A comprehensive overview on the existing regulatory and financial barriers on geothermal energy utilization in Austria, Hungary, Slovakia and Slovenia

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ABSTRACT

Enhanced use of geothermal energy in Austria, Hungary, Slovakia and Slovenia can significantly contribute to achieve the European goal of increasing the use of renewables to 20 % by 2020 due to favourable geothermal conditions in the western part of the Pannonian basin. Nevertheless, further development of geothermal resources by high level of abstraction and simultaneously the safe balance between competing stakeholders interests will be feasible only by efficient sustainable management. High level of cooperation between exploitation right holders and licence authorities is indispensable, thus also high level of public awareness is needed. Both can help to dismantle the most significant regulatory and financial barriers, pave the way to reliable (low risk / highly advanced) geothermal resources development projects which could be able to use up funds and essentially help to achieve the objectives.

To help to assess the sustainability of geothermal resources management and to facilitate public cooperation and decision making process we have defined ten main indicators, so called benchmarks which can be applied based on similar criteria in the areas of interest. The proposed ten indicators are: (1) status of the monitoring, (2) best available technology, (3) energy efficiency, (4) utilization efficiency, (5) balneological efficiency, (6) reinjection rate, (7) recharge of aquifer, (8) overexploitation, (9) quality of discharged waste thermal water and (10) public awareness.

1. INTRODUCTION

Austria, Hungary, Slovakia and Slovenia, countries that share the Pannonian basin as an important high potential transboundary geothermal resource in Europe had set actions and targets to increase the utilization of their geothermal resources till 2020 and beyond. From their National renewable energy action plans (NREAP) it is evident that the contribution of geothermal energy in renewable energy sources (RES) is planned to significantly rise during the period 2010 – 2020.

Following actual European policy, in the period 2020 - 2050 the share of renewable energy (RES) is expected to rise substantially and also the electricity would play much larger role in the decarbonization than today. The potential of utilisation of geothermal heat for heating and cooling sector and that the enhanced geothermal systems (EGS) for geothermal electricity production would further develop. The countries are encouraged to be prepared and cooperate in the research and development activities and also to deal with regulatory and financial barriers of the future geothermal resources development.

In the frame of the Transenergy project, the regional, national and European legislation on geothermal energy, as well as available financial supporting schemes were analyzed, taking also into account the requirements of the Water Framework Directive as an equally accepted water management policy. 40 authorities that are involved in geothermal energy regulation and 148 active and 65 potential users of 401 geothermal objects were interviewed in the 4 countries, Austria, Hungary, Slovakia and Slovenia (Lapanje, A. & Prestor, J., 2010).

There are apparently significant differences in geothermal resources management between all four countries. The Geological Act is known only in Slovakia and the system of geothermal concession exists only in Hungary. More often, mining and water concessions regulate geothermal utilization. Geothermal energy is owned by a land owner only in Austria, while thermal water is usually defined as having at least 20ºC outflow temperature, except Hungary, having the temperature limit at 30ºC. Confidentiality of production data is the strongest in Austria. The groundwater management aspect

focusing on the protection of water resources is very strong at the expense of energy utilization in all four countries, but especially in Hungary, where multiple taxation and other regulations (e.g. higher waste water fine) put energy users in disadvantageous position. Re-injection is an issue in all four countries, despite existing binding forces only a very small number of re-injection wells operate. Geothermal electricity is produced only in Austria, while use of geothermal heat is best applied in Slovakia and Slovenia. In Hungary much of the use is balneological.

Another important aspect which is impeding development of geothermal energy utilization is the lack of financial incentives in comparison with other renewable energy sources. More favourable feed-in tariffs, establishment of an off-take and support scheme for green-heat would be preferential. There are relatively limited funds available in all Transenergy countries to fund the high upfront costs. Even the existing funds can hardly be used due to lack of risk-insurances of highly advanced geothermal project developments. Other supporting measures are also weak, enabling some training and information; however no independent expert body has been established which could be responsible for promotion and development of the sector. A lot still needs to be done on standardization, research & development, too.

