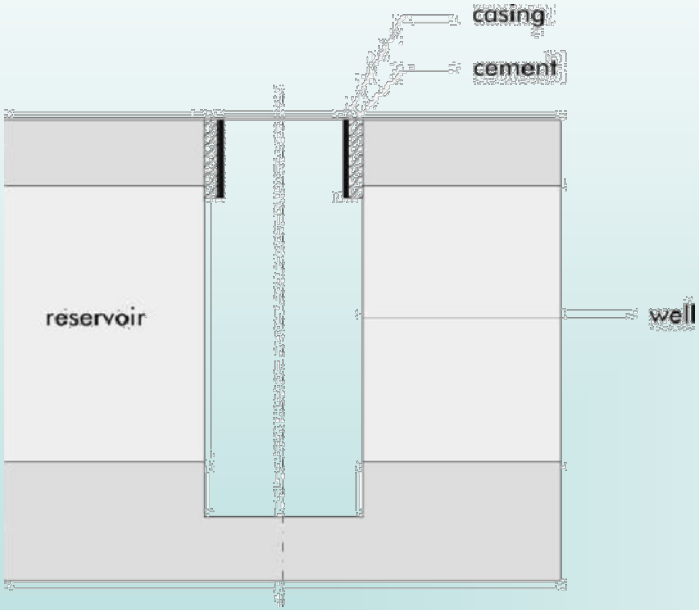
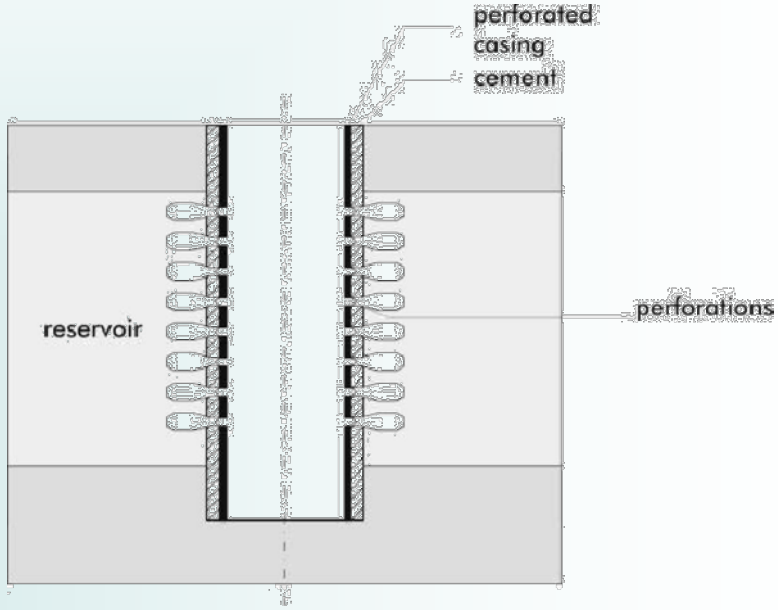
Technical design

More variants are open- and cased-hole installations for well compacted (consolidated) sandstones.

An advantage of the cased-hole variant is the good suitability for later treatment (setting of packer, etc.).



Open-hole completion



Cased-hole completion

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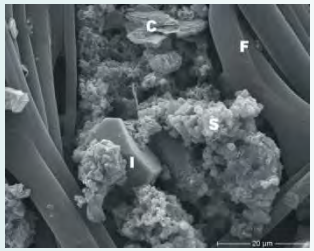
Technical design

Filtration of the thermal water:

Filtration technique to be selected with due consideration of the

- pore radii distribution
- content of solid materials
- grain size distribution of the suspended solids



Surface of a loaded filter fabric

F-fiber; I-iron sulphide; S-scaling of clay; C-clay

Filter unit (1…10 µm)

Surface installation I

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Technical design

✓ adequate material use

✓nitrogen inertisation to prevent oxygen entry into the thermal water loop

✓pressure maintenance above degassing/gas ex-solving point of all considerable gas components

✓appropriate operation (avoidance of pressure peaks, control of p-T-conditions in thermal water loop)

✓ thermal water additives

✓ equipment for operational and chemical monitoring (early detection of potential chemical and hydraulic changes)

Surface installation II

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Project examples & operational experience

Geothermal regions in Germany

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Project examples & operational experience

25 years of reinjection at the **Waren (Müritz)** GHP

(60 m^3/h; nitrogen inertisation, filtration (20/3 μm))

16 years of reinjection at **Neustadt-Glewe** GP

(110 m^3/h; nitrogen inertisation, filtration (20/2 μm))

9 years of operation of the **Berlin** ATES

(100 m^3/h; nitrogen inertisation, filtration (20/2 μm))

5 years of operation of the **Neubrandenburg** ATES

(100 m^3/h; nitrogen inertisation, filtration (20/2 μm))

3 years of reinjection at the **Unterhaching** GP

(fractured carbonates, 430 m^3/h; nitrogen inertisation, filtration (100 μm))

(+ Munich-Riem, Erding, Pullach, Unterschleißheim … , all Bavaria)

Overview of some successfully operated reinjection sites

(GHP-Geothermal heating plant; GP- Geothermal heating and power plant;
ATES-Aquifer thermal energy storage)

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Project examples & operational experience

Main building

Geothermal power and heating plant Neustadt-Glewe

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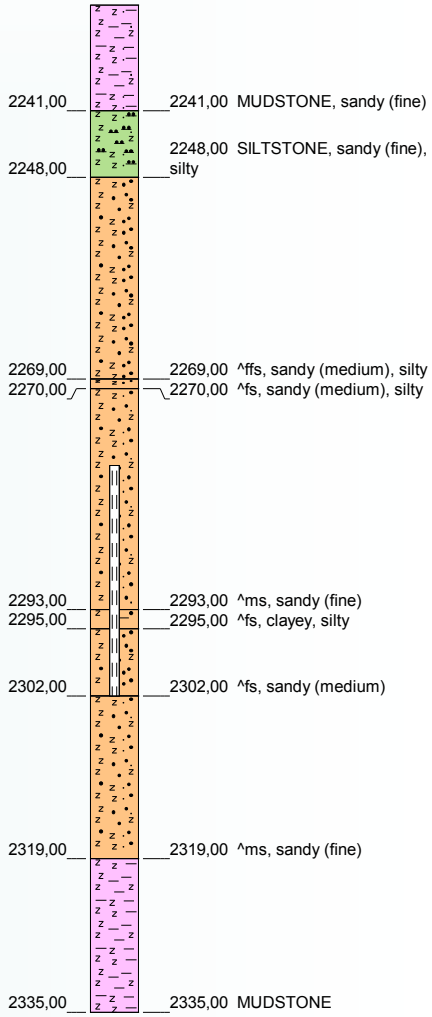
Project examples & operational experience

<u>Injection well</u>	*in operation since 1995*
Geological formation:	Contorta
Depth:	2,200 m
Effective thickness:	71 m
Production temperature:	98°C
Injection temperature:	40°C to 80°C
Mineralisation:	220 g/l
Injection flowrates:	up to 125 m^3/h
Iron content (Fe^{2+}):	82 mg/l
Water preparation:	Filtration (20 / 2 μm); nitrogen inertisation



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Project examples & operational experience

GP Neustadt-Glewe: Filter house 2

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Project examples & operational experience

Results of inspection:

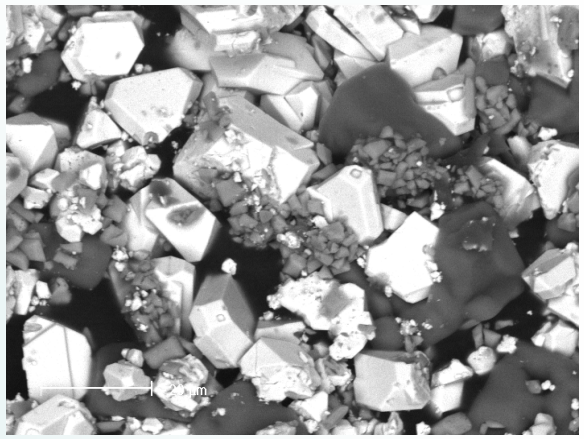
abt. 40% acid-soluble components in the underground screen section

Acidification („soft-acidising“)

objective: pH 2-3
✓ 15 % hydrochloric acid

Elements:
Ca, O, Fe, Na, Pb, Si, Sr, Ba

Minerals:
galenite, pyrite, aragonite, baryte



GP Neustadt-Glewe: Soft-acidising in1998

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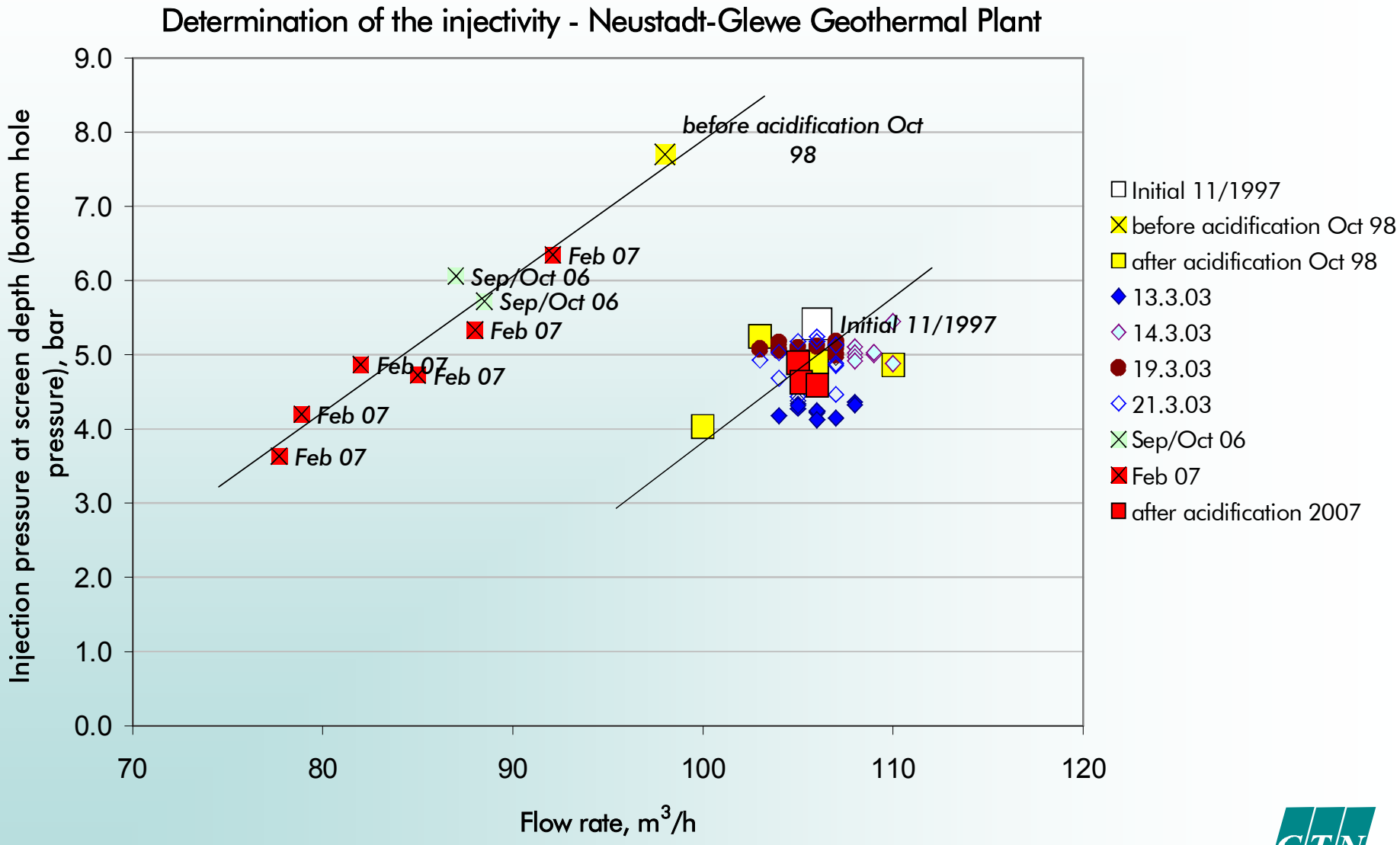
Project examples & operational experience



Results of soft acidising in 1998 and 2007

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Reinjection in sandstone: German experiences

- ✓ Injection of thermal waters into porous reservoirs is technically feasible but the exact knowledge of the geological parameters is essential for the successful implementation of a project.
- ✓ Planning requires close interlinking of technical and geological know-how (communication).
- ✓ The solutions are site-specific.
- ✓ Monitoring is a must for stable plant operation.

Summary I

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Reinjection in sandstone: German experiences

- ✓ The data recorded during exploration/installation and the operational data (monitoring) are an essential prerequisite to be able to take adequate measures immediately once injectivity decreases.

- ✓ Recent studies confirm that the experience obtained from the operation of German geothermal plants can well be transferred to many other sites in Europe with analogous geological conditions.

Summary II

GTN INGENIEURE & GEOLOGEN

History of Reinjection into Porous Geothermal Reservoirs in Hungary

János Szanyi

Geothermal Coordinating and Innovation Foundation

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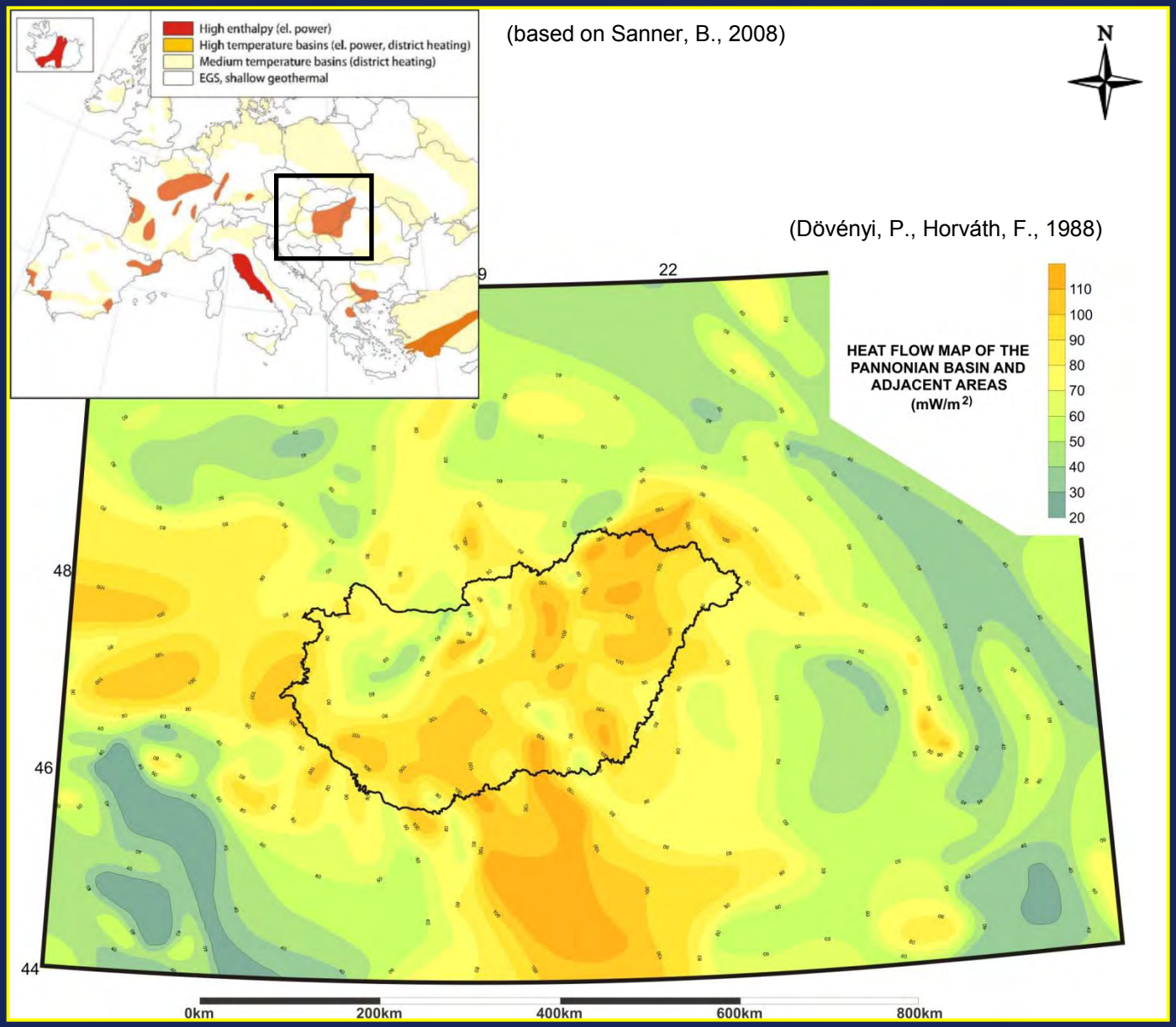
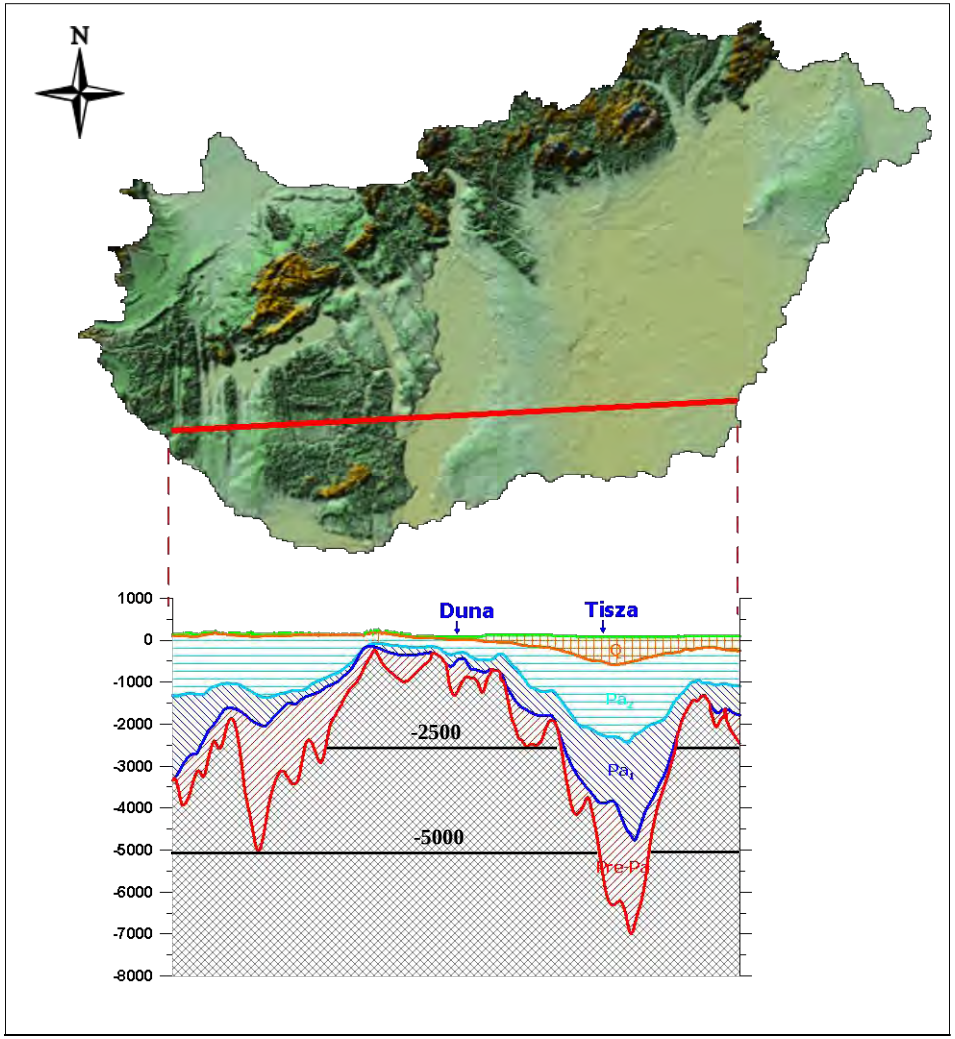
Outline

- General introduction of the geothermal potential in Hungary
- Short history of reinjection technology in Hungary
- Research (well testing and modelling)
- Preliminary results
- Future expectations
- Conclusions

Geothermal thematic map of Europe and Hungary



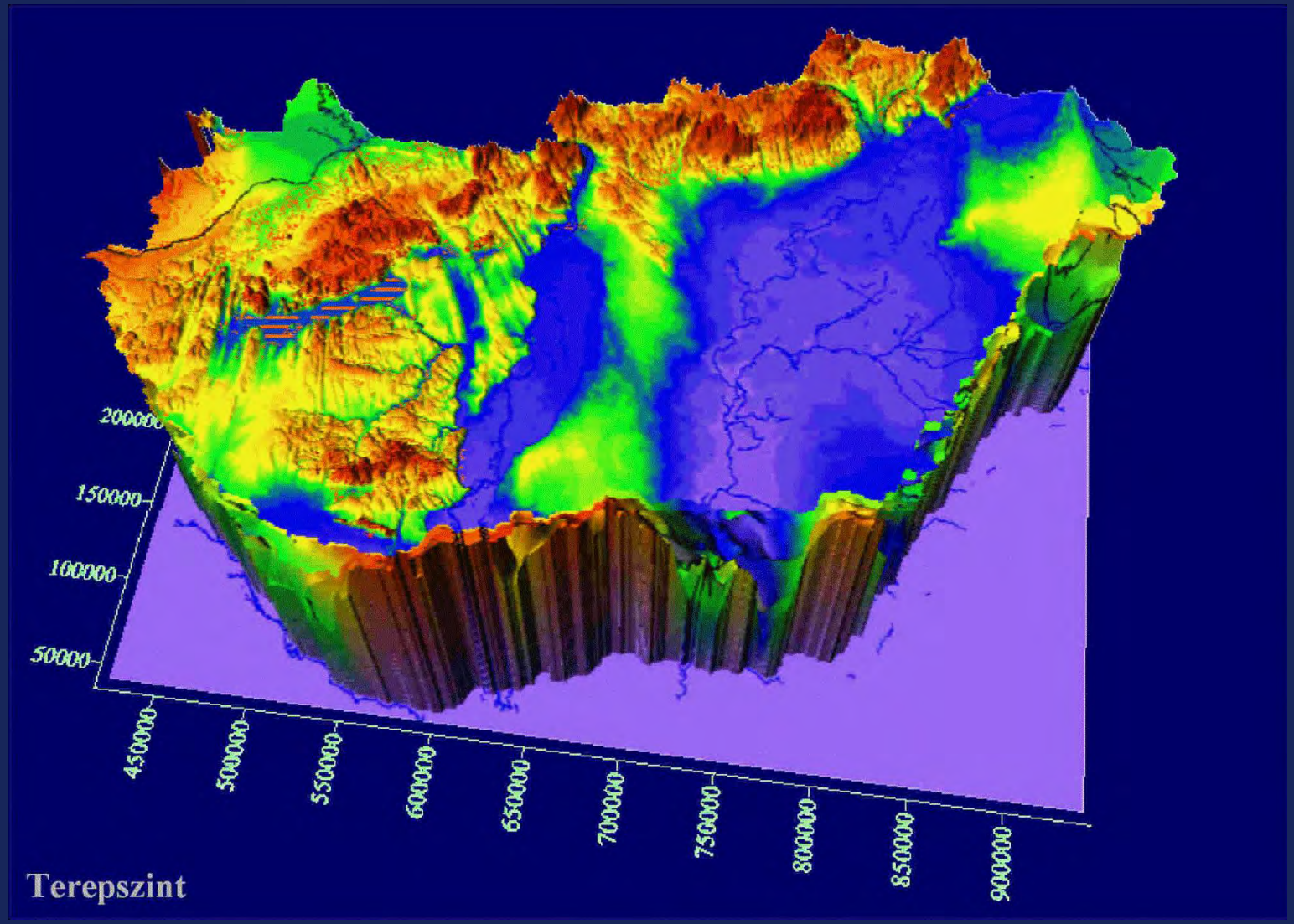
Geological background



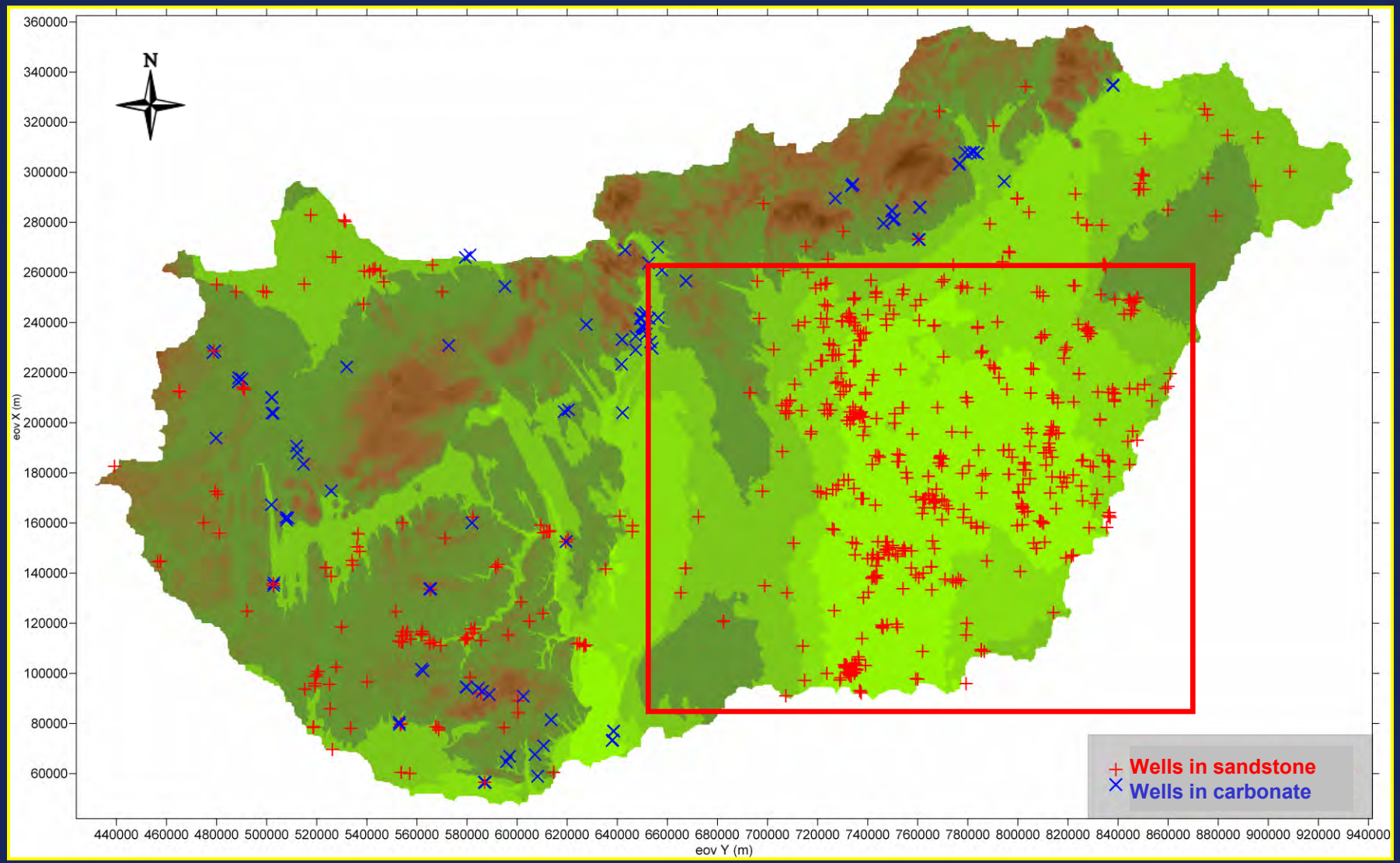
Due to plate tectonic events a quick subsidence of the surface occurred that made the Pannonian deep sea.

In the place of the former sea a huge sedimentary basin remained with sedimentary sequences up to 6-7,000 m thickness.

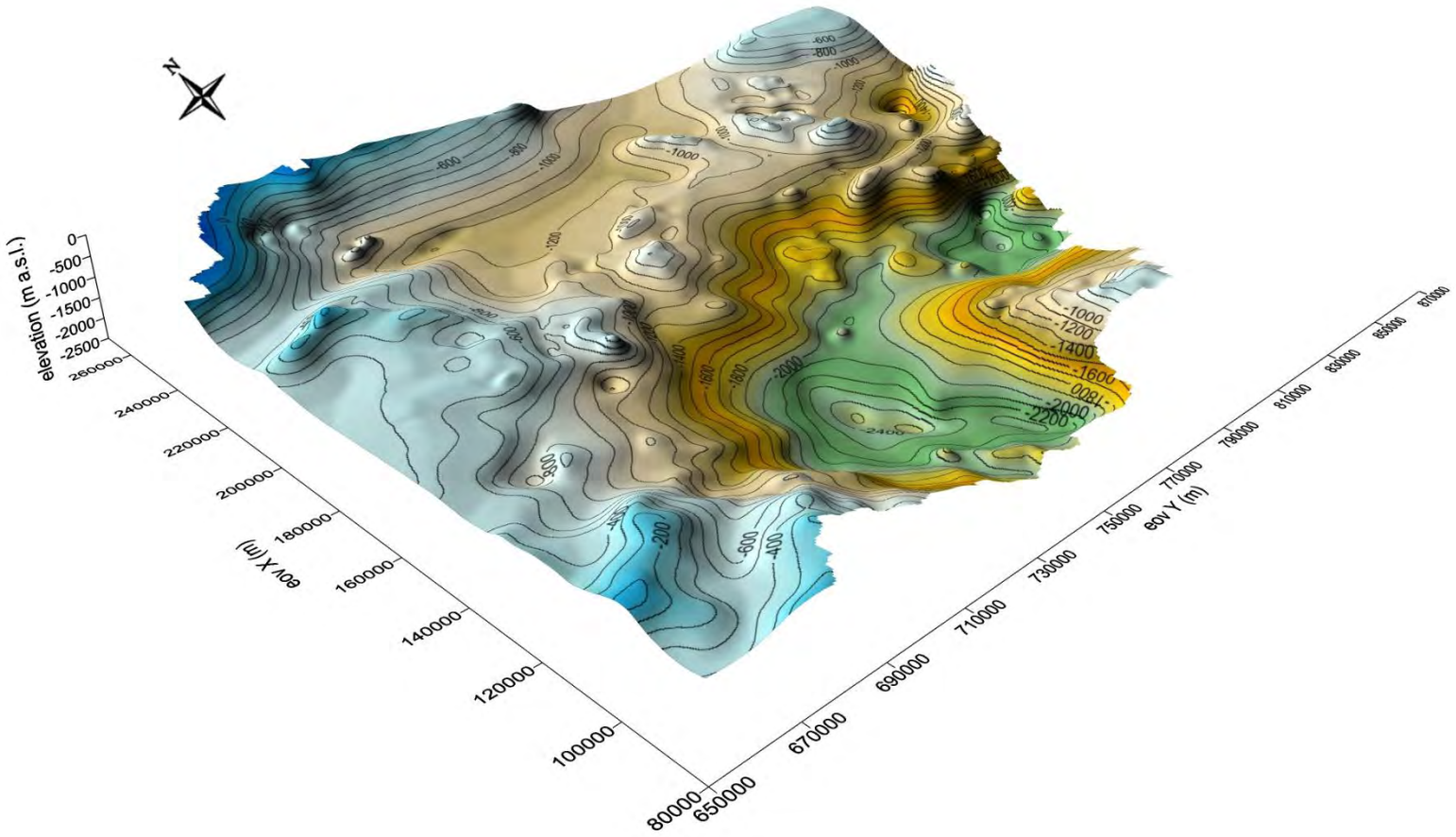
Geometry of hydrostatic units in Hungary



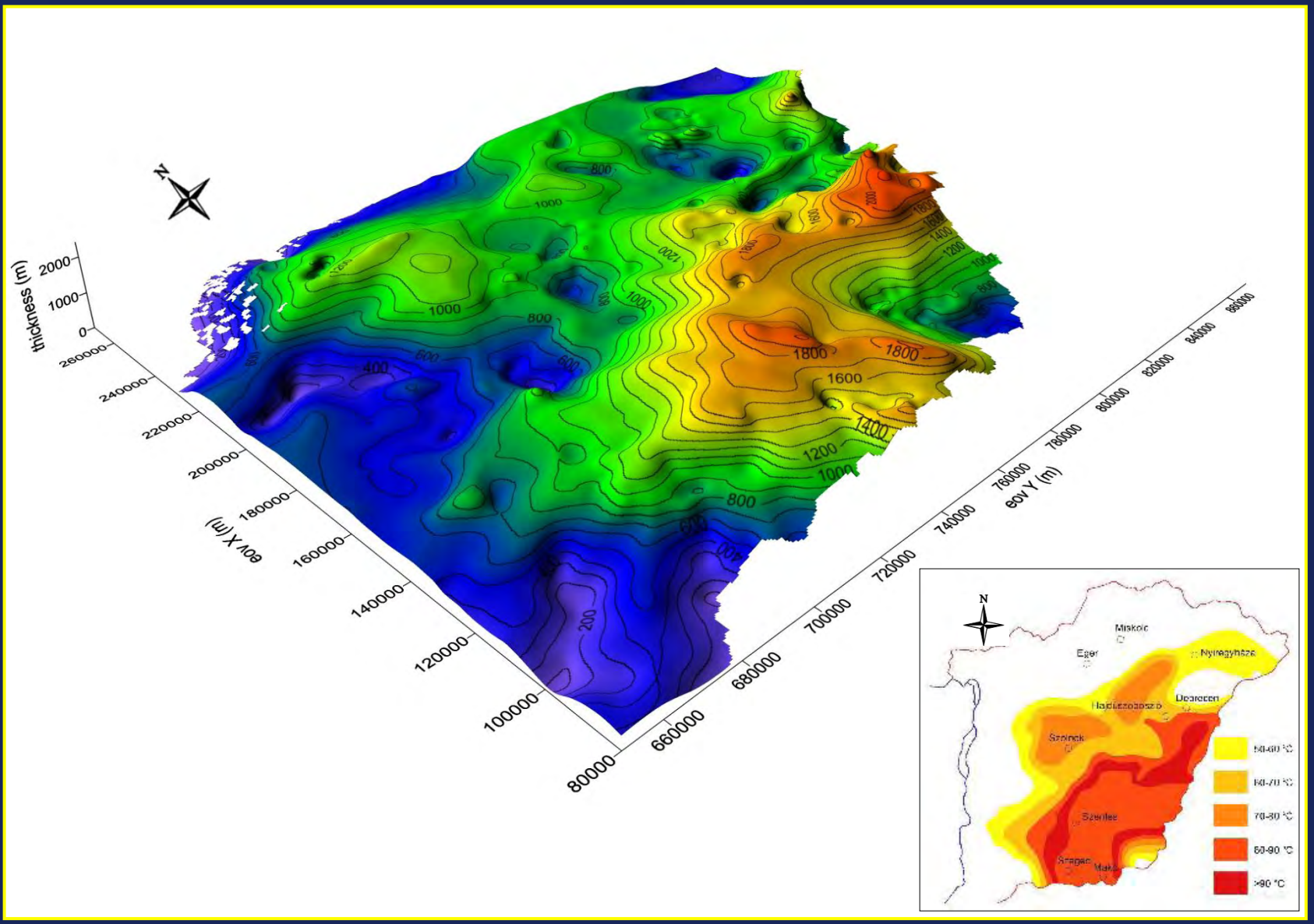
Locations of thermal wells



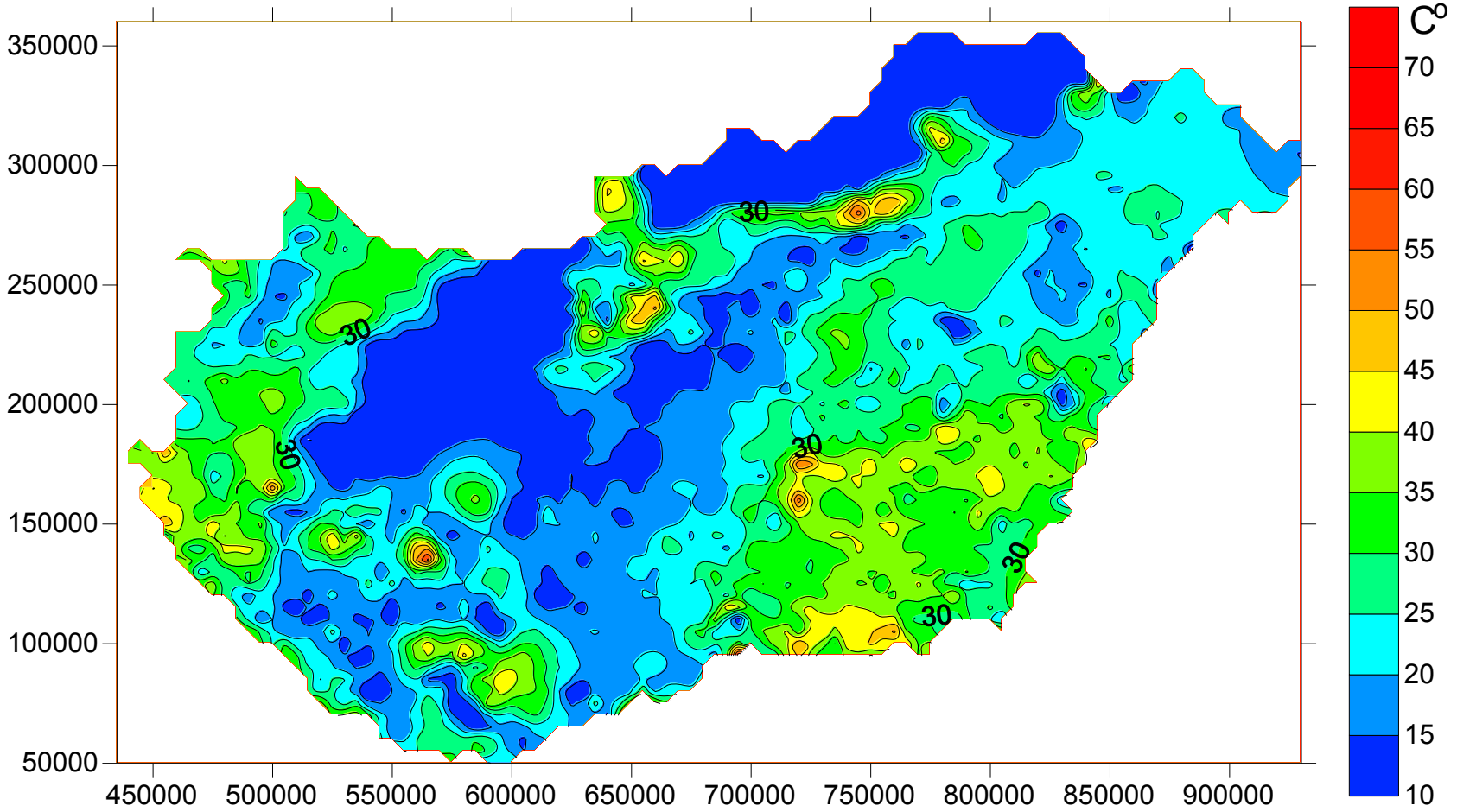
Bottom of the Upper Pannonian strata



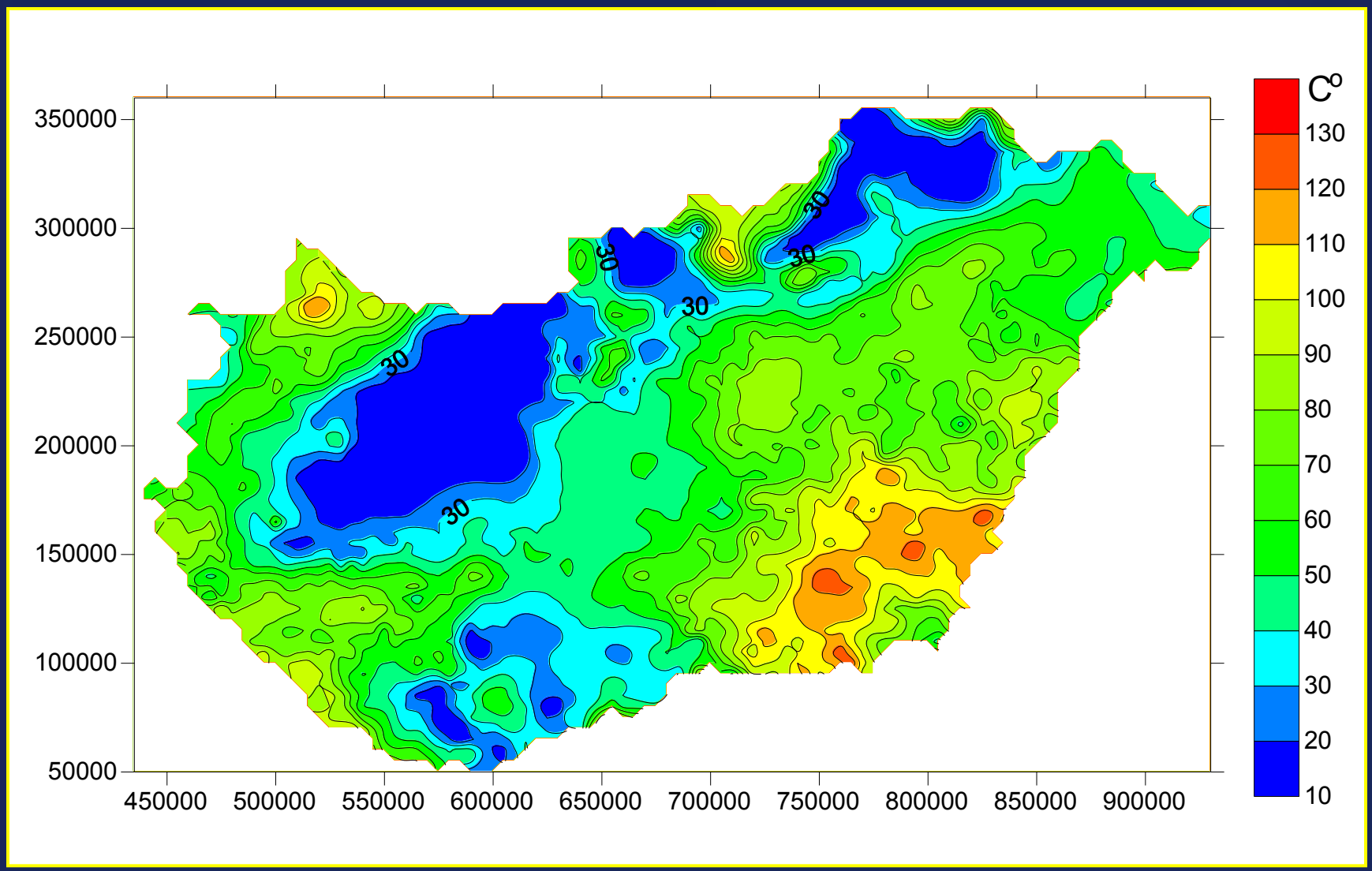
Thickness of the Upper Pannonian strata



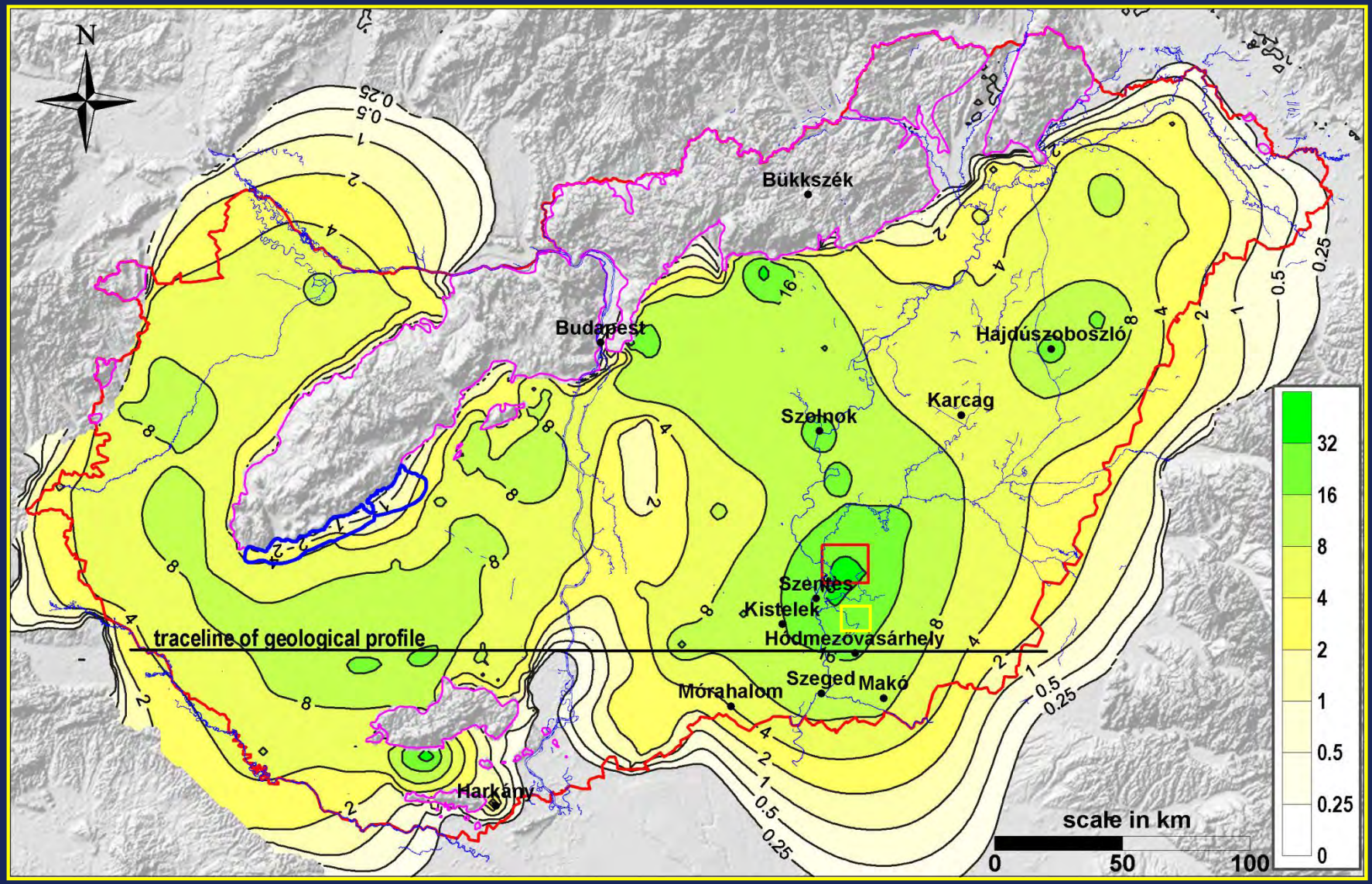
Temperature distribution on the bottom of the Quarter sequences



Temperature distribution on the bottom of the Upper Pannonian sequences



The calculated drawdown at the bottom of the Upper Pannonian sequences (Tóth, 2009)



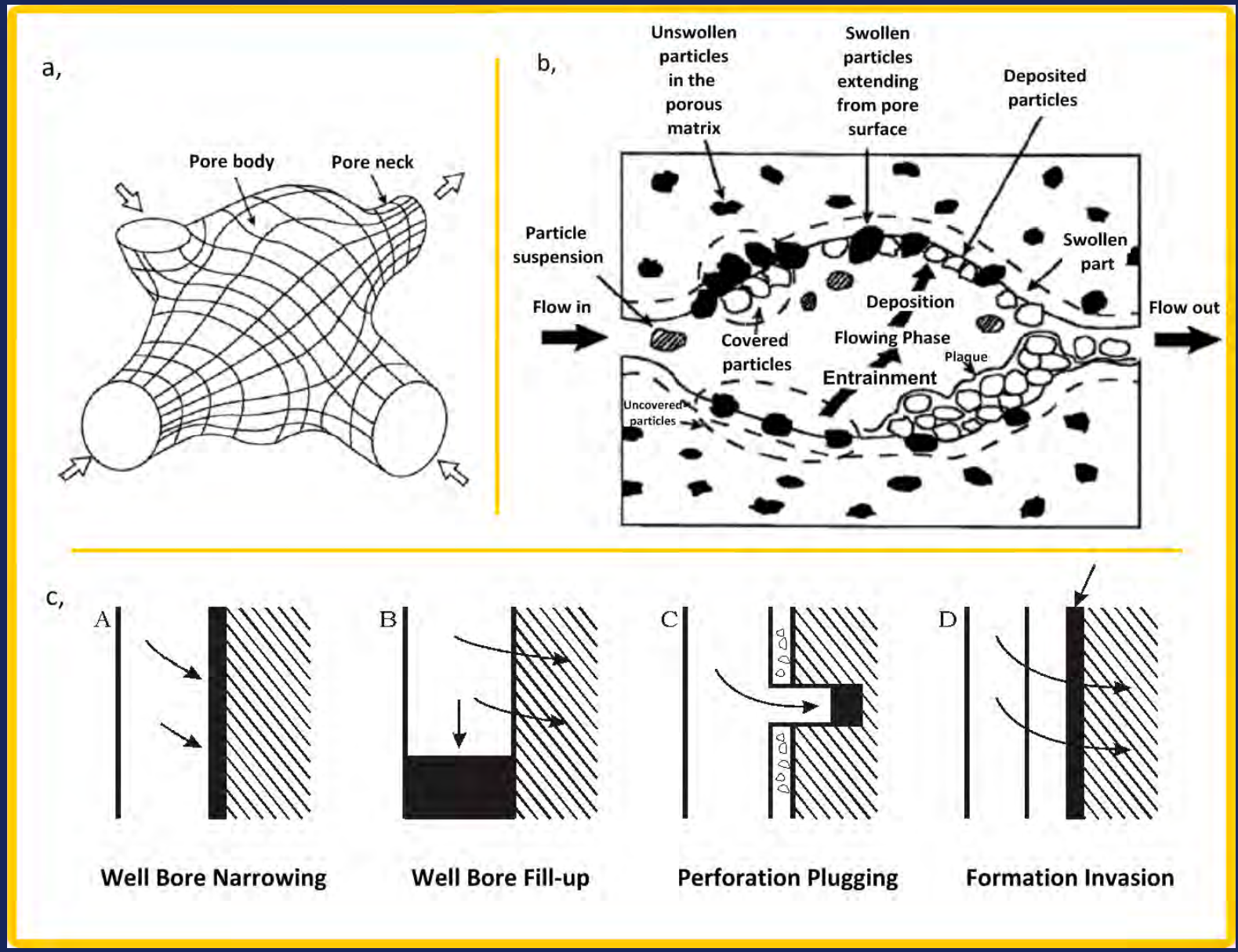
Thermal water wells in Hugary – state 01.01.2008.