2. GEOTHERMAL RESOURCES DEVELOPMENT

Future geothermal resources development in Austria, Hungary, Slovakia and Slovenia is undoubtedly linked to the common energy and environmental policy of Europe. Actions for geothermal resources development are planed dominantly in coordination between energy and water sectors in all countries.

Before adopting the Water Framework Directive in 2000, the geothermal energy was treated more as a “mineral resource” in the mining sector domain. However, the geothermal heat exploitation - from an environmental point of view - is similar to groundwater abstraction. Both the heat and the fluid are renewable, however at different rates and under different conditions (e.g Rybach and Mongillo 2006). The Water Framework Directive was the first European policy that highlighted and put into focus the long term availability of resource and its equilibrium that has to be achieved and respected. Nevertheless, distribution of management of geothermal resources between two sectors is actually still represented as an obstacle.

Years 2009 and 2012 were special milestones. In 2012 countries adopted simultaneously their River Basin Management Plans (RBMP), in the frame of the first cycle of water management plans under the umbrella of a common European water policy. Each country had to evaluate, among other, impacts of thermal groundwater abstractions: whether these abstractions exceeded available groundwater resources and if abstractions had any impact on ecosystems, i.e. is the thermal groundwater body in good or bad status. It was also investigated if good status will be achieved / assured by 2015, or additional or supplementary measures / costs are needed. At the latest till 2012 countries also had to implement the additional or supplementary measures to achieve good status of waters.

During preparation of River Basin Management Plans countries were faced with comprehensive evaluation of data and information to characterize the actual and near future environmental status of entire water body, to set the specific basin related environmental goals in the frame of common water policy, to set the critical points when the additional or supplementary measures would have to be implemented and to set up the sustainable integrated management of the water body.

Countries characterized theirs geothermal water bodies using guidelines from the Common Implementation Strategy guidance documents, however, rather differently, depending of the actual practice in the country and actual utilization, namely, significance of these resources. Anyway, as a regionalization is possible within one country, it is possible between two or more countries, but only by the aid of geological and hydrogeological science.

An important lesson learned from the comparison of the RBMP-s of the four Transenergy countries (Austria, Hungary, Slovakia and Slovenia) was, that although the Water Framework Directive provides an “umbrella” with common goals, the delineation and assessment of thermal groundwater bodies could be quite different over the state borders and have to be upgraded by complex bilateral actions to enable sustainable transboundary groundwater resources management.

Although Austria, Hungary, Slovakia and Slovenia as neighbouring countries have bilateral agreements on the water management since many years, they didn’t discuss the thermal groundwater as a special issue before. These negotiations started for the first time in the frame of the implementation of the Water Framework Directive, related to the characterization of the geothermal resources that appertain to the common cross border natural basins. There are also some ongoing discussions during the last years that have been initiated from the need of information exchange for cross border developments. These discussions will be undoubtedly needed to be continued in next coming years.

Status assessment of thermal water body within common supra region of Pannonian basin shared between Austria, Hungary, Slovakia and Slovenia stands debited for significant uncertainties. Some parts may certainly be regarded as very sensitive to overexploitation, due to natural conditions, above all, limited recharge. There are indications of local impacts between some wells of neighbouring abstractions that could cause the change of hydrogeological conditions and consequently worsen

the future exploitation conditions. There is also uncertainty because of actual scarcity of monitoring data (long term trends could not be evaluated), while there are indications of activations and interconnections of new layers in existing wells, increase of drawdowns in individual wells, increase of water demand and not efficient use.