Surface water temperature (°C)	Utilization										No. of wells	Pct. %
	WS	SPA	AGR	IND	COMM	MULT	REINJ	OBS	CLOS	ELIM		
30 - 39,99	199	70	88	30	1	12	1	52	86	103	642	43,94
40 - 49,99	23	138	21	14	3	17		45	45	31	337	23,07
50 - 59,99	7	61	21	8	3	17	6	11	20	14	168	11,5
60 - 69,99		40	16	8	1	28	7	4	18	11	133	9,1
70 - 79,99		9	20	7	3	11	2	2	11	3	68	4,65
80 - 89,99		4	33	1	3	1	1	1	7	1	52	3,56
90 -99,99		6	40	1	4				3	3	57	3,9
>100			1			1			2		4	0,27
Summarised	229	328	240	69	18	87	17	115	192	166	1461	100
Percantage %	15,67	22,4	16,5	4,7	1,23	5,95	1,16	7,9	13,14	11,4		
Producing well%	23,58	33,8	24,7	7,1	1,85	8,96					971	66,5

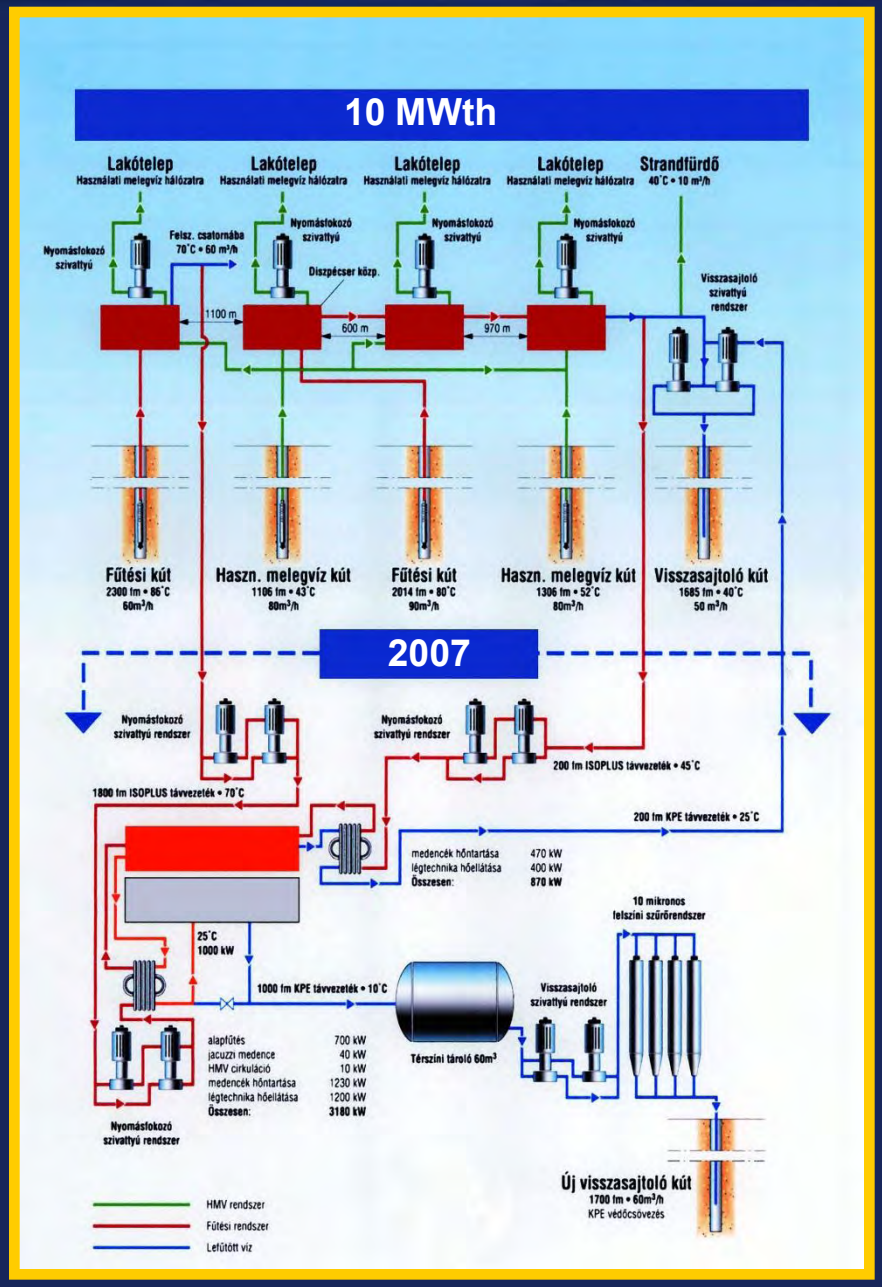
WS: water supply; SPA: thermal spas and hospitals; AGR: agricultural; IND: industrial; COMM: communal space heating; MULT: multiple-purpose; REINJ: reinjection wells; OBS: observation boreholes; CLOS: closed; ELIM:eliminated

Certificated medicinal water(2005):151 wells in 103 localities + Lakespring Hévíz + 4 groups of springs in Budapest and 2 groups of springs in Eger

Processes of the plugging (based on Civan, 2007)

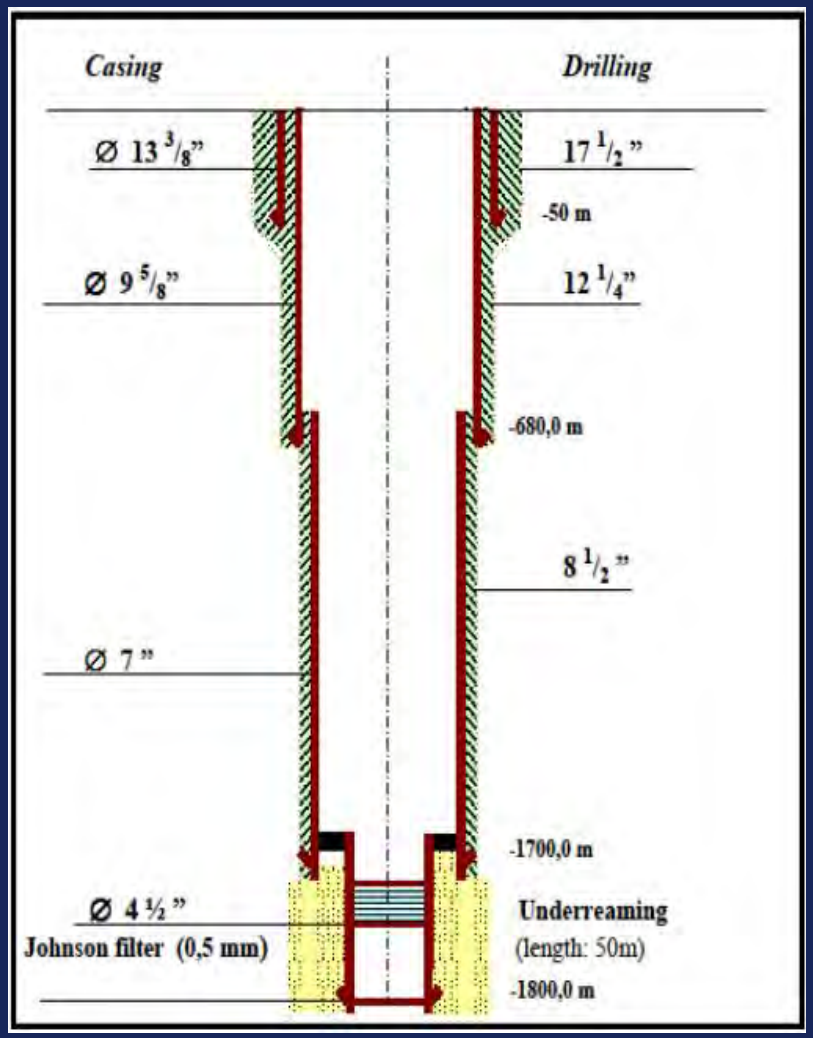


Existing method of reinjection

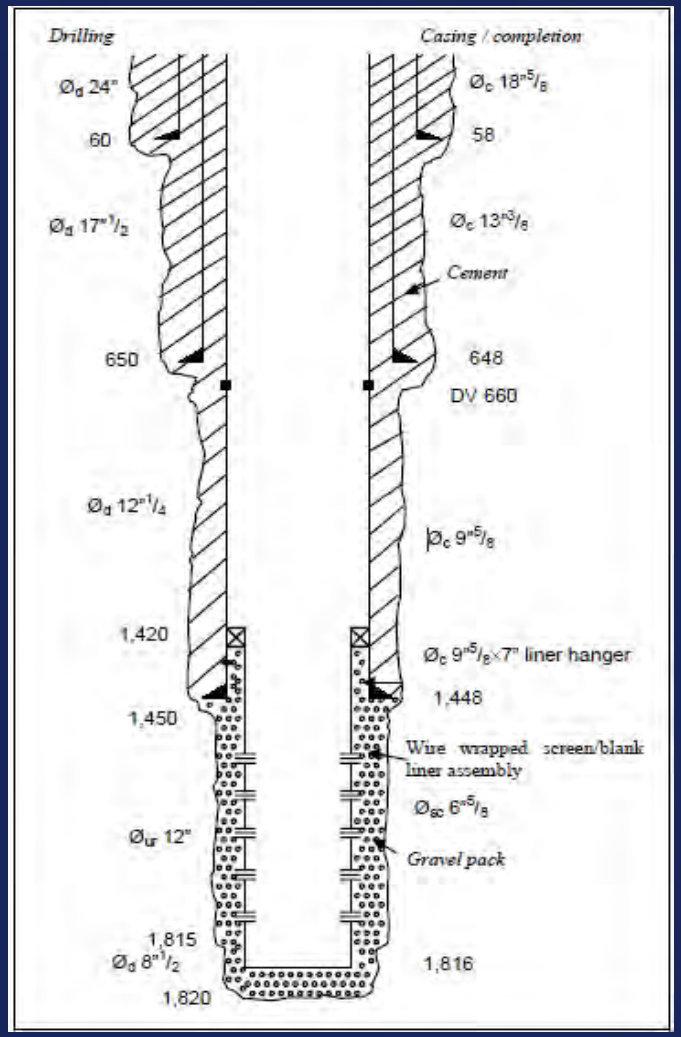


The surface filter system

Construction of reinjection wells

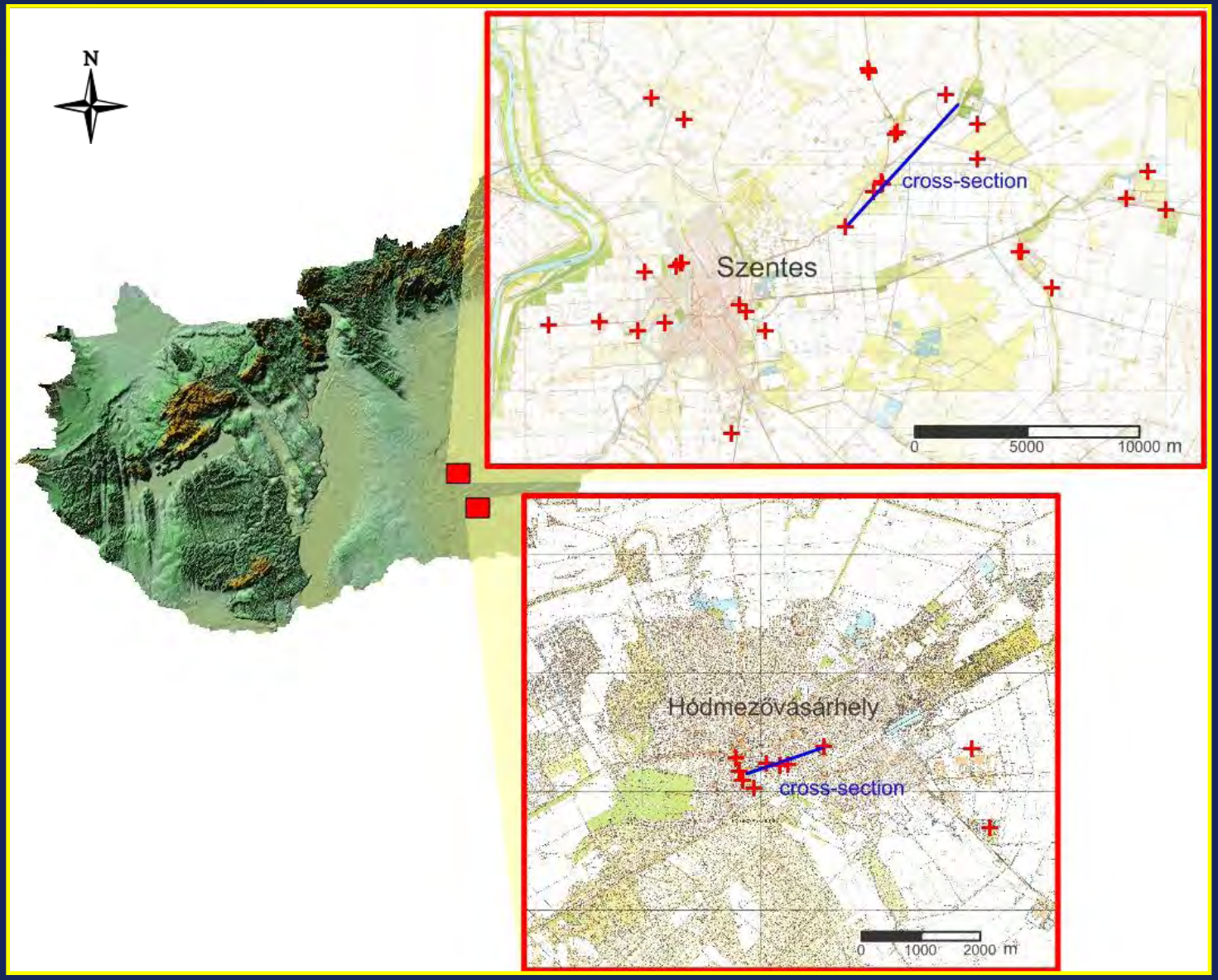


Existing reinjection wells

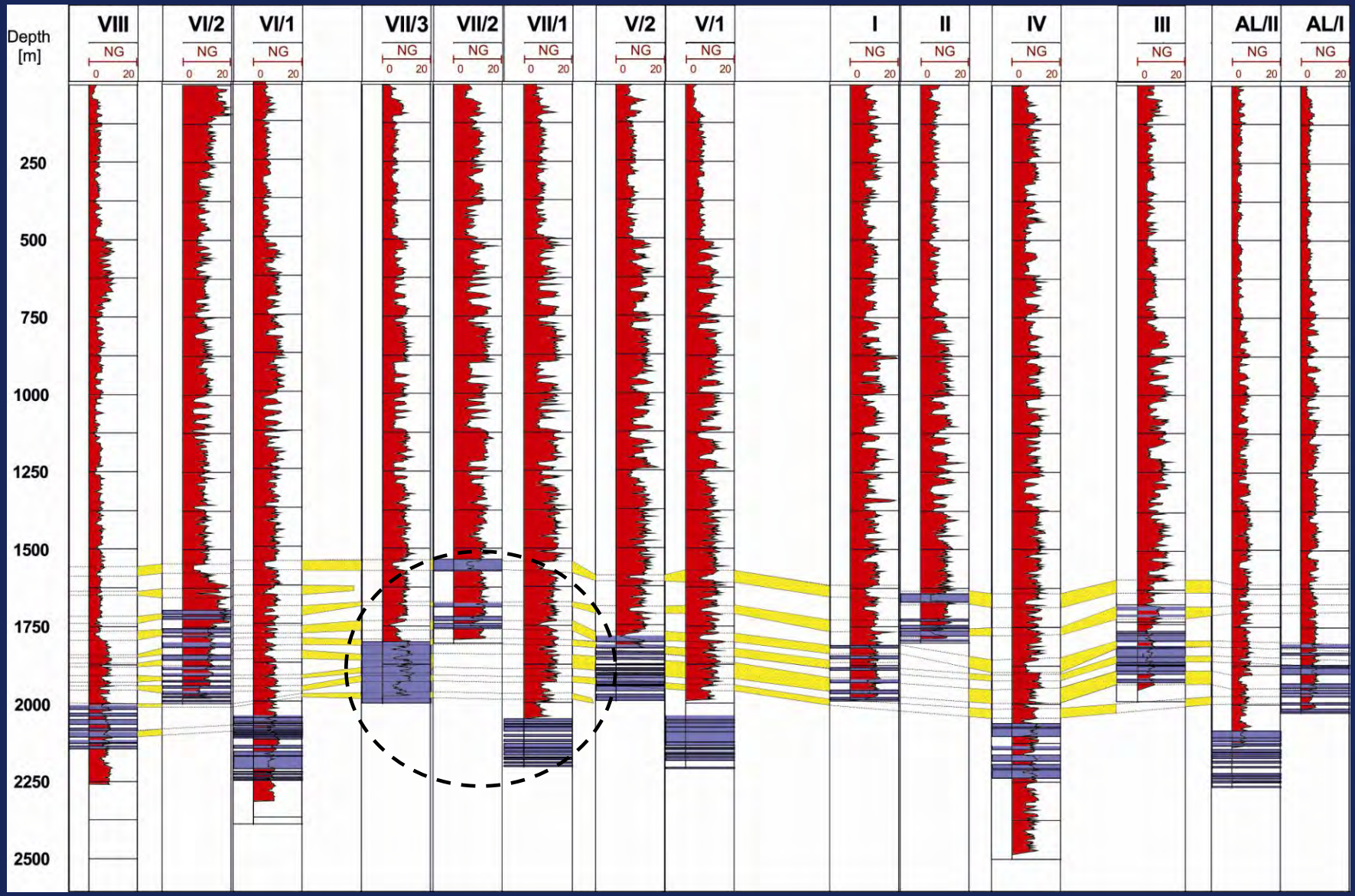


Recommended reinjection wells
(Antics, 2002)

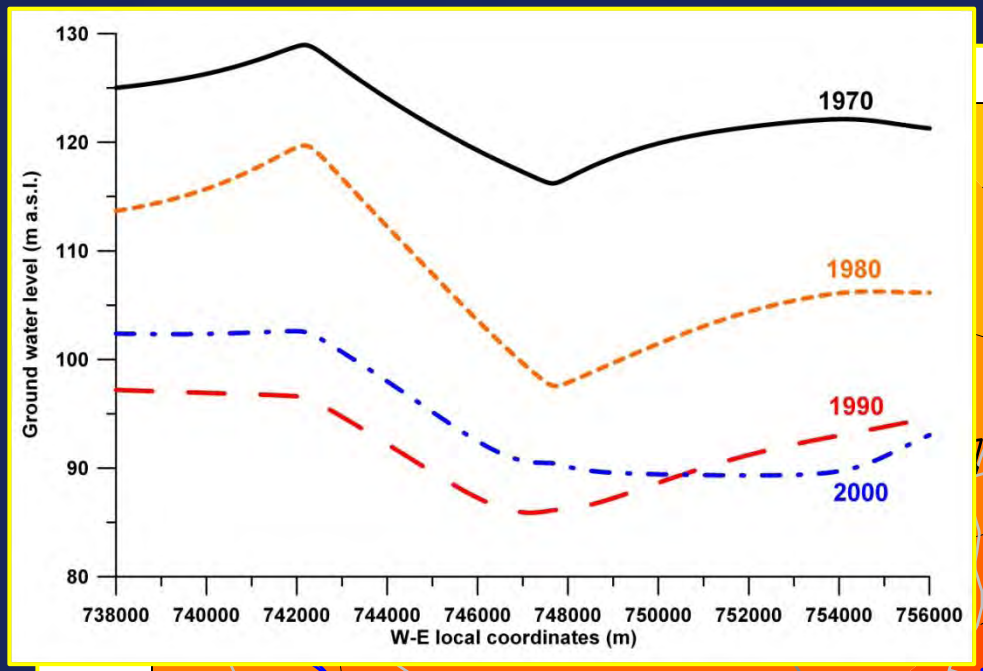
Location of the investigated areas



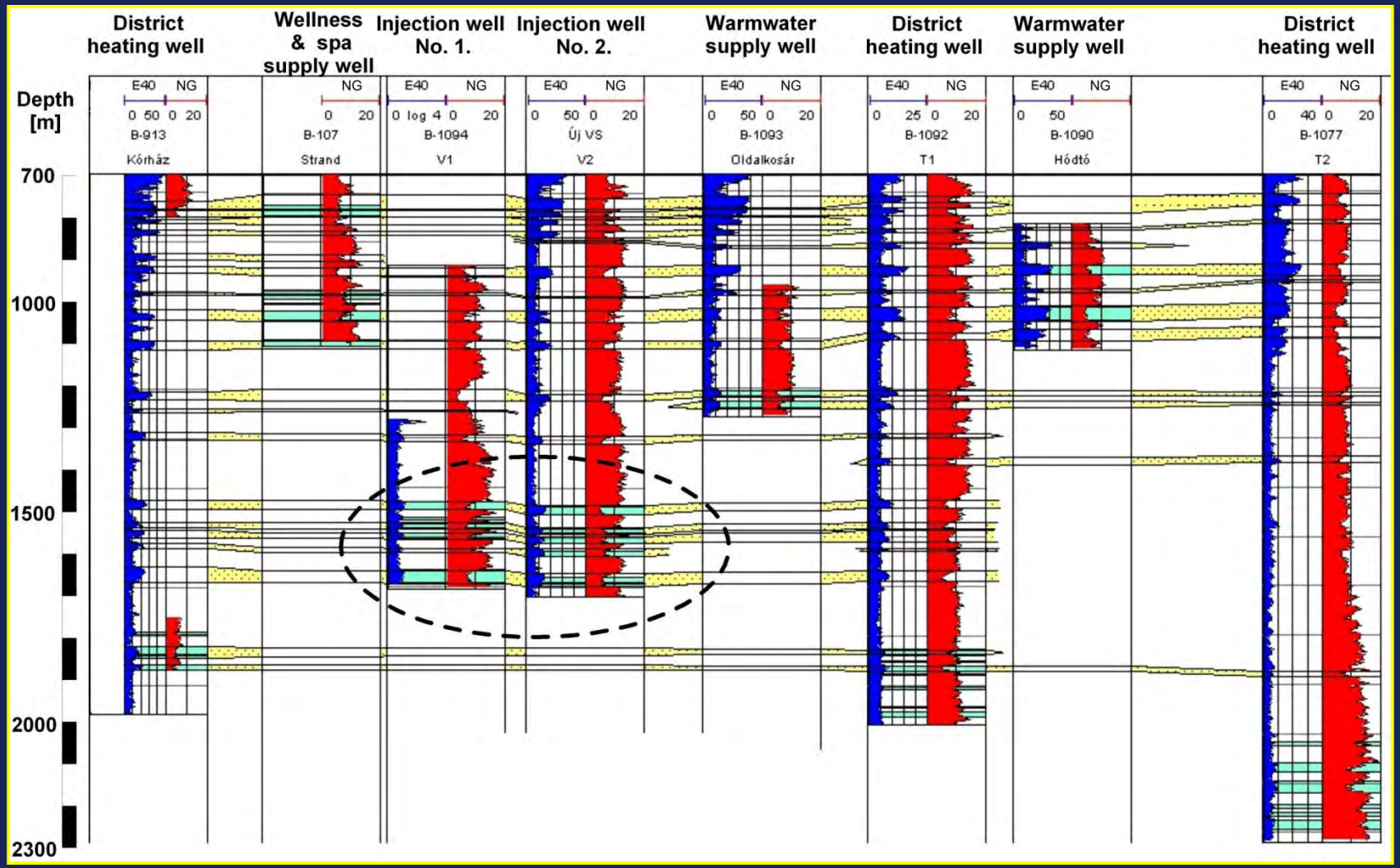
Geophysical cross-correlated profiles in the Szentes area



The change of the Szentes drawdown from the 1970's along an WE profile and the shape of depression cone in 2000

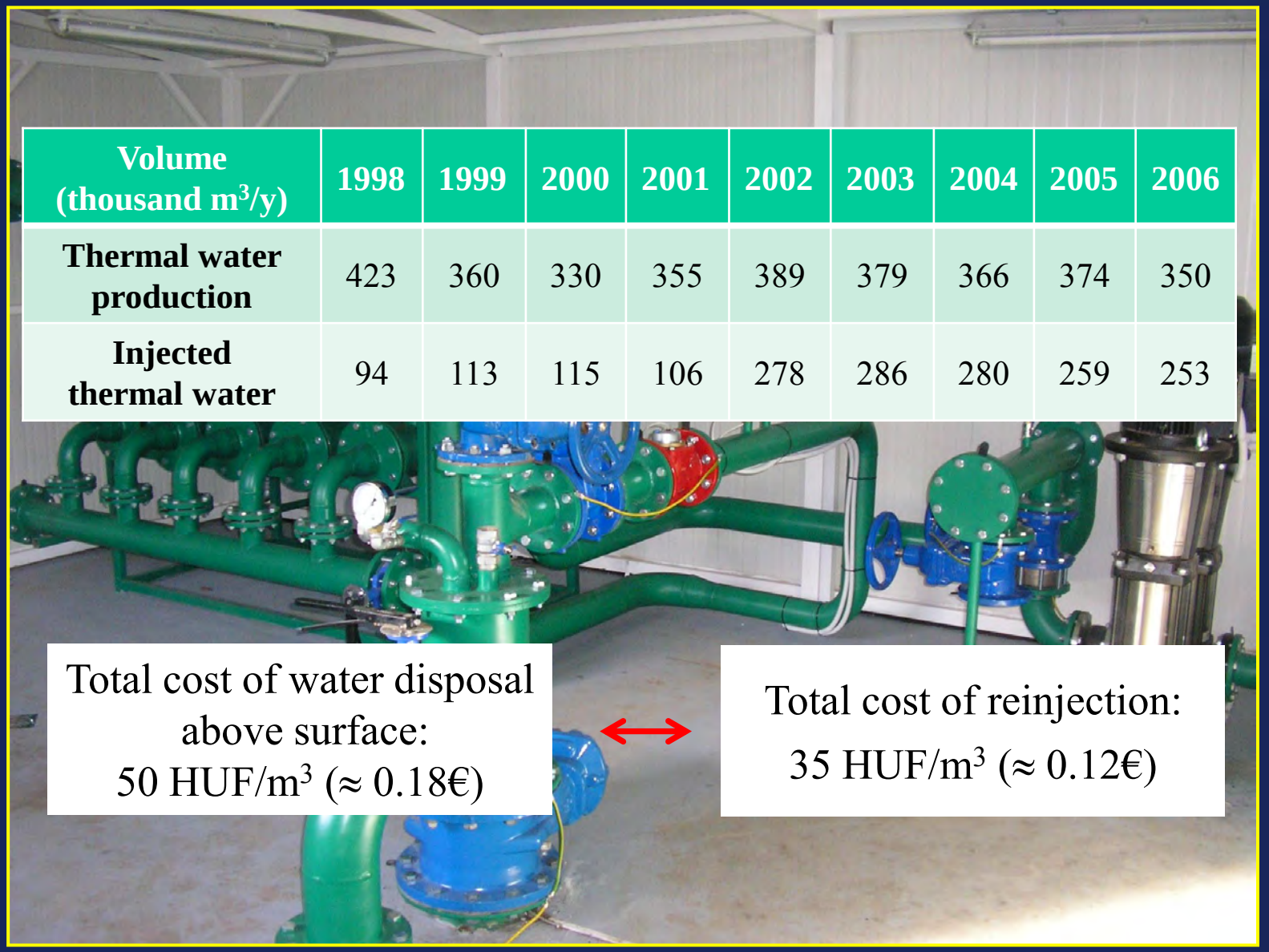


Geophysical cross-correlated profiles in the Hódmezővásárhely area



Comparison of exploited and injected thermal water volume at Hódmezővásárhely site-I.

Volume (thousand m^3/y)	1998	1999	2000	2001	2002	2003	2004	2005	2006
Thermal water production	423	360	330	355	389	379	366	374	350
Injected thermal water	94	113	115	106	278	286	280	259	253

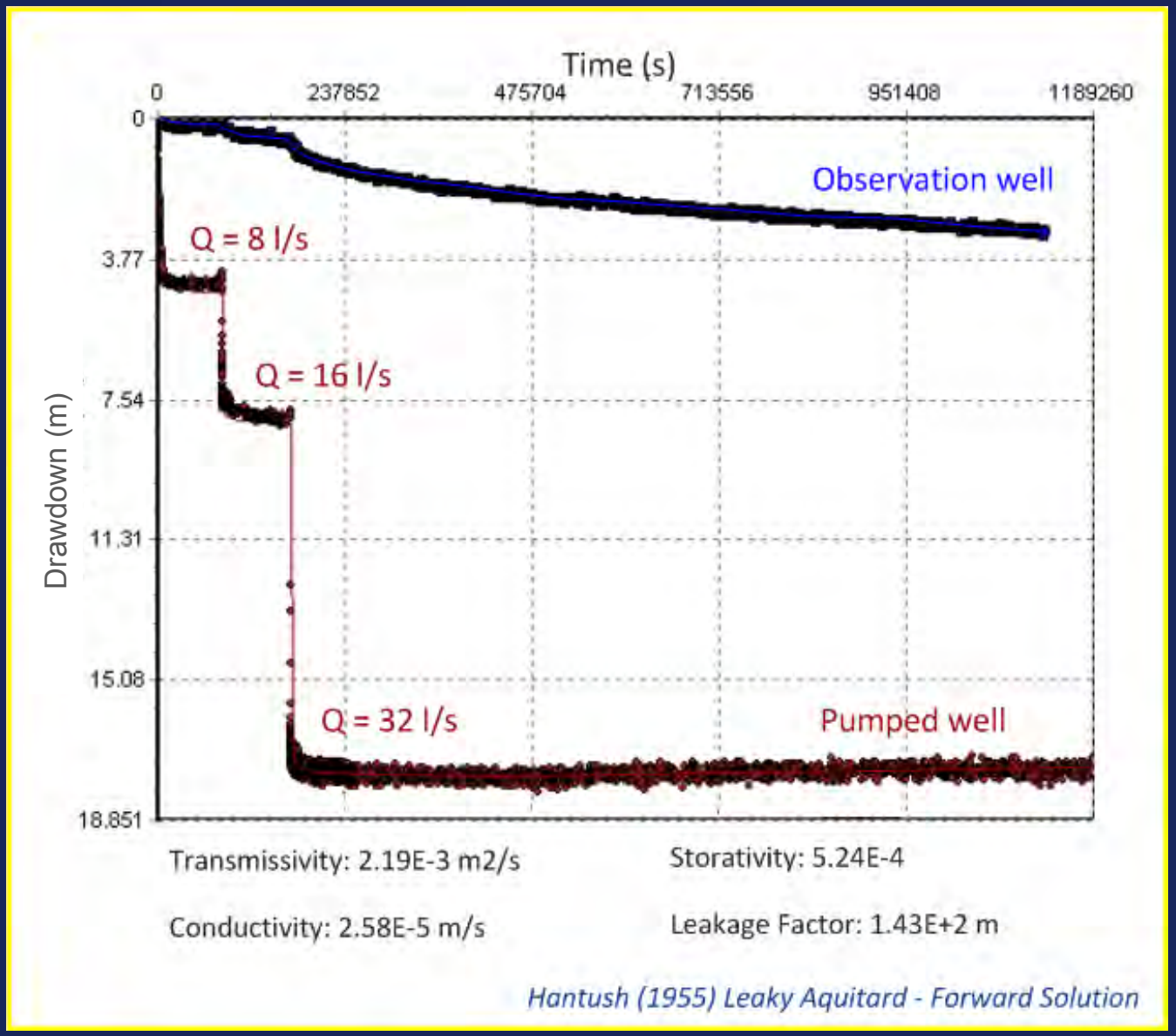


Total cost of water disposal above surface:
50 HUF/m^3 (≈ 0.18€)

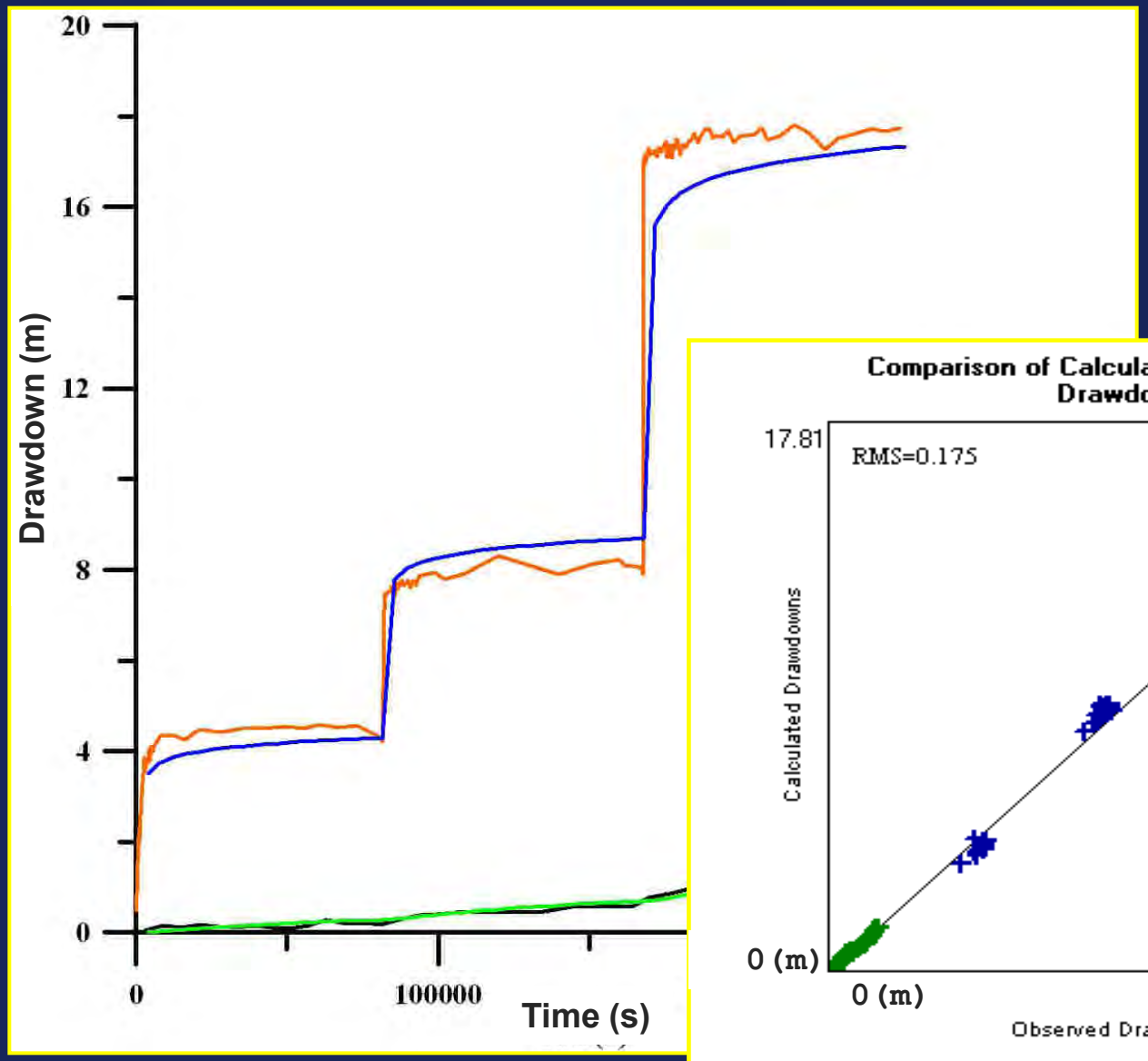
↔

Total cost of reinjection:
35 HUF/m^3 (≈ 0.12€)

Determination of hydrogeological parameters by 3 steps pumping test

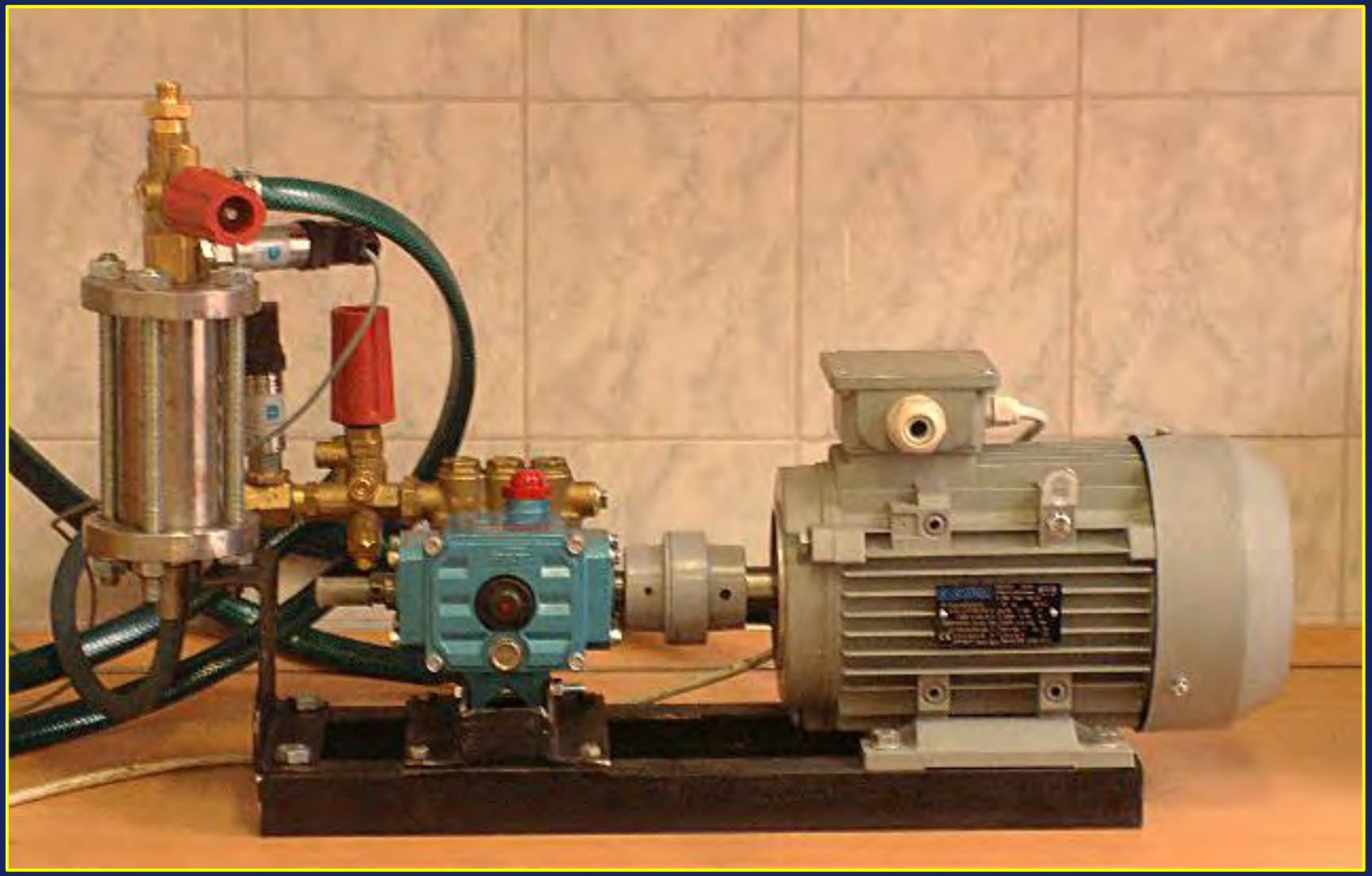


Model calibration



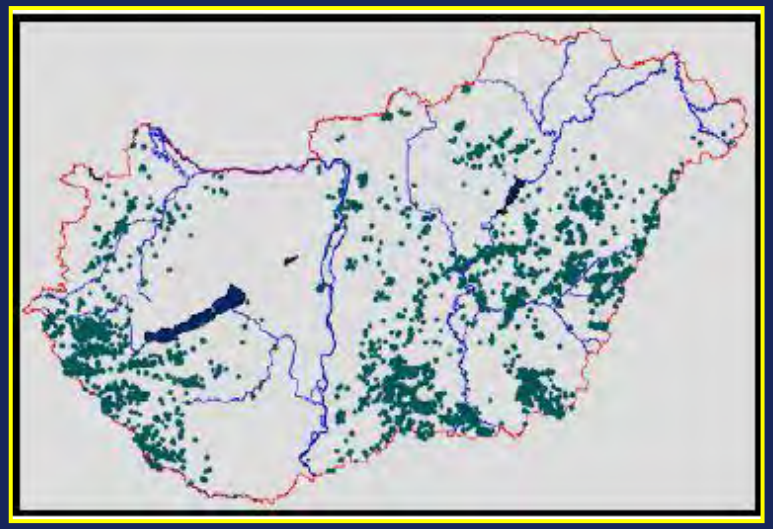
New instrument for the measurement of plugging

GEKKO



Future tasks

to improve efficiency



to use abandoned hydrocarbon wells (>3000)

to build new projects

Conclusions

- The calculations and test results show that geothermal operation in the area has long term hydraulic effect on the aquifer
- A sustainable aquifer management is needed because thermal water withdrawal has significant vertical affects
- Both theoretical studies and field experience clearly demonstrate the beneficial effects of reinjection, thus reinjection is considered to be an essential part of good field management.
- Reinjection is considered an additional cost to geothermal operations. However a proper cost analysis over the whole lifetime of the reservoir will most likely reveal that exploitation with reinjection is a more economical alternative than operating without reinjection. The reason for this is simply that, without reinjection, only a small fraction of the thermal energy available in the reservoir can be recovered.

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

Umwelt Bundes Amt
Für Mensch und Umwelt

BfN Bundesamt für Naturschutz

Rödl & Partner

Feed-in-tariffs regarding geothermal energy

German Renewable Energy Act

Budapest, 17 February 2011

Attorneys
Auditors
Tax Consultants
Business Consultants

Renewable Energy Act (EEG)

Integrated Energy and Climate Programme (IEKP)

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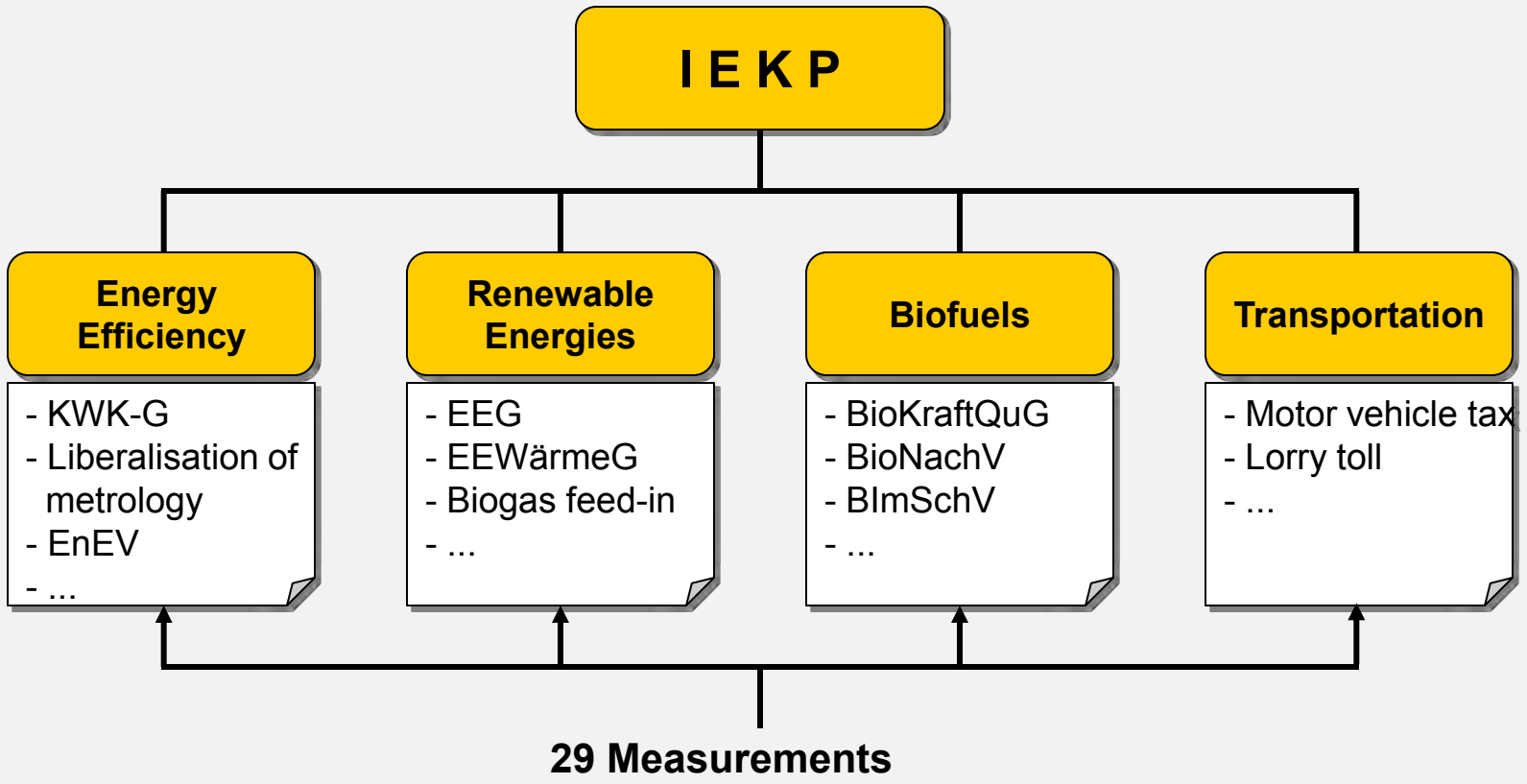


Renewable Energy Act (EEG)