Different supplementary or additional measures are foreseen in the frame of all four countries River Basin Management Plans, to assure achieving the environmental objectives. These measures, as a compilation, are focused to:

1. Start licensing for water abstractions that are actually without permits; if necessary, terminating them.
2. Modifications or restrictions in water rights granting depending on the trend of water level or reinjection.
3. Appropriate well technology application, well reconstruction.
4. Development of re-injection technologies.
5. Detailed definition of the depth and the exploited aquifer in the application for acquiring groundwater research permit.
6. Explicit permitting for activation of new layers in the same well, in the research permit.
7. Elaboration of deep aquifers maps, survey of geothermal units.
8. Particular attention to the selected cross-border services, because they have higher demands on the quantity and quality of the data for the assessment.
9. Databases development of geothermal resources and their exploitation and processing of geothermal water balance.
10. Evaluation of available thermal water reserves for the direct use of heat abstraction and tourism.
11. Re-evaluation and updating of geothermal potential of significant structures.
12. Definition of critical levels and alert system establishment where the water demands could exceed available reserves.
13. Determination of referential observation points.
14. Further development of established monitoring system.

Activities in the last years revealed non stable status of thermal water resources at different locations and also negative trends on sub-regional areas within the area of Transenergy project. Obviously, this fact additionally slows down further development of new abstractions and granting new water and mining rights in the region. It was recognized that the common understanding of natural systems extending across the state borders is essential for sustainable resources management. Austria, Hungary, Slovakia and Slovenia made a very important progress by common characterization of actually the most important cross border geothermal reservoirs on the high expert level in the Transenergy project (Central Europe Program). This is the basis for self-confidence and encouragement to develop these resources till 2020, following energy and environmental goals together. Without these activities, any further development of cross border thermal reservoirs would be unsecure or highly unpredictable. In the next programming period 2014 – 2020 we can expect successful development towards common transboundary management.

Comprehensive and effective management of geothermal resources requires an up-to-date understanding of the geothermal system. This is primarily based on the results from surface and subsurface exploration. Nevertheless, the most important knowledge is obtained by observation of the geothermal system’s response to long-term pressure, i.e. water or heat abstraction and storage. Monitoring of a geothermal reservoir is thus an indispensable part of any sustainable management program, where operational problems can be held to a minimum (e.g. scaling, corrosion), over-exploitation can be avoided, production may be sustained for a long time and cost-benefit is optimal.

Geothermal resources and geothermal reserves are comparable terms to groundwater resources and groundwater availability. Resources and available reserves are always the subject of assessment and estimation. The reliability of the estimation and forecast depend directly on the results of observations, length of data time series and on the range of pressure / response measurements.

Organization of monitoring in all four countries tends to consist of three levels: (1) “national monitoring” system – by public agency, (2) individual “users monitoring” system – by users (water/mining rights holders) and (3) “special monitoring” system of specific, occasional, targeted actions – by other institutions. As the scope of monitoring is to control the response of the geothermal natural system to the pressures, where the most important stress is expected to be the abstraction, the “users monitoring” is the most important monitoring. The user is the closest performer and observer in the stress – response act, and so the most important person to report. Although the user is interested to get benefits from his production and his role is to be in the advantage, the exploitation license has to transparently protect public interest and follow the sustainability, precautionary principles and combined approach policy. “Users

monitoring” is the core executive monitoring system, while “national monitoring” system should ensure integrated evaluation of monitoring results with special emphasis on interconnection between cold and thermal water bodies, as well as on detecting impacts of climate changes.

The Upper Austrian State Government publishes a report every 5 years containing monitored data from thermal water users. This report gives a good overview about water extraction, water level and possible changes in the aquifer. In general the received reservoir data are company secrets in Austria. However, according to article (§59a (3) and (4) WRG 1959) the competent federal authority is allowed to use monitoring data privately gained by users for updating the national groundwater management plan (NGP 2009). This is an important good practice example how to encourage users and stakeholders to increase step by step public awareness, respecting privacy, confidentiality and confidence.

Integrated resource management with high level of user self-regulation is indispensable, guided by aquifer modelling and monitoring (Cap-net, 2010). In the period 2014 till 2020, the supra regional area of Austria, Hungary, Slovakia and Slovenia could proceed towards stable highly developed geothermal resources with the highest stage of comprehensive and effective management, where high level of abstraction is reached in the frame of sound balance between competing stakeholders interests.