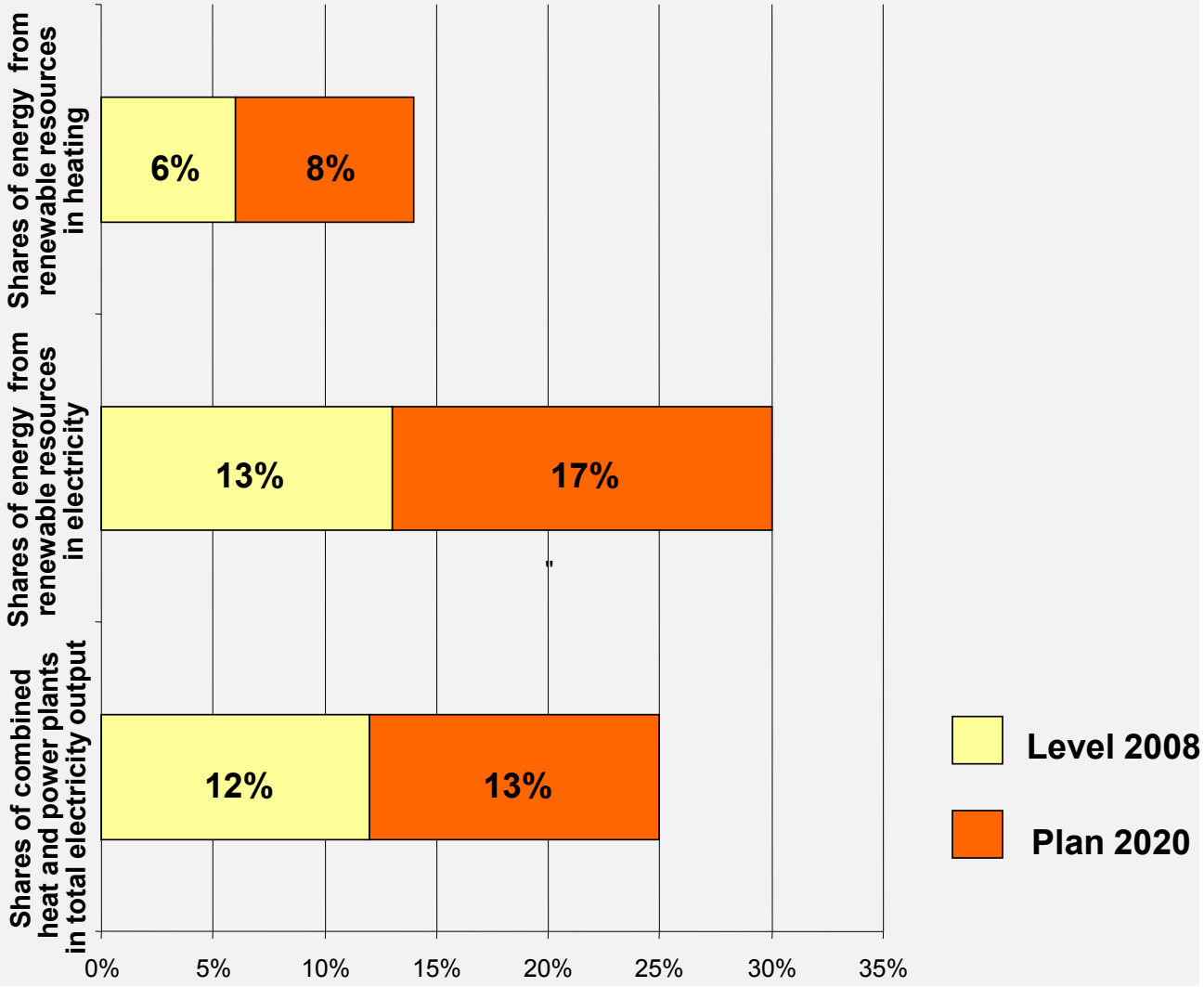
Rödl & Partner

Package of measurements to be in force since 1st January 2009

EEWärmeG
(Renewable Energies Heat Act)

EEG
(Renewable Energy Act)

KWK-G
(Combined Heat and Power Act)



Renewable Energy Act (EEG)

Development of the legal framework

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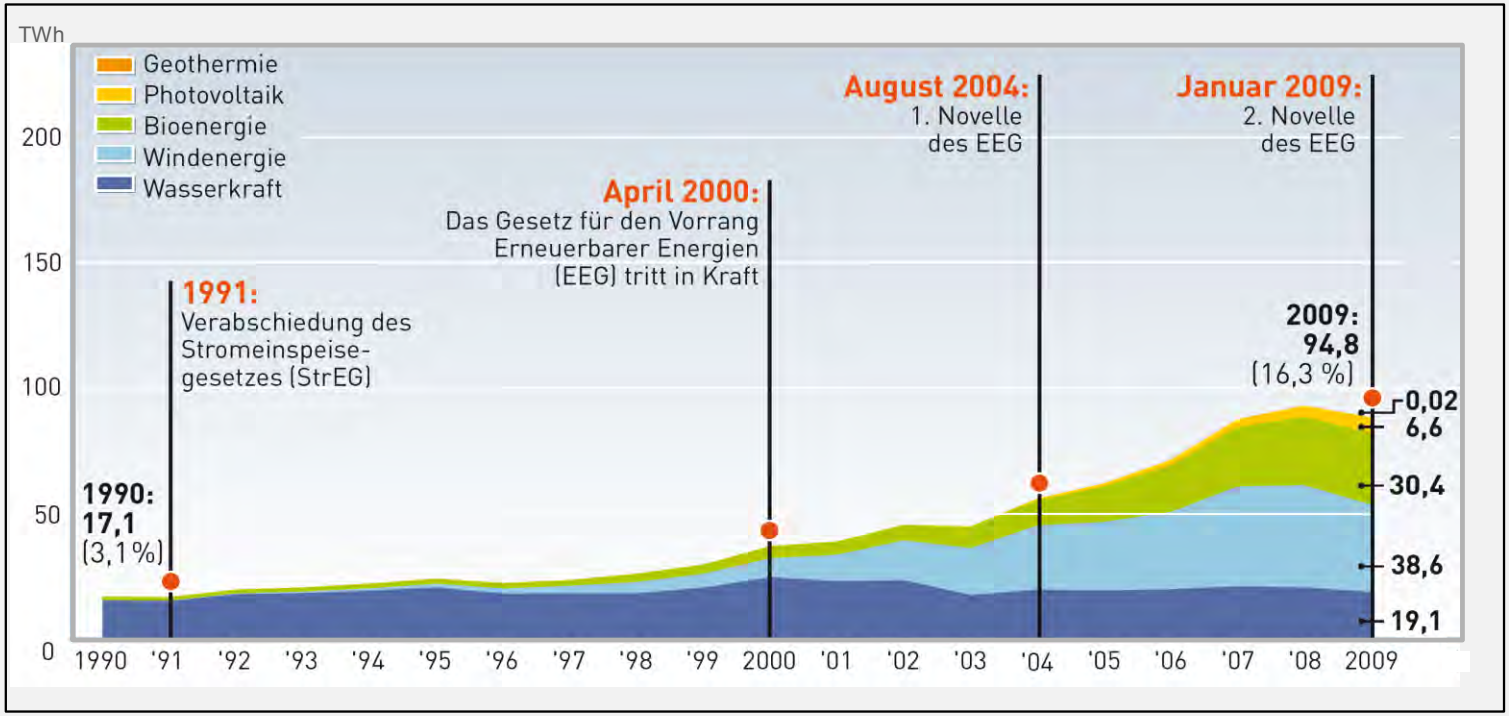

Source: Bruns, Ohlhorst, Wenzel

2010:

- **Renewable Energy Resources share 17 % of the total electricity consumption and 6,7 % of the total energy consumption (primary energy)**

Renewable Energy Act (EEG)

Core elements (1)

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- Legislation came into force in 2000 and was amended in 2004, 2009 and especially for PV in 2010 and 2011 (expected)
- Intention: Speeding up the market launch of technologies for power generation from solar radiation, wind power, biomass etc.
- Subsidized feed in tariffs are refinanced by charging **all** electricity consumers in Germany (**not tax financed)**

Obligation of grid operators to

- **Give priority access to electricity from renewable energy sources**
- **Pay for it according to tariffs fixed by the law for 20 years (plus year of commissioning) – no cap**
- **Amplify grid to enable injection**

Renewable Energy Act (EEG)

Core elements (2)

Rödl & Partner

- **Duration of Payment** as guaranteed by the EEG is limited in time and is usually 20 years plus the year of commissioning of the installation (§ 21 EEG)
- The amount of tariff differs for every source of energy (technology), system capacity and year of commissioning (§§ 18 -33 EEG)
- The tariffs (incl. Bonuses) will be gradually reduced. The **degression** principle is meant to provide an incentive to reduce costs through technological progress. The tariffs for new systems will be reduced by a legally fixed percentage depending on the year of commissioning and the energy source used (§ 20 EEG)
- The costs of the feed-in tariffs are borne by the final consumers (§§ 34 - 44 EEG)

Renewable Energy Act (EEG)

Rödl & Partner

General conditions regarding grid access for Renewable Energies

- **§ 5 (1) EEG:** power plants from renewable resources are granted an appropriate (voltage-level) grid access (direct), such as the air-line distance. Except, there is a superior microeconomic alternative existing or the grid operator allocates a different attaching point (BUT: additional costs occurring through this are borne by the grid operator (§ 13 (2) EEG))

- **§ 13 (1) EEG:** required costs for the grid access, concerning the distance from the power plant to the attaching point as well as costs for metrology devices, are borne by the power plant operator

- **§ 14 EEG:** costs concerning the optimization, amplification and extension of the grid are borne by the grid operator

Renewable Energy Act (EEG)

System of refinancing of remunerations

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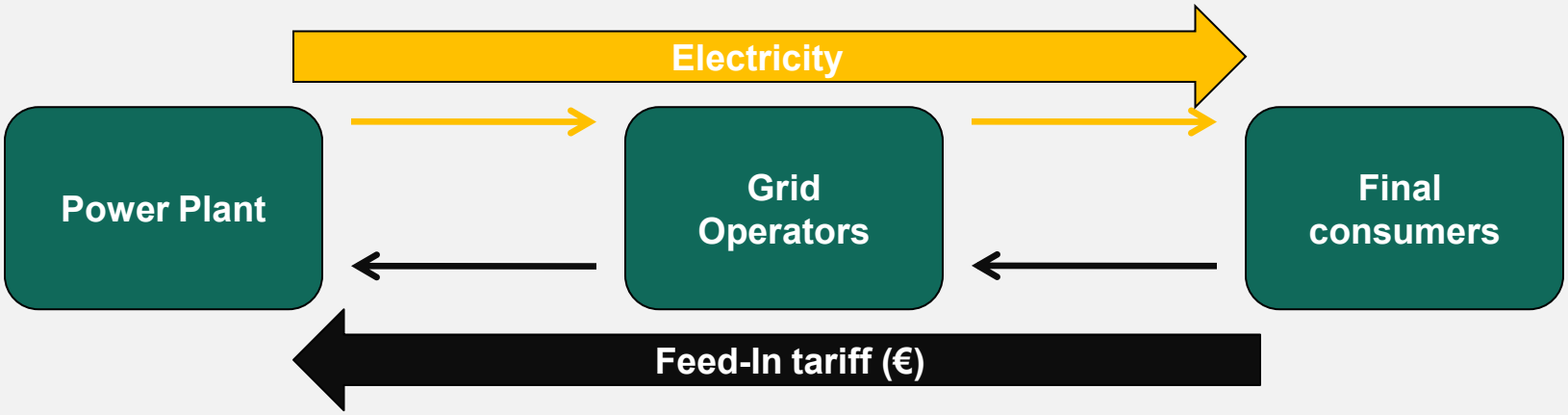


- ➔ **Allocation of costs to all electricity customers to finance feed-in tariffs**
- ➔ **No re-financing by tax**

Renewable Energy Act (EEG)

Geothermal Energy

Rödl & Partner

- Tariffs as of 01.01.2011
- The degression rate is 1.0 % (§ 20 (6) EEG)
- Feed-in tariff amounts are exclusive VAT
- The gross electricity output is remunerated
- Additional Bonuses are feasible:
  - Bonus for systems commissioned prior to 1st January 2016 (early starter bonus)
  - Heat use bonus (“20% of heat capacity” replaces fossil fuels)
  - Bonus for usage of petrothermal technology
- Feed-in tariffs are calculated in proportion to the installed capacity

Renewable Energy Act (EEG)

Geothermal Energy

Rödl & Partner

Feed-in tariffs 2011:

§ 28 Geothermal Energy EEG	
15.68 € cents per kWh	up to 10 MW
10.3 € cents per kWh	over 10 MW
	Additional: • Bonus of 3.92 €ct/kWh for systems commissioned prior to 1st January 2016 plus • Heat use bonus 2.94 €ct/kWh plus • Bonus for use of petrothermal technology of 3.92 €ct/kWh

Project example Unterhaching commissioned in April 2009:

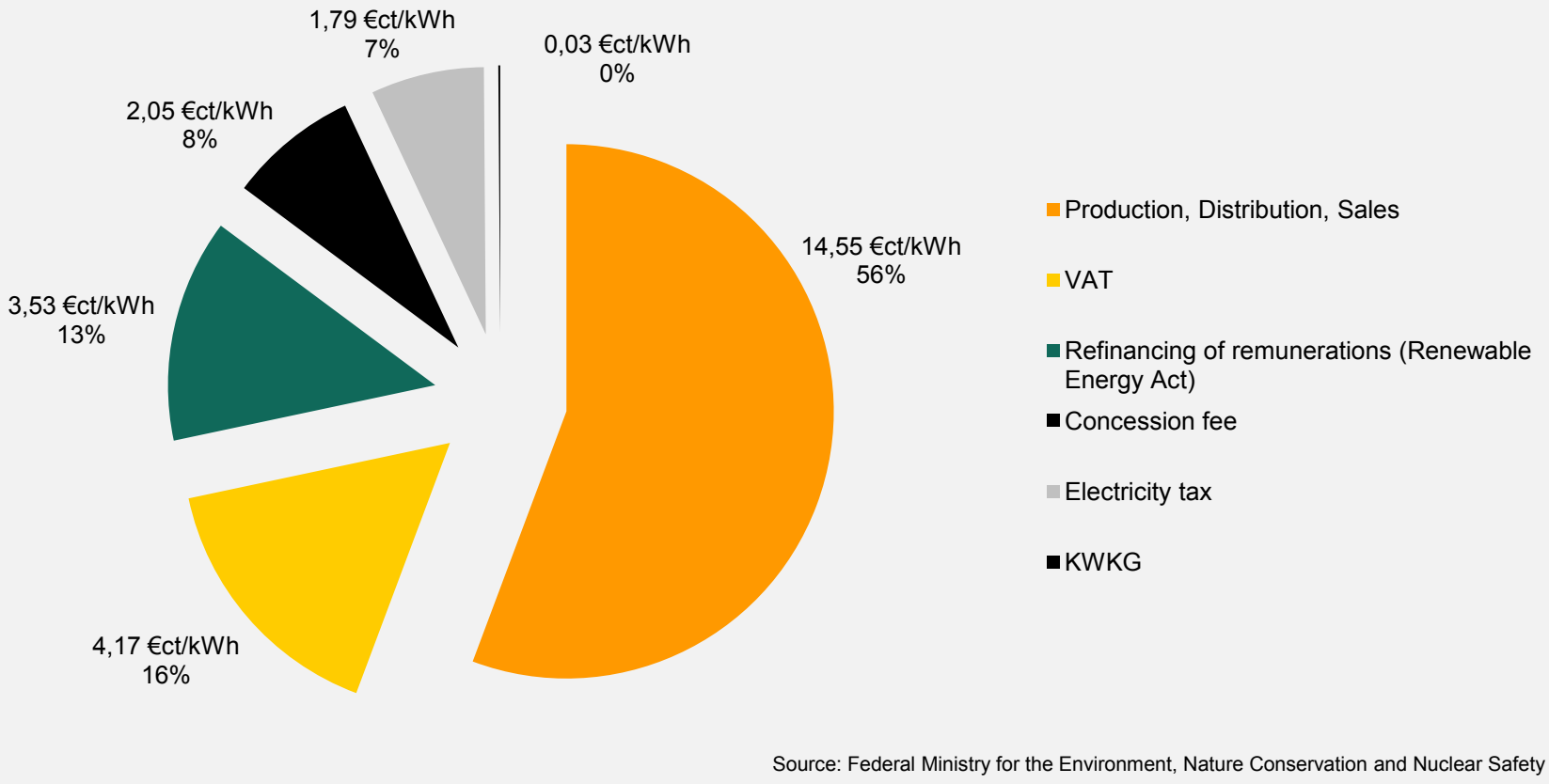
Installed capacity: 3,36 MW

16 €ct/kWh + 4 €ct/kWh (early starter) + 3 €ct/kWh (heat use) = 23 €ct/kWh

Renewable Energy Act (EEG)

Composition of the electricity price in the private sector

Rödl & Partner



Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Renewable Energy Act (EEG)

Discussion

Rödl & Partner

➔ **Expectations of the amendment of the EEG 2012 for geothermal power generation?**

Thank you for your attention…

Kai Imolauer
Economic Engineer
Associate Partner

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Feed-in-tariff structure in Hungary

Attila Bagi
Hungarian Energy Office

Geothermal energy in Hungary - update barriers and solution statements

Budapest, 2011. február 17.

MAGYAR ENERGIA HIVATAL

Current background

- Electricity Act (VET; 86/2007) - link
  - most relevant parts: Paragraphs 9 – 11
    - principles
- Government Decree 389/2007 - link
  - Detailed rules of the feed-in system
- Actual Feed-in-tariffs
  - Hungarian Energy Office website - link

Feed-in-tariffs

- Actual prices for geothermal plants

HUF/kWh	Peak	Valley	Deep valley	Baseload
<=20 MW	33,35	29,84	12,18	28,64
20 - 50 MW	26,67	23,88	9,74	22,91
> 50 MW	20,74	13,27	13,27	16,70

EUR/MWh	Peak	Valley	Deep valley	Baseload
<=20 MW	123,51	110,53	45,11	106,09
20 - 50 MW	98,79	88,43	36,06	84,86
> 50 MW	76,81	49,16	49,16	61,83

270 HUF/EUR

This applies for most of other renewables too (except wind, PV, large hydro)

Time zones 1

Duration of parts of the day (time zones) on **workdays** according to GD

- by the (Central European) time being in force (hereafter referred to winter time)
- by the summer time set by a special rule

is as follows:

Time zones	Winter time	Summer time
Peak	*06:00 – 22:00*	*07:00 – 23:00*
Valley	*22:00 – 01:30 and 05:00 – 06:00*	*23:00 – 02:30 and 06:00 – 07:00*
Deep valley	*01:30 – 05:00*	*02:30 – 06:00*

On non-working days:

Time zones	Winter time	Summer time
Valley	*06:00 – 01:30*	*07:00 – 02:30*
Deep valley	*01:30 – 06:00*	*02:30 – 07:00*

Time Zones 2

Peak	Valley	Deep valley
46%	38%	16%

Other features

- Price indexation: CPI – 1%
  - 389/2007. Government Decree appendix 5
- Feed-in period
  - Set by the Hungarian Energy Office
  - Project by project, benchmark used if possible
  - No working geothermal plant in Hungary
  - No benchmark for geothermal
    - discounted cash-flow model
    - Maximum 15 years

How to apply

- Rules: 389/2007 Government Decree 6. §
- Documentation needed:
  - For setting the feed-in period – link
  - For electricity license (over 0,5 MWe) - link

MAGYAR ENERGIA HIVATAL

Possible changes

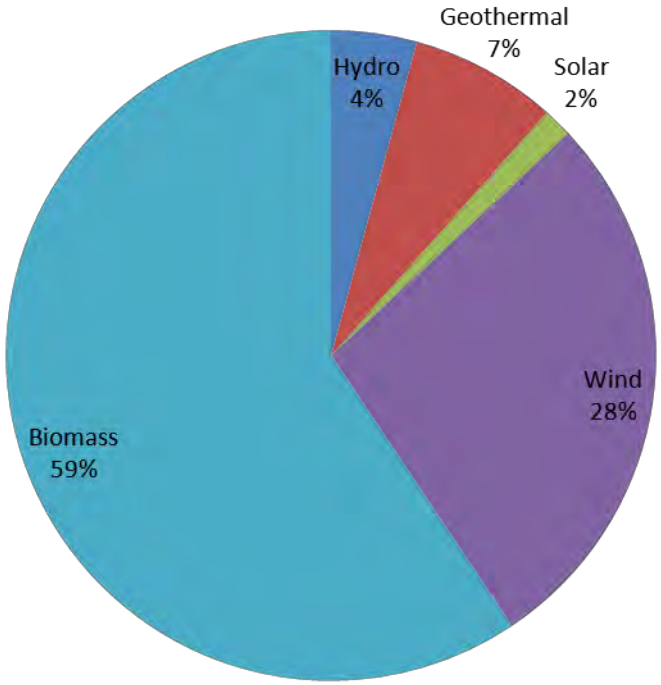
- Modification of the Electricity Act is ongoing
  - Government Decree would pre-set the
    - Tariffs
    - Length of the feed-in period
    - Maximum electricity feeded-in
    - No project by project decision
  - Future changes only for new projects
  - Tariffs and tariff structure is likely to change
    - Possibly this year

New Tariff levels?

- No information yet, but
- Study by external consultant for needed feed-in-tariffs (link):
  - For small (1 MW) geothermal:
    - 36,68 Ft/kWh (136 EUR / MWh)
  - For large (50 MW) geothermal:
    - 30,8 Ft/kWh (114 EUR/MWh)
- Just for information

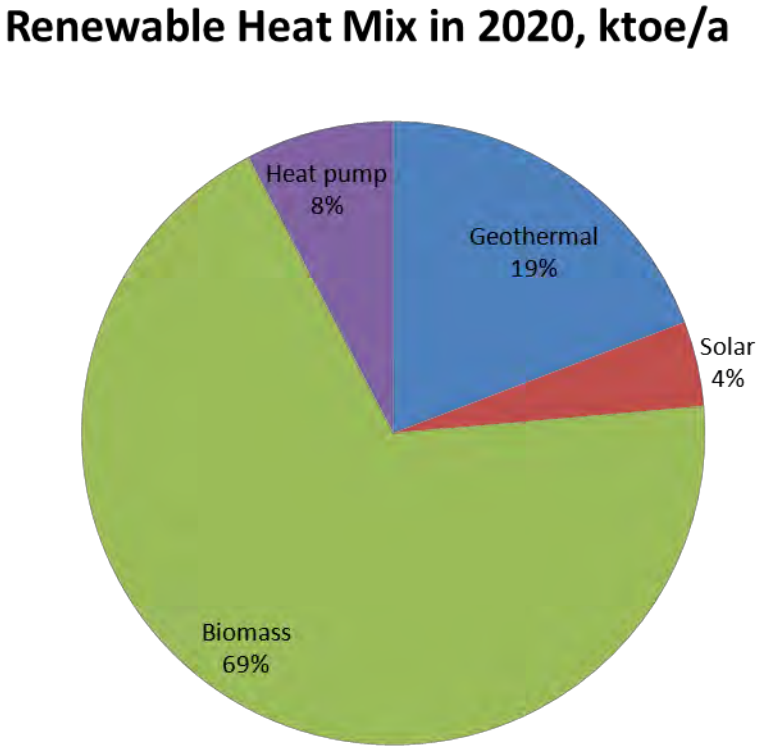
Goals for 2020

Renewable Electricity Mix in 2020, GWh/a



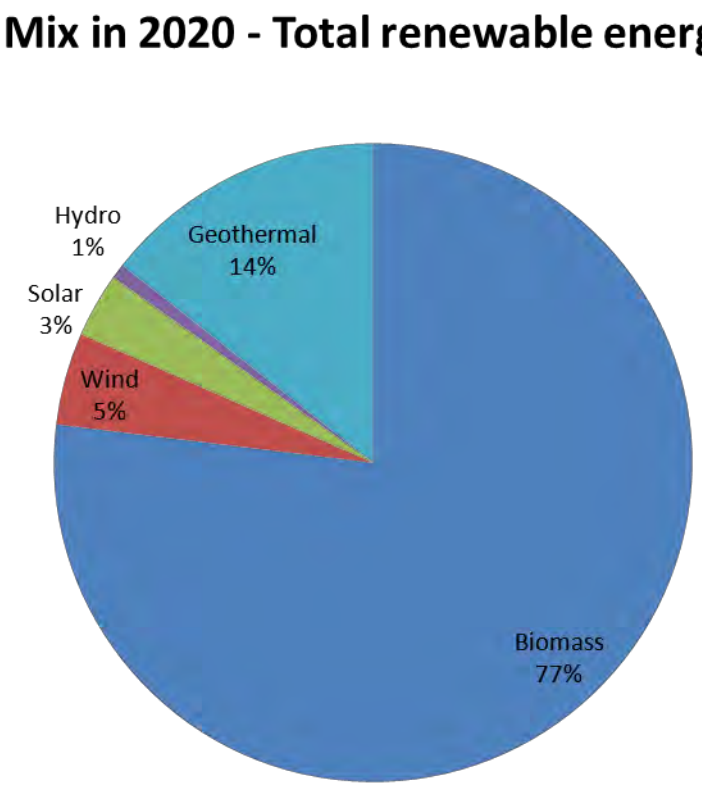
Total: 5598 GWh/a, Geothermal: 410 GWh/a

Goals for 2020



Total: 1859 ktoe/a; Geothermal: 357 ktoe/a

Goals for 2020



Total share of renewables: 14,65% (2879 ktoe)

Thank you very much for yor attention!

Attila Bagi

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http://www.eh.gov.hu

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

Umwelt Bundes Amt
Für Mensch und Umwelt

BfN Bundesamt für Naturschutz

Rödl & Partner

German regulations & heat price modeling

Budapest, 17 February 2011

Attorneys
Auditors
Tax Consultants
Business Consultants

Agenda

- Regulation
- Influencing factors
- Recommendations

Regulation
General Conditions

Rödl & Partner

German ´´Regulation on general conditions for the supply with district heating`` (AVBFernwärmeV) (except industrial consumers)

In this regulation several aspects of supply are fixed, e.g.:

- Type of supply (combustibles, etc.)
- Scope of supply
- System of communication if there are unforeseen difficulties with supply
- Liabilities in case of supply interruptions
- Calculation of costs for connection to the heating network
- Utilization of real estate
- Definitions of interfaces
- Measurement of heat volume
- Utilization of heat
- Etc.

Regulation
General Conditions

Rödl & Partner

General conditions from legal base for the:

- Contract for final costumers
- **Price sliding clause** is the core element of heat price integrating several aspects:
  - Combustibles
  - Wage
  - Power
  - Capital goods index
  - Etc.

Regulation
General Conditions

Rödl & Partner

The relevant paragraph concerning the price regulations defines among other aspects the following (§ 24 (4), AVBFernwärmeV):

"The **price sliding clause** has to be defined in that way, that both, the **development of costs of the production** and **supply of district heat** and the respective **circumstances** on the **heat market** are included appropriate. It has to disclose the relevant calculation factors completely and in a generally comprehensible form. If the price sliding clause is being applied, the **price factor** which determines the contribution (in percent) of the costs for combustibles has to be shown **separately in any change of price**."

Regulation
General Conditions

Rödl & Partner

Such a regulation as base of supply contracts has the following advantages:

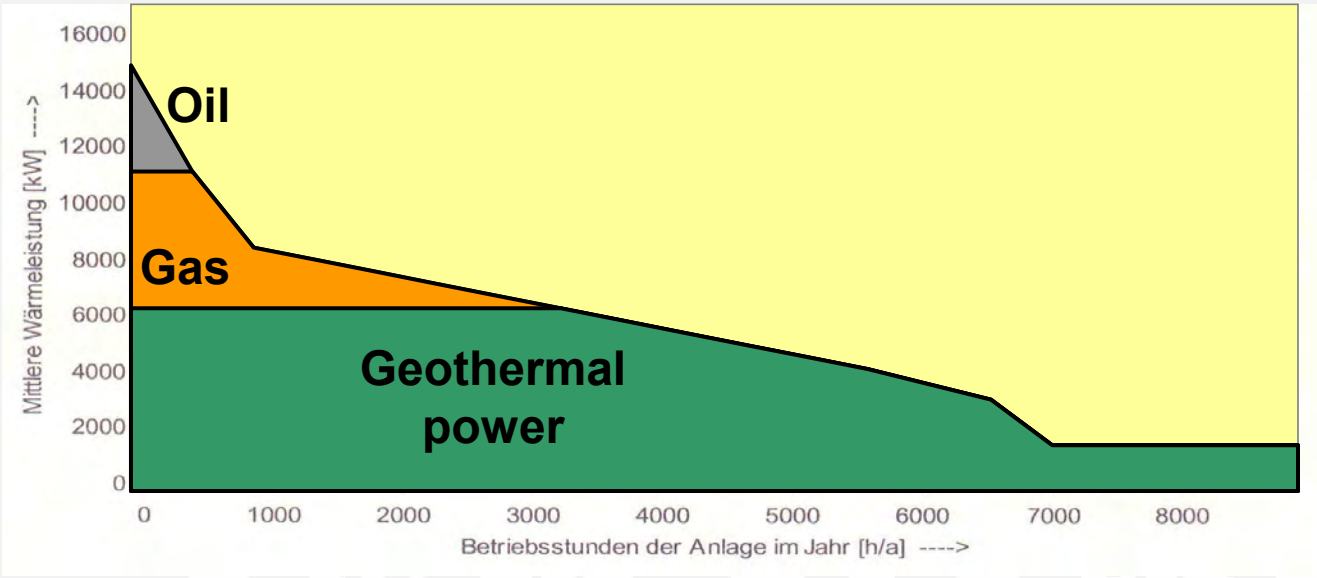
- **Fair risk contribution** between supplier and consumer regarding cost increases
- **Cost reductions** would have to be transferred to the retail prices according to the price sliding clause
- The general conditions would have to be published and therefore **transparent for** any heat **costumer**
- The **market competition** would lead to the installation of the supply steam with the **lowest** and/or most **stabile** energy production **prices** and could provoke **modernizations** of existing systems
- The heat supply contract would **not** be **interfered** by public authorities, that could be led also by political matters

Influencing factors
In general

Rödl & Partner

- Competition to the normal heat market of fossil fuels
- Heat can be cross-subsidized through combined heat and power if a) the power generated is refunded at subsidized feed-in tariffs and b) a low heat price is the objective of the operator

Exemplary annual characteristic curve of the district heating network:



Annual characteristic curve and distribution of the heat production on the single heat producers

Influencing factors

Prices from a consumer's point of view

Rödl & Partner

Composition of the whole price (one-time costs):

- Building cost subsidy (70 % of „invest“) in €, prorated on kW heat consumption,
- House connection costs €/m
- Connection fee for:
  - Inlet into the basement of the costumer
  - Adequate heat exchanger
  - Installation of heat exchanger
- Additional, costs for:
  - Disposal of the old boiler
  - Closing of the chimney
  - Possible repayment to gas supplier

Influencing factors

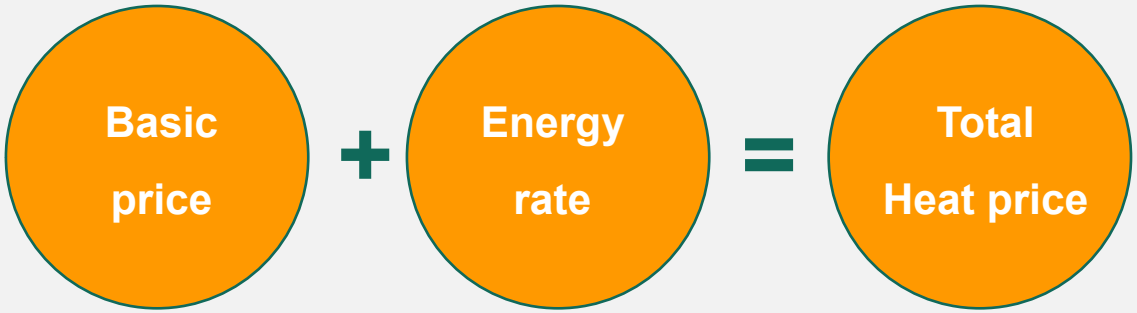
Prices from a consumer's point of view

Rödl & Partner

Composition of the whole price (example):

Current costs:

- Basic price EUR/kW/a
- Energy rate € Cent/kWh_{th}



→ Contribution differs according to project constellation

Influencing factors
Example Unterhaching

Rödl & Partner

Geothermie Unterhacing GmbH & Co. KG works profit-oriented.

During the operating stage the investment should amortize as quickly as possible and later make up a steady part of the source of income for the municipality of Unterhacing.

Aim: Long-term realization of profits

Company tasks:

- Refinancing of the investment
- Payment of the investment risk and payment of interest of the equity capital lodged by the shareholders respectively

In general (aim varies according to investing group)**:**

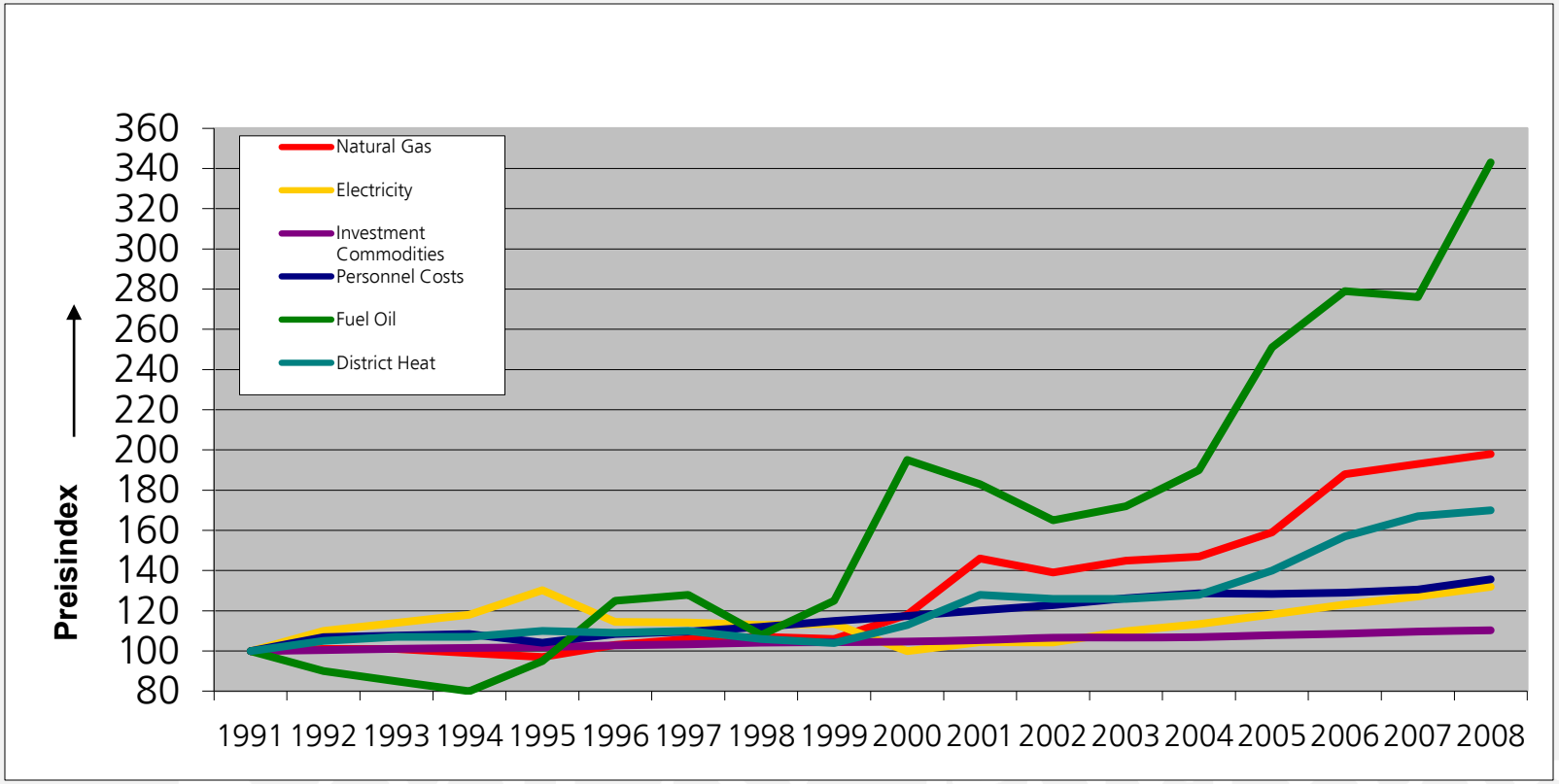
- Communities
- Strategic investor
- Private equity investor

Influencing factors

Example Unterhaching

Rödl & Partner

Development of the heat price: example calculations, based on the geothermal project in Unterhacing, near Munich:



Stability for heat price is given, due to the fact that the heat supply contracts are based on the price sliding clause.

The heat price could not have been increased stronger.

Influencing factors

Determination of demand

Rödl & Partner

The demand after the acquisition of costumers reacts probably **very inelastic**, i.e. that only strong price changes will have an influence on the sales.

This is due to the following facts:

- The Geothermie Unterhacing GmbH & Co. KG is currently the only district heating supplier in Unterhacing
- The expenses for the heat supply are counted from most households to running cost that can hardly be influenced. The part of the expenses for the heat supply on the total expenses is relatively low
- Effect of consequential costs: The heat tariff makes up the consequential costs for the customer, who is bound in the contract

Influencing factors

Estimate of costs

Rödl & Partner

Lower price limit:

The determination of the lower price limit according to the following steps leads to a first estimation:

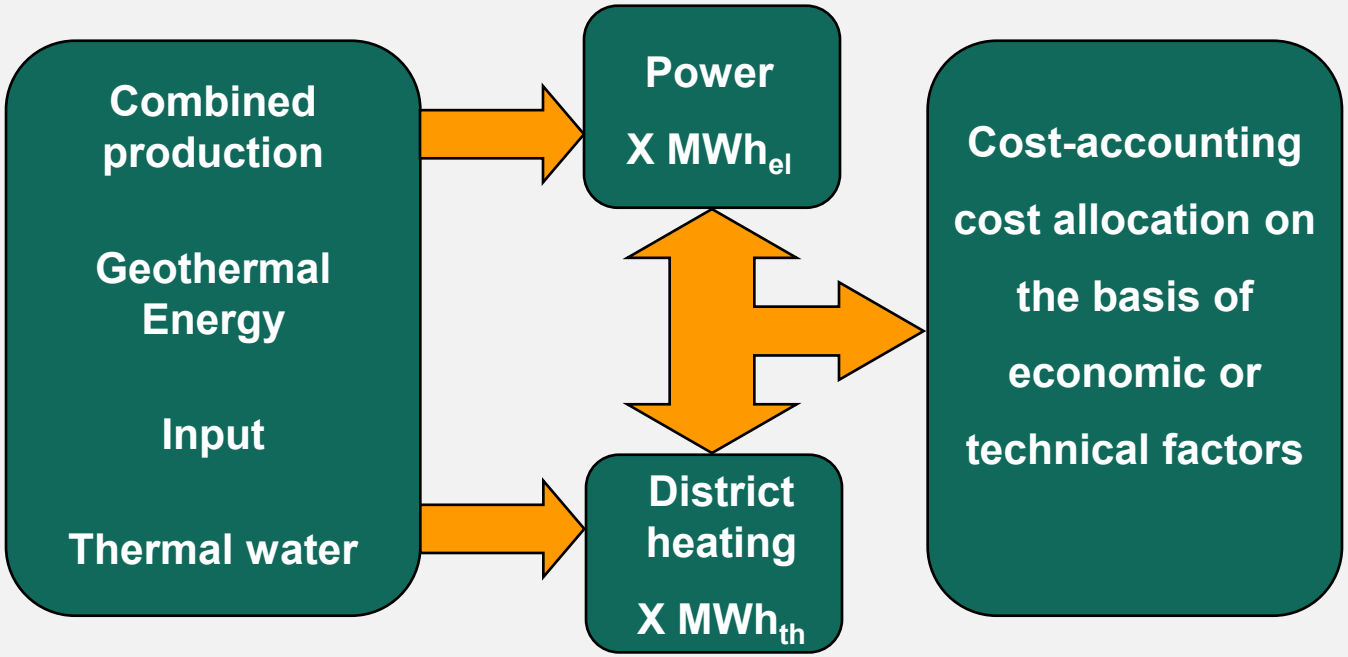
- Determination of total costs
- Distribution of total costs
- Calculation of unit cost

The long-term lower price limit is determined in the point in which all fixed and variable actual costs and the cost-accounting costs are covered.

Influencing factors

Cost distribution at combined production

Rödl & Partner



Essential Question:

According which mode the costs are distributed to the value-added chain.

Recommendations

In consequence, the following advantages can be achieved:

- The price is not regulated by any third party
- The price always includes the actual development of all influencing factors
- The price also has to be decreased if the factors show a development
- The price is transparent for clients

In relation to a geothermal heat supply project, the price, if such a price sliding clause forms the base of a heat supply contract, would in consequence not be effected such strongly by rising price for combustibles as a “conventional” heat supply network.

Price stability is therefore the main argument for renewable heat production and sales.

Thank you for your attention…

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District heating / price regulation in Hungary

District heating – Situation at present in Hungary

Rödl & Partner

Price regulation § 57-57/C Act No. XVIII of 2005 on district heating

- In the field of district heating **two authorities** are empowered:
  - the Hungarian Energy Office (Office)
  - the local municipal council
- There are two ways in changing the district heating price:
  - **initiative proposal** of a district heat supply company
  - **official** price change
- The field of responsibility has changed by the Act No. LXVII of 2008 on making the district heating more competitive, but it is clearly regulated by the Act No. XVIII of 2005 on District Heat [4-8, 57-57/C].
- Before 01 July 2009 the minister commented the district heat prices

District heating – Situation at present in Hungary

Rödl & Partner

Price regulation §§ 57-57/C Act No. XVIII of 2005 on district heating

1. **Initiative proposal** of a district heat supply company:

- From 01 July 2010 on **the Office** within an administrative proceeding (30 days) judges the initiative of the company based on a benchmark and releases a decree about the price change.

- The district heat company has to forward the initiative together with the decree from the Office to the **local municipal council**.

- The local municipal council releases a legal ordinance about the price change.

District heating – Situation at present in Hungary

Rödl & Partner

Price regulation §§ 57-57/C Act No. XVIII of 2005 on district heating

2. **Official** price change within an administrative proceeding

- **The Office** arranges a price control proceeding to determine, whether the grid connection fee and the district heating price are correct
  - If the fee or price are not correct, **the office** warns the district heating supply company to change and turns to the regulating authority of the local municipal to revise the legal ordinance

- The Office arranges a price control proceeding to audit whether the contracting price between the district heating producer and the district heating supplier is correct
  - If the contracting price is not correct, the contracting parties have to change it

District heating – Situation at present in Hungary

Rödl & Partner

Licensing procedure §§ 12,13 Act No. XVIII of 2005 on district heating

- Permission is always necessary **to produce and to supply** district heating
- In case the heat generation plant has an installed capacity of less than 50 MW, a **simplified** licensing procedure is applicable

1. Constructing and operating permission

- In case of the **constructing and operating permission** for a heat producing facility, the Office and the notary of the local municipal are the competent authorities
- The **validity term** of the permission for the construction of a heat producing facility is included in the constructing permission itself. Its validity can be prolonged once by the original validity, but by two years at most.
- The **operating permission** is granted for an indefinite period

2. Permission for supplying district heat

- The **permission for supplying district heat** has to be requested at the notary of the local government and it is granted for an indefinite period as well.

District heating –

Situation at present in Hungary

Licensing procedure §§ 4-7 Act No. XVIII of 2005 on district heating

Rödl & Partner

- In the licensing procedure **the administration deadline** is 3 months.

- **Resolutions** of the Hungarian Energy Office and of the local municipal (also of the notary) cannot be appealed. However a review of their resolutions can be demanded by the court.

- **District heat retail prices**: regulated by a decree of the municipal council, which decides after obtaining the opinion of the Minister (7 (5), Act Nr LXXXVII of 1990 on Pricing).

- **The highest price** is to be settled in such a way, that the expenditures and profits of an efficient operating corporation shall be covered by the regulated prices, also with regard to deprivation and subsidies (8 (1), Act No LXXXVII of 1990 on Pricing).

Thank you for your attention!

Zsuzsanna Serra

zsuzsanna.serra@roedl.de

StMWIVT
- VI/5a -

München, den 01.05.2007
089/2162-2451

Hinweise zur Antragstellung bei Erlaubnissen zur Aufsuchung von Erdwärme

Anträge auf Erteilung einer bergrechtlichen Erlaubnis zu gewerblichen Zwecken sind schriftlich zu stellen.

Der Antrag (2 Originale, 7 Kopien) an das Staatsministerium für Wirtschaft, Infrastruktur, Verkehr und Technologie muss folgendes beinhalten:

a. Bodenschatz, der aufgesucht werden soll, hier Erdwärme
b. Bezeichnung des Antragstellers, dies können natürliche, juristische Personen und Personenhandelsgesellschaften sein
c. Erlaubniskarte nach den Vorschriften der Unterlagen-Bergverordnung
d. Arbeitsprogramm zur Aufsuchung des Bodenschatzes, z.B. bei Erdwärme:
    - Geologische und geophysikalische Vorerkundung
    - Bohrungen zur Erschliessung der Erdwärme
    - Leistungstests
    - Wärmegutachten.

Die Darstellung des Arbeitsprogrammes sollte ferner beinhalten:

- Beschreibung der geologischen Verhältnisse
- Prognosen über die zu erwartenden Temperaturen und Schüttungen, Beurteilung des Fündigkeitsrisikos
- Technische Beschreibung der Bohrungen
- Zeitlicher Ablauf der Arbeiten

- Kostenschätzung für die Durchführung des Arbeitsprogrammes
- Ausblick auf eine mögliche spätere Nutzung der Erdwärme (Strom/Wärme etc..).

e. Beantragter Zeitraum der Erlaubnis, in der Regel 3 Jahre
f. Glaubhaftmachung der Gesamtfinanzierung des Arbeitsprogrammes
g. Erklärung nach § 11 Nr. 4 BBergG.

Die Gesamtfinanzierung der Aufsuchungskosten, bei Projekten der Tiefengeothermie in den Bohrteufen zwischen 1.500 bis 5.000 m gegenwärtig alleine für die Bohrungen in einer Grössenordnung von 1.200 €-2.000€/Bohrmeter, ist vor Erteilung der Erlaubnis glaubhaft zu machen. Dies kann z.B. durch den Nachweis von Eigenkapital, Finanzierungszusagen von Banken, bei Unternehmen Vorlage von Geschäftsberichten und Bilanzen geschehen.

Der Zeitraum der Erlaubnis richtet sich nach dem zeitlichen Umfang des Arbeitsprogrammes und beträgt in der Regel 3 Jahre. Der Umfang des Erlaubnisfeldes richtet sich nach dem räumlichen Umfang des Arbeitsprogrammes. Über den Zuschnitt entscheidet der Antragsteller. Hierbei ist es wichtig den Zuschnitt im Hinblick auf eine spätere Gewinnung so zu wählen, dass möglichst günstige geologische Bedingungen (z.B. Störungszonen und andere Faktoren) angetroffen werden.

Sollten konkurrierende Anträge eingehen, entscheidet zunächst nicht die zeitliche Priorität sondern es gilt die Regelung nach § 14 Abs.2 BBergG, wonach derjenige das Recht erteilt bekommt, der den Anforderungen an eine sinnvolle und planmäßige Aufsuchung am besten Rechnung trägt. Dies sind Faktoren wie Intensität und Qualität des Arbeitsprogrammes sowie Faktoren, die für eine rasche Umsetzung sprechen: Qualität der notwendigen Finanzierung, Nachweis über geeignete Bohrgrundstücke, Nachweis über die Verfügbarkeit von Bohranlagen sowie die Gesamtkompetenz des Unternehmen selbst. In diesem Zusammenhang ist es wesentlich, dass ein industrieller Investor auch mit Bergbauhintergrund am Unternehmen beteiligt ist.

Nach Eingang der vollständigen Unterlagen erfolgt die Einleitung des Beteiligungsverfahrens nach § 15 BBergG. Hierzu werden Stellungnahmen erbeten zu folgenden Themen: Natur- und Landschaftsschutz, Landesplanung und Raumordnung, Wirtschaftsförderung, Wasserwirtschaft, Geologie des tieferen Untergrunds und Hydrogeologie, Bergaufsicht. Ggf. werden gutachterliche Stellungnahmen angefordert. Für die Erstellung der Antragsunterlagen empfiehlt sich die Einschaltung eines qualifizierten Ingenieurbüros.*

Zimmer

Bergdirektor

*: Für Kommunen ergibt sich eine Verpflichtung zur Ausschreibung in erster Linie aus dem Haushaltsrecht (§ 31 Kommunalhaushaltsverordnung). Bei einem Auftragswert von mehr als 200.000 € sind darüber hinaus die §§ 97 ff GWB einschlägig.

StMWIVT
VI/5a

München, den 01.12.2010
089/2162-2451

Hinweise zur Antragstellung bei Bewilligungen zur Gewinnung von Erdwärme (hydrothermale Geothermie)

Anträge auf Erteilung einer bergrechtlichen Bewilligung sind schriftlich zu stellen.

Der Antrag (2 Originale, 7 Kopien) an das Staatsministerium für Wirtschaft, Infrastruktur, Verkehr und Technologie muss folgendes beinhalten:

a. **Bezeichnung des Antragstellers** - dies können natürliche, juristische Personen und Personenhandelsgesellschaften sein. **Antragsteller ist in der Regel der Erlaubnisfeldinhaber.**

   Anträge von Dritten auf eine bergrechtliche Bewilligung zur Gewinnung von Erdwärme, die ganz oder teilweise ein bestehendes Erlaubnisfeld umfassen, werden dem Rechtsinhaber des Erlaubnisfeldes unverzüglich zugesandt. Dieser kann innerhalb von drei Monaten einen Gegenantrag auf bergrechtliche Bewilligung innerhalb seines Erlaubnisfeldes stellen, der nach § 14 Abs.1 BBergG Vorrang vor allen anderen Anträgen hat. **Das Bundesberggesetz gibt somit dem Erlaubnisfeldinhaber einen Vorrang bei der Erteilung einer bergrechtlichen Bewilligung vor konkurrierenden Anträgen.**

b. **Lageriss** nach den Vorschriften der Unterlagen-Bergverordnung.

c. **Nachweis der technischen Gewinnbarkeit** nach Lage und Beschaffenheit durch Vorlage der **Ergebnisse der Zirkulationstests**. Mindestangaben:
   - Nachweis der **technisch förderbaren** Wassermenge
   - Fördertemperatur
   - Absenkung
   - Nachweis der **technisch verpressbaren** Wassermenge

- Reinjektionstemperatur
- Chemismus der Wässer
- Ergebnisse von **Beweissicherungsmessungen** in den Nachbarbohrungen, soweit im Rahmen der Pumpversuche durchgeführt.
- Gewinnungsrißwerk von einem anerkannten Markscheider (kann nachgereicht werden).

d. Technisches Arbeitsprogramm zur Gewinnung der Erdwärme (Beschreibung der technischen Anlagen in den Bohrungen und zwischen den Bohrungen bis zum Wärmetauscher)

e. Nutzungskonzept für die Gewinnung von Erdwärme (Wärme, Strom, Balneologie etc.)

- **<u>Geothermische Stromversorgung</u>**:

  Bei geothermischer Stromerzeugung ist für die **Erteilung einer Bewilligung Voraussetzung**, **dass** – soweit aufgrund von Wärmeabnehmern technisch-wirtschaftlich möglich - **auch Wärme ausgekoppelt wird.** Hierzu ist im Bewilligungsantrag ein **Konzept für die Auskoppelung und Nutzung von Wärme**, z.B. in einem Nahwärmenetz für die Wärmeversorgung in einer Kommune oder industriellen Verbrauchern vorzulegen. Anreiz hierfür bietet der Wärmebonus des EEG. Hinsichtlich der erforderlichen Höhe der Wärmeauskoppelung gilt die dem Wärmebonus mindestens zugrunde legende Wärmeleistung als Richtwert.

  Im Antrag sind technische Angaben notwendig zur erzielbaren Stromleistung, zum Eigenverbrauch des gesamten Kreislauf (Bohrungen, Kraftwerk, Kühlung etc.) sowie zur aus zukoppelnden Wärmeleistung, den anzuschließenden Wärmeverbrauchsstrukturen mit einem Zeitplan für den Bau des Kraftwerks und des Anschlusses der Wärmeverbraucher.

- **<u>Geothermische Wärmeversorgung</u>:**

  Notwendig sind Angaben zur nutzbaren geothermischen Wärmeleistung und Wärmeverbrauch in den einzelnen Heizperioden, Heizzentrale, ggf. Redundanzheizkraftwerk, möglichen Kombinationen mit anderen Energieträgern, anzuschließende Wärmeverbraucherstrukturen.

- Weitere Anschlußnutzungen, die geplant sind, z.B. Balneologie, Kühlung oder Wärmespeicherung im Untergrund sind darzustellen.

f. Wärmebergbaugutachten

Im Wärmebergbaugutachten ist die betriebsbezogene strukturgeologische Modellierung des genutzten Aquifers in den Grenzen des Erlaubnisfeldes darzustellen. Grundlage hierfür sind die erhobenen Daten aus den seismischen Untersuchungen, den Bohrungen, der Pumpversuche und **Messungen in den Nachbarbohrungen**. Soweit möglich und zugänglich, sollten die Erkenntnisse aus den Nachbarfeldern und den begleitenden geowissenschaftlichen Untersuchungen des Landesamts für Umwelt bei der Modellierung berücksichtigt werden.

Zur Bewertung der Auswirkungen durch den Dublettenbetrieb ist mindestens folgendes aufzuzeigen:

- die Linie der hydraulischen Absenkung bei der Förderbohrung von 10 m (<u>z.Zt. Richtwert auf Grund der bisherigen Erfahrungen</u>)
- und die Abkühlung <u>von 1 K</u> um die Reinjektionsbohrung

bezogen auf den beantragten Bewilligungszeitraum.

Weitere Details zu den wesentlichsten Inhalten und den zu erhebenden Daten sind in den jeweiligen Erteilungsbescheiden der bergrechtlichen Erlaubnis sowie im Rahmen der bisherigen wasserrechtlichen

Gestattungen dargestellt worden. Einzelheiten zu den Beweissicherungsmessungen bei Pumpversuchen werden in den Wasserrechtsverfahren gefordert. Die dabei gewonnenen Daten sind bei der Zusammenstellung der Antragsunterlagen für das Wasserrechtsverfahren zum endgültigen Betrieb darzulegen, z.B. bei der Erstellung eines nachvollziehbaren Grundwassermodells.

g. **Beantragter Zeitraum der Bewilligung**, max. 50 Jahre. Nach Ablauf der 50 Jahre ist eine weitere Verlängerung – soweit der Betrieb noch sichergestellt werden kann – möglich.

h. **Glaubhaftmachung der Gesamtfinanzierung** des Arbeitsprogrammes einschließlich des Ausgleichs unvermeidbarer Schäden (z.B. durch Hapftpflichtversicherung)

Da die plausible Erstellung eines Wärmebergbaugutachtens ggf. eine längerfristige Datenerhebung in der Betriebsphase erfordert, ist die Erteilung einer bergrechtlichen Bewilligung nach der gängigen Verwaltungspraxis **bis max. 5 Jahre auch ohne Wärmebergbaugutachten** möglich. Voraussetzung hierfür ist allerdings in jedem Fall, dass die Fündigkeit durch die Zirkulationstests nachgewiesen ist und bei den Pumpversuchen keine messbaren Beeinträchtigungen der Nachbarbohrungen (z.B. hydraulische Absenkung und Temperaturerniedrigung, die die technische Umsetzung des Projekts gefährden) aufgetreten sind sowie die übrigen Voraussetzungen zutreffen. Nach diesem Zeitraum und Vorlage des Wärmebergbaugutachtens kann eine weitere Verlängerung um max. 45 Jahre beantragt werden.

Die Feldesgröße der Bewilligungen ist für den Regelungsinhalt nicht wesentlich. Die bergrechtliche Bewilligung gibt ein eigentumsgleiches Recht an der Gewinnung der Erdwärme in den Bohrungen; **die in den Bohrungen stattfindende Gewinnung darf durch den Betrieb in späteren Nachbarbohrungen nicht beeinträchtigt** werden. Reine Beeinflussungen über die Feldesgrenzen hinweg, die zu keiner Beeinträchtigung der technischen Gewinnung in den Bohrungen führen, sind im Bergrecht **generell zu dulden.** Die maximalen Feldesgrenzen orientieren sich an den Modellierungsergebnissen des Wärmebergbaugutachtens, wobei die

Feldesgrenzen der angrenzenden Erlaubnisse – vorbehaltlich einer Einigung - nach § 14 Abs.1 BBergG nicht zu überschreiten sind.

Die dauerhafte Gewinnung der Erdwärme laut Arbeitsprogramm ist spätestens drei Jahre nach Erteilung aufzunehmen; ansonsten liegt ein Widerrufsgrund vor.

Im Verwaltungsverfahren werden nach **§ 15 BBergG** die Fachbehörden Landesamt für Umwelt und die jeweils zuständigen Regierungen sowie die betroffenen Kommunen beteiligt; das Wärmebergbaugutachten wird dem Landesamt für Umwelt zur Prüfung vorgelegt. Ferner werden die Antragsunterlagen denjenigen Feldesnachbarn, deren Projekte schon in der Betriebsphase bzw. Testphase nach Durchführung der Bohrungen sind ebenfalls zugestellt, um Gelegenheit zur Stellungnahme im Hinblick auf gemessene Beeinträchtigungen zu geben; dies gilt auch für spätere Verlängerungsanträge.

Die genaue Festlegung der zulässigen Förder- bzw. Reinjektionsmenge – ggf. auch mögliche Beschränkungen aufgrund **nachgewiesener** hydraulischer Beeinträchtigungen einer benachbarten Geothermieanlage - erfolgt **im wasserrechtlichen Verfahren** der Regierung von Oberbayern, Bergamt Südbayern.
Amtlicher Sachverständiger in diesem Verfahren ist die Wasserwirtschaftsverwaltung. Wesentlicher Bestandteil der notwendigen Antragsunterlagen im Wasserrechtsverfahren ist der Teil des Wärmebergbaugutachten, der die hydraulischen Wechselwirkungen mit benachbarten Anlagen möglichst unter Berücksichtigung der dort vorherrschenden strukturgeologischen Verhältnisse aufzeigt.
Beide Verfahren sind **zeitnah parallel zu beantragen**, damit durch die Behörden eine enge Verzahnung des bergrechtlichen und des wasserrechtlichen Verfahrens möglich ist.

Rainer Zimmer
Ministerialrat

Teil 3 Ausgewählte Beispiele aus dem Bereich der Bergbehörde

A 3.1 Ausbau der Tiefengeothermie in Bayern

1. Erschließungskonzepte

Die Erschließung und Nutzung der tieferen Geothermievorkommen in Bayern ist schon seit einigen Jahren im Aufbruch begriffen. Die Gründe hierfür sind vielfältig – Klimaschutz, Erneuerbares Energien-Gesetz, weitere Förderprogramme von Bund und Land, Aspekte der Versorgungssicherheit mit der dauerhaften Verfügbarkeit des Energieträgers und Unabhängigkeit von fossilen Energieträgern. Ein Grund liegt natürlich auch in den für die Verhältnisse in Deutschland günstigen geologischen Bedingungen:

Mit den bis zu 600 m mächtigen Malmkarbonaten verfügt Bayern über einen Aquifer, der in einem erschließbaren Temperaturbereich von 80-160 °C bei Bohrteufen von 1.500 m bis 5.500 m über ausreichende Ergiebigkeiten von 30 - > 100 l/s verfügt, die einen flächendeckenden Einstieg in die geothermische Wärme – und ggf. Stromerzeugung ermöglichen.

Bild A: Schnitt von N-S durch den geothermalen Zielhorizont: Malmkarbonate

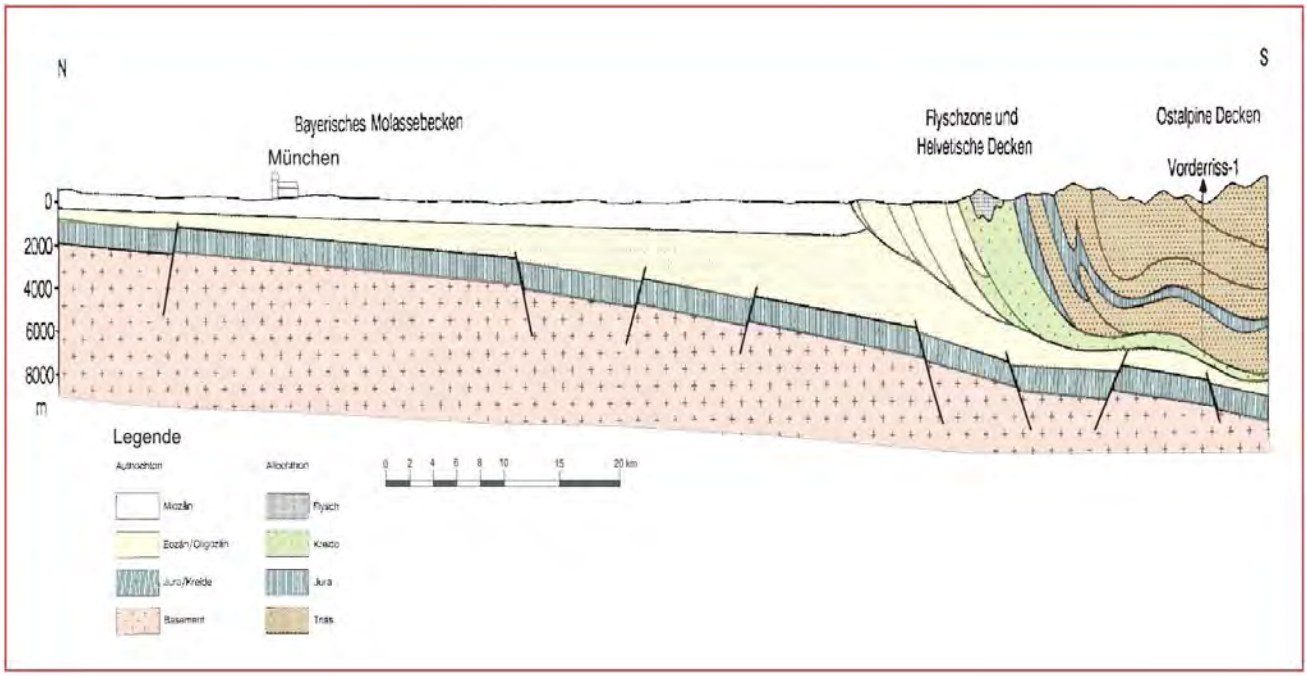
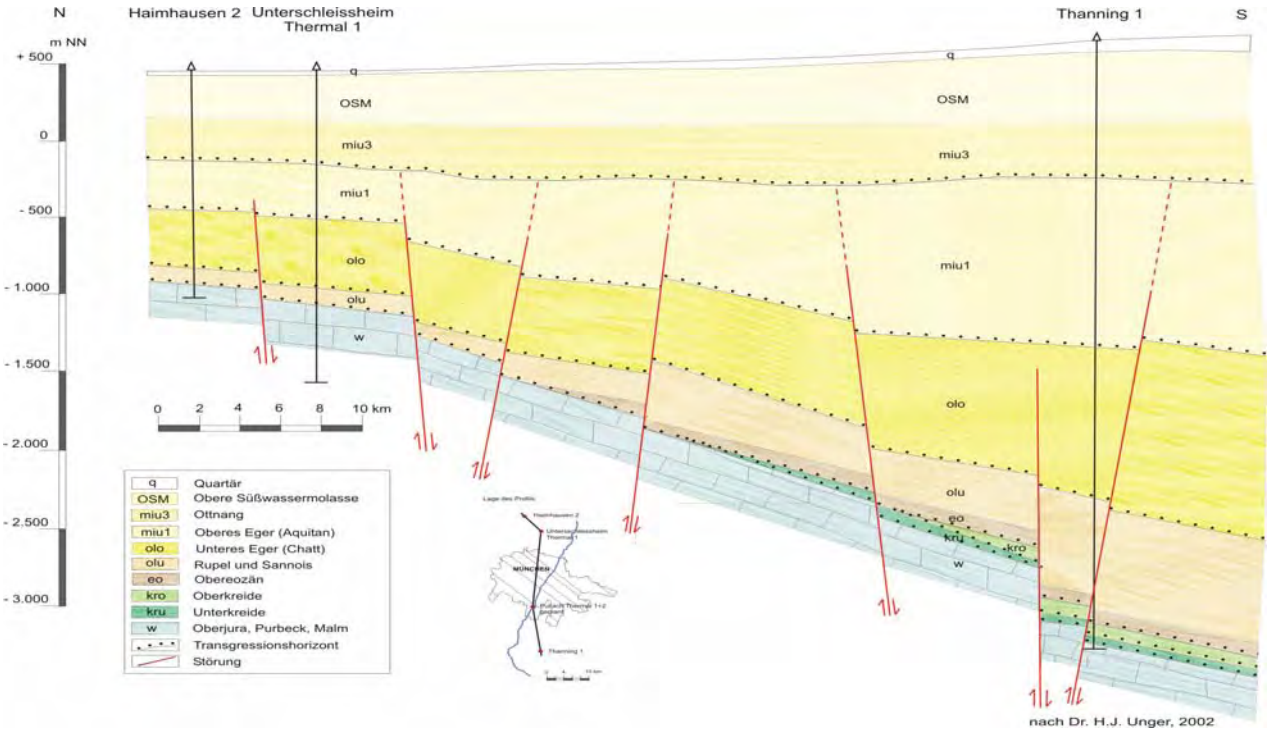


Bild B: N-S Verlauf Malm im Großraum München



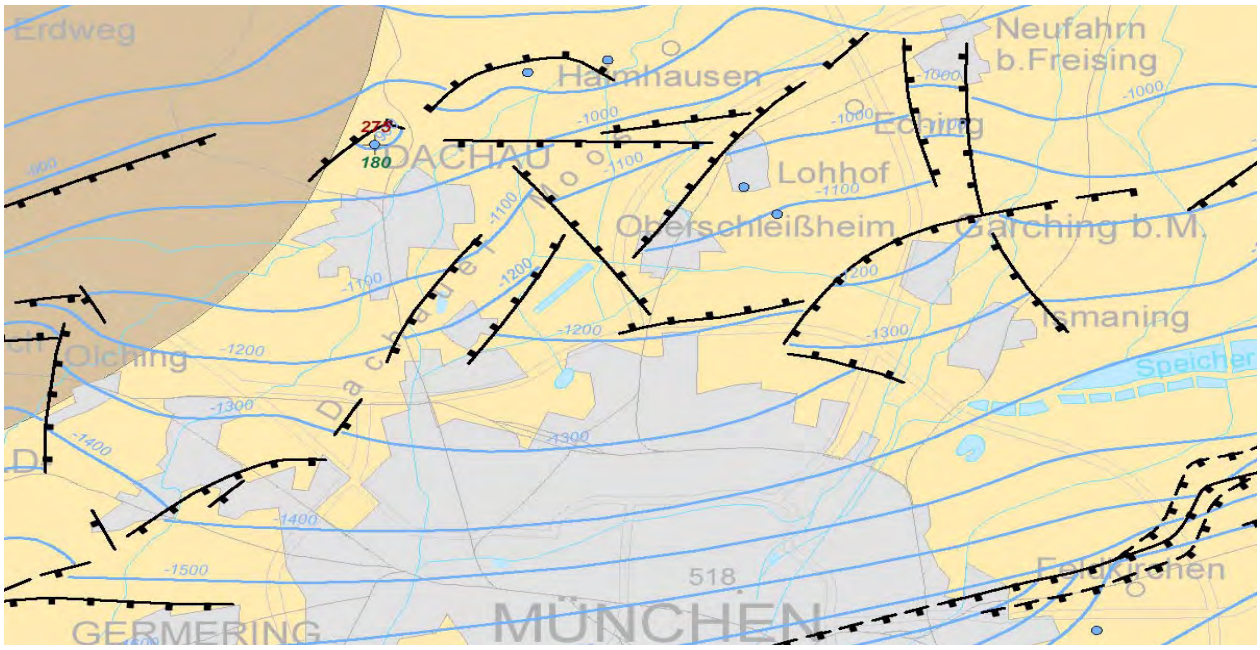
Insbesondere um höhere Schüttungen, wie sie für die Stromerzeugung notwendig sind, zu erreichen, müssen Bruchzonen im Gebirge angebohrt werden. Die bisherigen Erfahrungen zeigen, dass eine gute Verkarstung im Gebirge hierfür nicht ausreichend ist.

Dies setzt eine intensive Vorfelderkundung voraus. In Frage kommen hierbei das Reprocessing seismischer Linien aus der Kohlenwasserstoffindustrie in Verbindung mit der Durchführung konkretisierender neuer Seismik. Auch sind gravimetrische Messungen schon durchgeführt worden.

Hilfestellung insbesondere für die Antragstellung zur Erteilung bergrechtlicher Erlaubnisse kann der April 2005 vom Staatsministerium für Wirtschaft, Infrastruktur, Verkehr und Technologie herausgegebene Geothermieatlas geben.

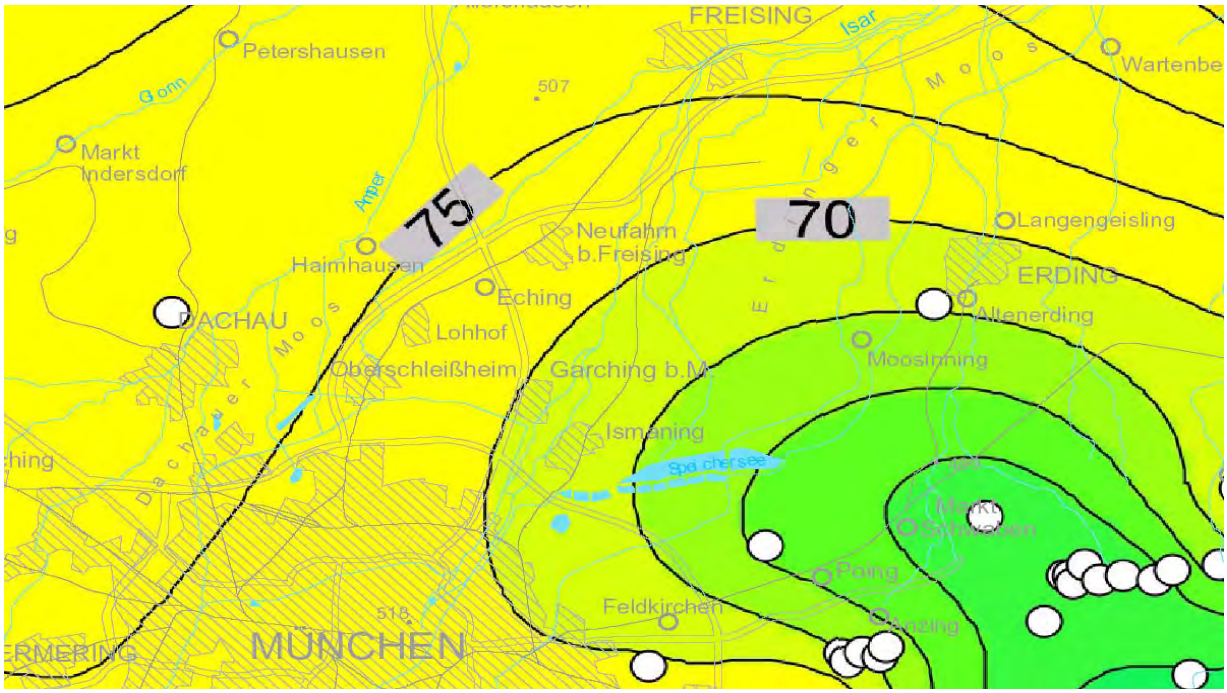
Aus dem Geothermieatlas sind die tektonischen Bruchstrukturen im Malmkarst sowie der Verlauf der Oberkante Malm einschließlich Teufenangabe erkennbar.

Bild C: Geologische Ansprache aus dem Bayerischen Geothermieatlas



Ferner enthält der Geothermieatlas für das betreffende Gebiet Temperaturangaben für den Top-Malm:

Bild D: Temperaturangaben Top-Malm



Beispiel: Geothermieprojekt fiktiv im Raum Eching

Teufe: -1.000 m NN für den Top-Malm

Erwartete Temperatur am Top-Malm ca. 73 °C

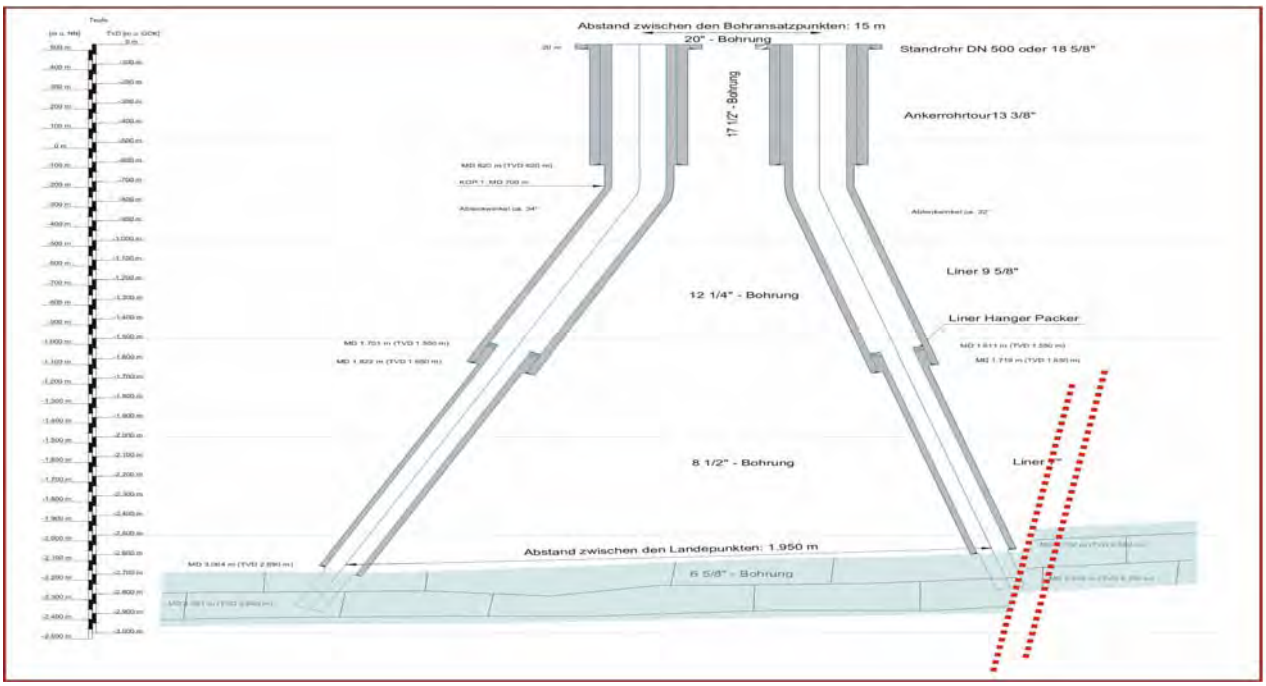
Aufbauend auf diesen Angaben kann unter Berücksichtigung der Geländehöhe und der anvisierten Durchörterung des Malm die endgültige Bohrteufe prognostiziert werden:

Beispiel: Geländehöhe Eching ca. 450 m
Vertikale Bohrstrecke im Malm ca. 300 m
Bohrteufe ca. 1.750 m
Erwartete Temperatur ca. 80 °C

Für eine erste grobe Planung ist der Bayerische Geothermieatlas ein Einstieg. Er ersetzt jedoch auf keinen Fall eine fundierte strukturgeologische Untersuchung und darauf aufbauend eine intelligente Bohrkonzeption.
Auch ist zu berücksichtigen, dass nicht genau prognostiziert werden kann, in welchem Maße die Temperatur im Malm zur Teufe zunimmt. Dies hängt insbesondere damit zusammen, dass die Lokationen der Zuflüsse im Malm nicht bekannt sind. Bei über Bruchstrukturen oder Kluftsysteme aufsteigenden Tiefenwässern aus den unteren Bereichen des Malm, kann wie z.B bei den Projekten in Unterschleißheim, Unterhaching oder Altdorf bei Landshut (hier 12,5 °C/100m) mit höheren Temperaturen als nach dem normalen Gradienten zu erwarten ist gerechnet werden. Möglich ist auch ein Zufluss kälteren Wasser aus den höheren Bereichen des Malm, so dass die Temperaturen wie in Simbach niedriger anzusetzen wären.

Für eine erfolgreiche Erschließung und den Nachweis der Fündigkeit sind immer zwei Bohrungen notwendig, eine Bohrung zur Förderung und eine Bohrung zur Reinjektion des energetisch genutzten entwärmten Wassers:

Bild E: Geothermische Dublette im Malm mit abgelenkten Bohrungen (Sammelbohrplatz)



Die Landepunkte der beiden Bohrungen sollten so gewählt werden, dass sie sich bezogen auf die Lebensdauer der Anlagen (mindestens 50 Jahre) möglichst thermisch nicht beeinflussen. Berechnungen ergaben hierbei einen Mindestabstand von ca. 2.000 m. In der Regel werden die Bohrungen von einem Sammelbohrplatz ausgeführt.
Dies macht jedoch aus technisch-wirtschaftlicher Sicht auch im Hinblick auf die noch durchzuführenden Sondenmessungen im Bohrloch nur Sinn, wenn die Ablenkstrecken der Bohrungen, die in der Regel in die vorhandenen Bruchstrukturen geführt werden, nicht übermäßig groß werden. Bei Planungen von Ablenkstrecken von mehr als 1.500 m sollten daher in der Regel Bohransatzpunkte gewählt werden, die mit einer geringeren Ablenkung auskommen. Ggf. sind dann zwei mehrere km entfernte Bohrplätze notwendig. Im Hinblick auf die Risikominimierung werden zunehmend sogenannte Triplettenkonzepte (2 Förderbohrungen und eine Reinjektionsbohrung) favorisiert, insbesondere dort, wo mit geringeren Ergiebigkeiten zu rechnen ist.

Das geologische Fündigkeitsrisiko ist je nach Nutzungskonzeption und der erhofften Wirtschaftlichkeit nicht unerheblich – dies gilt insbesondere für die Stromprojekte. Seitens der Versicherungswirtschaft werden hierzu Versicherungslösungen angeboten, die jedoch relativ teuer sind und bis zu 25% der Bohrkosten ausmachen. Der Bund strebt ein staatliches Modell an, dessen Einzelheiten jedoch noch nicht vorliegen.

Der Zuschnitt der Erlaubnisfelder ergibt sich aus der Antragstellung und wird somit vom Antragsteller festgelegt. Der Antragsteller ist im eigenen Interesse gehalten, den Zuschnitt so zu wählen, dass die prognostizierten Strukturen unter Berücksichtigung möglicher geeigneter Bohransatzpunkte, der Minimierung von Wechselwirkungen zu den Bohrungen anderer Projekte und der Versorgungsstrukturen im Feld liegen. Aufgrund des starken Interesses und der relativ hohen Erlaubnisdichte sind nachträgliche Korrekturen nur noch schwer möglich.
Eine begleitende hydraulische und thermische Modellierung des Feldes im Vorfeld der Detailerkundungen und der Bohrungen wäre zwar hilfreich und wünschenswert, ist jedoch aufgrund der ungenügenden Datendichte und der sehr komplexen Detailstrukturen im Malm belastbar nicht möglich und wäre spekulativ. Die thermischen und hydraulischen Wechselwirkungen lassen sich deshalb erst dann beurteilen, wenn entsprechende Testversuche und Beweissicherungsmessungen nach Durchführung der Bohrungen vorgenommen werden.

2. Wirtschaftliche Nutzungskonzepte

In Bayern sind zur Zeit mehr als 80 Erlaubnisfelder vergeben, davon wären bei einem Temperaturniveau ab Top-Malm von mehr als 100 °C ca. 50 Felder für die geothermische Stromerzeugung geeignet.

Insgesamt wurde das gesamte Potential in Südbayern auf ca. 500 MW elektrisch geschätzt - dies sind ca. 5,6 % des bayerischen Stromverbrauchs in der Grundlast. Dazu kämen bis zu 3.500 MW thermisch, die in die geothermische Wärmeversorgung einfließen könnten, sofern hierfür genügend Abnehmer vorhanden wären.

Die Abnehmerdichte ist letztendlich auch ein begrenzender Faktor, denn die Geothermie macht wirtschaftlich nur dort Sinn, wo auf engstem Raum auch Verbraucherstrukturen, möglichst mit schon vorhandenem Wärmenetz vorhanden sind. Hier wären insbesondere die Städte und deren Umland anzusprechen. Gerade die Landeshauptstadt München verfügt bereits über ein gut ausgebautes Fernwärmenetz. Außerhalb von München ist der Ausbau der Netze weniger gut; der Freistaat Bayern setzt bei der Förderung der Geothermie daher auf den Ausbau der kommunalen Wärmennetze.

Würden alle möglichen Geothermieprojekte realisiert, ergäbe sich ein Investitionsvolumen für Bohrungen, Kraftwerksbau und Aufbau von Wärmenetzen von mindestens 6 Mrd. Euro.

Nutzungsvarianten sind oder werden in Bayern gegenwärtig wie folgt realisiert:

- Geothermische Stromerzeugung ab 100 °C und mehr als 100 l/s mit der anschließender Nutzung von Wärme für die geothermische Wärmeversorgung. Beispiel hierfür wäre das Projekt Unterhaching bei einer vorgesehenen Stromleistung von 3,4 MW elektr. und einer Wärmeleistung von bis zu 28 MW thermisch sowie auch die meisten anderen noch in der Planung befindlichen Projekte.

- Geothermische Wärmeversorgung in Kopplung mit Biomasseheizkraftwerken. Hier wird die Geothermie für die Grundlast eingesetzt – die erforderliche Redundanz ist durch die Biomasse gegeben. Bei den niedertemperierten Projekten kann das Thermalwasser durch die Abwärme der Biomasse zusätzlich aufgeheizt werden.

  Gleichzeitig ergeben sich Möglichkeiten des Einstiegs in die unterirdische Wärmespeicherung. Im Sommer wird das zusätzlich über die Abwärme aufgeheizte Wasser im Malm – der sich aufgrund seiner spezifischen Aquifereigenschaften hervorragend als Wärmespeicher eignen könnte – wieder versenkt und im Winter das über Lagerstättentemperatur befindliche Wasser gefördert.

- Ausschließlich Projekte der geothermischen Wärmeversorgung für die Wärmeversorgung von Gemeinden oder industriellen Betrieben.
  Die bisher realisierten Projekte in Straubing, Erding, München-Riem, Simbach am Inn, Pullach und Unterschleißheim sind ausschließlich Projekte der geothermischen Wärmeversorgung bei einer gegenwärtig installierten geothermischen Leistung von ca. 46 MW therm, die jedoch noch ausgebaut werden kann.

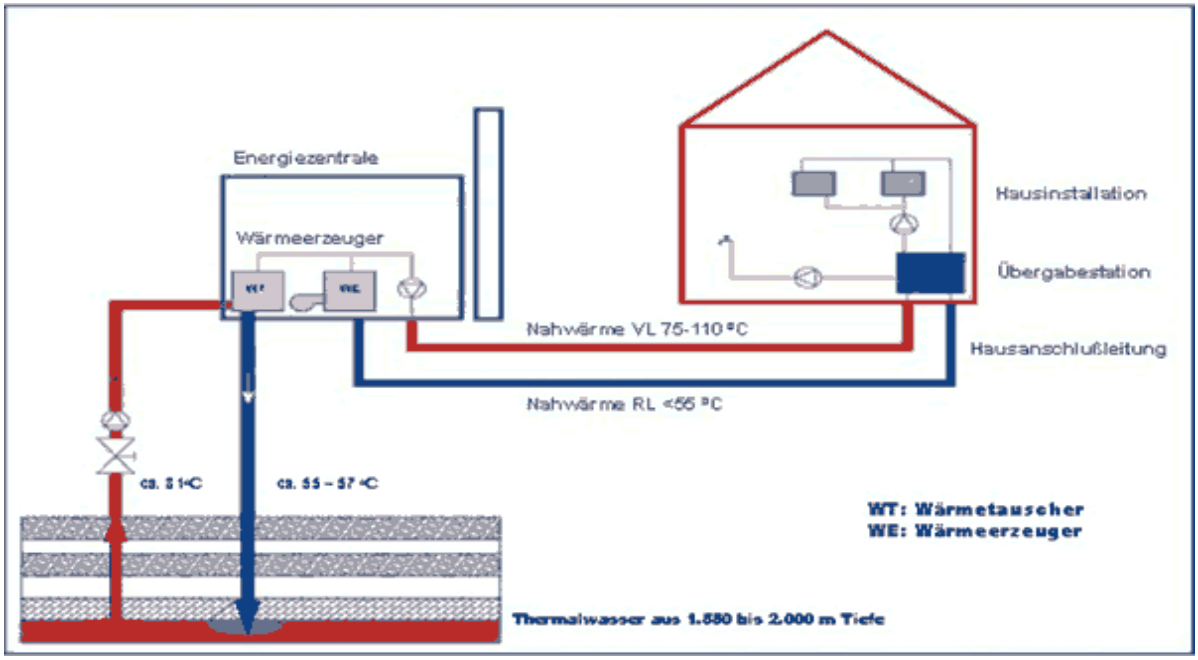
Bild F: Platzsparende Geothermienanlage: Beispiel Pullach





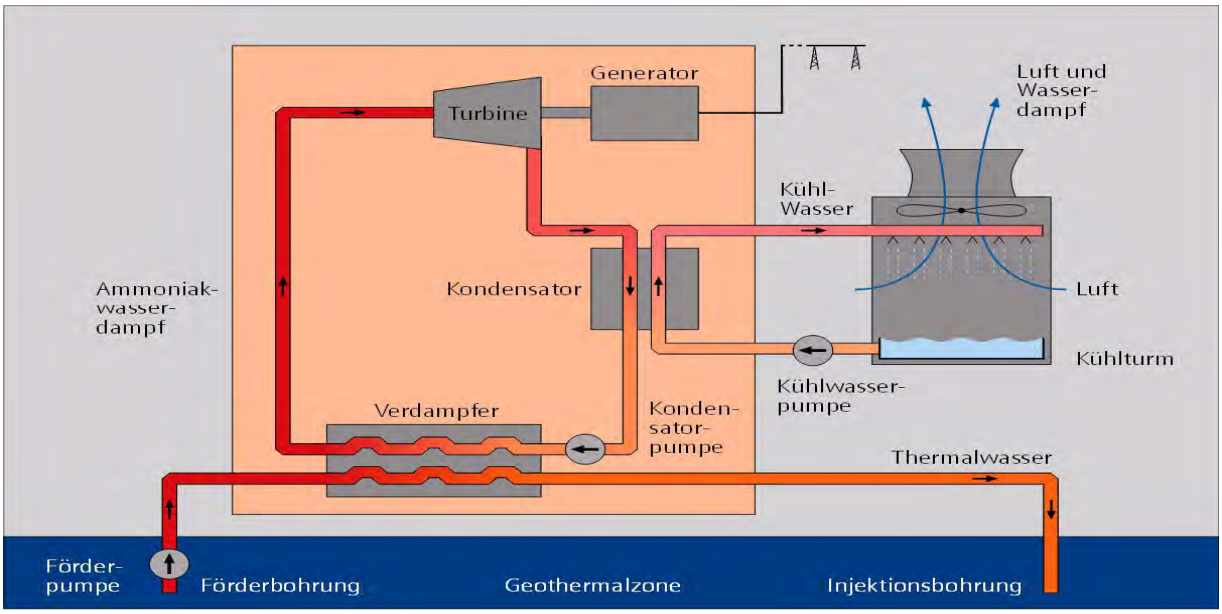

Quelle: Geothermie Pullach

Bild G: Schema der geothermischen Wärmeversorgung – Beispiel Unterschleißheim



Quelle: Geothermie Unterschleißheim AG

Bild H: Schema einer Kalina- Anlage zur Stromerzeugung



Quelle: Siemens AG, Erlangen

Für den Niedertemperaturbereich von 100- 160 °C wird in Bayern für die Stromerzeugung vorrangig die Kalina-Technologie, benannt nach seinem russischen Erfinder, Professor Kalina eingesetzt. Es handelt sich um einen klassischen Dampf-Turbinen- Prozess, bei dem die Wärmenergie aus dem Thermalwasser über einen Wärmetauscher auf ein zweites Medium (Ammoniak-Wasser) übertragen wird. Durch Nachschaltung eines Kreisprozesses wird Dampf auf höherem Temperaturniveau erzeugt, so dass über eine Turbine Strom erzeugt wird. Dabei ist jedoch ein Kühlungssystem zur Entspannung und Verflüssigung notwendig. Das Problem hierbei ist die Verfügbarkeit von Kühlwassermengen bis 30 l/s aus dem Grundwasser. Daher werden zunehmend auch Überlegungen angestellt, hybride Systeme (Luft-Wasser-Kühlung) einzusetzen. Direktkühlung wie in Island ist in Bayern nicht möglich.

Die geothermischen Wirkungsgrade der Kalina-Technologie liegen bei ca. 10 - 15 % in Abhängigkeit von der Eingangstemperatur, Ausgangstemperatur und Kühltemperatur. Hierzu ein Beispiel:

Kalina-Kraftwerke: Beispiel für Bayern

T-Vorlauf: 130 °C, T-Rücklauf: 60 °C, Kühltemperatur Winter: 4 °C, Sommer: 15 °C, Ergiebigkeit : 120 l/s

	Winter	**Sommer**
Carnot	24,5 %	21,5 %
Technisch	14,2 %	12,6 %
Strom	*4,7 MW*	*4,2 MW*

Die Wirkungsgrade des Prozesses sind deutlich niedriger als bei konventionellen Kraftwerken mit über 40%. Zur optimalen Ressourcennutzung und zur Minimierung des Kühlwasserbedarfs wurde daher die Forderung aufgestellt, nicht nur Strom zu produzieren, sondern auch eine Wärmenutzung anzuschließen. Dies kann durch die Auskoppelung von Wärme im Primärkreislauf (z.B. Strom von 130 bis 85 °C, dann Wärmenutzung von 85 bis 50 °C) oder Nutzung der beim Stromkreislauf anfallenden Abwärme geschehen. Dabei ist aber zu beachten, dass der größte Teil der Abwärme in einem Temperaturbereich unterhalb von 50 °C vorliegt.

3. Ausblick

Die hohe Zahl der Erlaubnisfelder für Erdwärme belegt, wie groß das Interesse an der Tiefengeothermie in Bayern ist. Bayern verfügt mit den Projekten Straubing, Erding, Simbach, Unterschleißheim, München-Riem, Pullach und Unterhaching über sieben bestehende Anlagen und ist damit Spitzenreiter in Deutschland. Mindestens vier weitere Projekte sind in einer sehr konkreten Bohrvorbereitung und sollen bis Ende des nächsten Jahres realisiert werden. Es bleibt abzuwarten, ob diese ähnlich erfolgreich verlaufen wie die bisherigen Projekte und sich der Boom in Bayern fortsetzen wird.

Text: Bergdirektor Rainer Zimmer,
Bayerisches Staatsministerium für Wirtschaft, Infrastruktur, Verkehr und Technologie

REGIERUNG VON OBERBAYERN
Bergamt Südbayern ⚒ Sachgebiet 26
Maximilianstraße 39, 80538 München

Merkblatt Geothermie

Stand: Dezember 2010

Phase 1 – Erkundung

Was wird für die Erkundungsphase benötigt?

1. Bergrechtliche Erlaubnis zum Aufsuchen von Erdwärme
2. Bergrechtliche Betriebspläne für die Bohrlochherstellung
3. Gewerberechtliche Genehmigung für Sonn- und Feiertagsarbeit
4. Bergrechtlicher Betriebsplan für den Pumpversuch
5. Wasserrechtliche Erlaubnis für den Pumpversuch

Wer macht **Was?**

zu 1.) Der **Unternehmer** beantragt die bergrechtliche Erlaubnis gemäß § 7 in Verbindung mit § 3 Abs. 3 Nr. 2 Buchst. b Bundesberggesetz (BBergG) beim **StMWIVT**[1]. Die bergrechtliche Erlaubnis ist die Grundvoraussetzung für alle Aufsuchungsarbeiten.

zu 2.) Der **Unternehmer** legt dem **Bergamt Südbayern**[2] je einen Betriebsplan für die Herrichtung des Bohrplatzes (Hauptbetriebsplan, Teil A) und für die Durchführung der eigentlichen Bohrarbeiten (Hauptbetriebsplan, Teil B) vor; siehe hierzu auch § 51 i.V.m. § 2 Abs. 1 Nr. 1 und § 3 Abs. 3 Nr. 2 Buchst. b BBergG. Die Betriebspläne müssen detailliert auf den Bau des Bohrplatzes mit Zuwegung bzw. auf die technischen Einrichtungen der Bohranlage, auf den Personaleinsatz und auf Maßnahmen zum Umweltschutz (einschließlich Lärmschutz) und Arbeitsschutz eingehen.

zu 3.) Der **Bohrunternehmer** beantragt beim **Bergamt Südbayern** in begründeten Fällen eine Feststellung der Voraussetzungen für Sonn- und Feiertagsarbeit nach § 13 ArbZG[3] i.V.m. § 2 Abs. 1 ASiMPV[4]

zu 4.) Der **Unternehmer** legt dem **Bergamt Südbayern** den Betriebsplan für die Durchführung des Pumpversuchs vor. Der Betriebsplan muss detailliert auf die technischen Einrichtungen der Bohrung während des Pumpversuchs (unter- und übertätige Einrichtungen, sicherheitstechnische Anlage) und auf den Personaleinsatz eingehen.

[1] Bayerisches Staatsministerium für Wirtschaft, Infrastruktur, Verkehr und Technologie, Referat VI/5, 80525 München
[2] Regierung von Oberbayern – Bergamt Südbayern, Maximilianstr. 39, 80538 München
[3] Arbeitszeitgesetz (ArbZG) vom 06.06.94 (BGBl. I. S 1171)
[4] Verordnung über Zuständigkeiten auf dem Gebiet des Arbeitsschutzes, der Sicherheitstechnik, des Chemikalien- und Medizinprodukterechts vom 02.12.98 (GVBl. S. 956)

26-011-I/12.10 – B -

zu 5.) Der **Unternehmer** beantragt beim **Bergamt Südbayern** für den Pumpversuch und für das Ableiten von Tiefenwasser aus der Bohrung eine wasserrechtliche Erlaubnis nach § 8 WHG i.V.m. Art. 64 Abs. 1 BayWG.

Phase 2 – Gewinnung

Was wird für die Gewinnungsphase benötigt?

1. Bergrechtliche Bewilligung für die Gewinnung von Erdwärme
2. Bergrechtliche Hauptbetriebsplan für die Gewinnung von Erdwärme
3. Wasserrechtliche Erlaubnis für die Benutzung des Tiefenwassers

Wer macht **Was**?

zu 1.) Der **Unternehmer** beantragt eine bergrechtliche Bewilligung gemäß § 8 i.V.m. § 3 Abs. 3 Nr. 2, Buchst. b BBergG beim **StMWIVT**. Die bergrechtliche Bewilligung ist die Voraussetzung für eine Gewinnung von Erdwärme.

zu 2.) Der **Unternehmer** legt dem **Bergamt Südbayern** einen Hauptbetriebsplan für die Führung des Gewinnungsbetriebs vor (§ 52 BBergG). Der Betriebsplan muss Angaben zu den technischen Einrichtungen zum Gewinnen von Erdwärme (unter- und übertägige Einrichtungen, Bohrlochkopf, sicherheitstechnische Anlagen bis einschließlich Wärmetauscher) enthalten. Der Sekundärkreislauf hinter dem Wärmetauscher (bei Reinjektion) oder die Fortführung der Leitung nach dem letzten Schieber des ersten Ausgleichsbehälters (bei balneologischer Nutzung) sind nicht Gegenstand der Genehmigung.

zu 3.) Der **Unternehmer** beantragt beim **Bergamt Südbayern** eine wasserrechtliche Erlaubnis nach § 8 WHG i.V.m. Art. 64 Abs. 1 BayWG für das Entnehmen, Zutageleiten und Ableiten von Tiefenwasser aus der Bohrung im Rahmen der geothermischen Nutzung der Tiefenwässer.