The effects of additional and supplementary measures from River Basin Management Plans will start to have effects in next years. The weaknesses and threats (that are addressed by 14 measures mentioned above) can be categorized in following significant issues:

1) Monitoring, permitting and reporting.

2) Best available technology use and utilization efficiency.

3) Recharge of thermal aquifers and overexploitation.

4) Re-injection development.

These issues shall be carefully observed because they should have the most important role in the decision making process and investments in further geothermal resources development.

3. REGULATORY AND FINANCIAL BARRIERS TO GEOTHERMAL RESOURCES DEVELOPMENT

In order to gain an insight in regulation and licensing concerning geothermal energy in the four partner countries (Austria, Hungary, Slovakia and Slovenia) a questionnaire for authorities involved in management of geothermal energy was prepared (Prestor, J. & Lapanje, A., 2010).

The analysis of the incoming data had a goal to allow the comparison of differences between countries and to identify legislative and legal problems with geothermal utilization. A questionnaire was prepared based on the recommendations of the GeoThermal Regulation - Heat (GTR-H) project. This was distributed among project partners to serve as a foundation for authorities’ data gathering, which was then compiled in the so called Authorities database, where answers from 40 authorites were incorporated and analyzed. In this manner transparent and plain comparison was achieved.

All countries considered that geothermal energy is not effectively regulated through existing legislation. Unanimous consideration is that the existing systems of licensing for exploration and exploitation of geothermal resources do not efficiently regulate and help to develop the national geothermal sector.

The main barriers and the most significant management issues, considered unanimously by all four countries are:

1. An independent expert body (competent professional body) responsible for promotion and development of the geothermal energy sector has to be established.

2. Awareness campaigns for Renewable Heating and Cooling (RES-H) technologies and in particular for geothermal energy which proactively target professionals (engineers, architects and installers) have to be foreseen.

3. Research and development support in the form of funding for the cost of site characterization has to be established.

4. In order to assist in the development of the sector, appropriate exemptions from the regulation related to national planning and environmental impact assessment should be considered for the exploration stage of geothermal energy projects. Waived or reduced cost of national drilling permits for the completion of geothermal energy boreholes has to be provided.

5. Recommendations for other supporting measures seem to be more exploited than financial incentives, at least training and information fields, while the standardization and research & development support measures seem to be rather unexploited. It seems that this is also the reason for lack of reliable (low risk / highly advanced) geothermal resources development projects which could be able to use up existing funds.

6. Different possibilities for financial incentives are apparently the most unexploited or unknown tools for the stimulation of geothermal resource development. This is especially noted at financial burden (fees regulation) and definition of financial incentive parameters. These issues seem to be

significantly weaker than the existing financial incentive schemes.

7. The procedure for the project assessments for financial incentives has to be based on long term geothermal energy production data.

8. Templates have to be developed to ensure full reporting monitored data included also from surface production facilities, such as the heat or power plant efficiencies, heat output, electrical power output and fouling of heat exchangers.

9. The confidentiality of all submitted data associated with licensed geothermal exploitation operations have to be defined by licence period, confidentiality period or after licence surrender period.

The actual questionnaire result represents the status as reported in September 2010 and is cross section of the initial reconciliation between sectors that were engaged in this questionnaire survey. This result should stimulate the sectors to reconsider some questions and answers and to make the improved survey in the next steps. We proposed that the questionnaire is updated regularly using the database provided on the Transenergy project web page (http://transenergy-eu.geologie.ac.at). This would enable to follow the actual reconsideration about barriers.

In the licensing of a geothermal project it seems that environmental assessment is the most demanding procedure. Projects are likely to have significant effects on the environment, therefore an environmental assessment should be made, prior to their approval or authorization. Consultation with the public is a key feature of environmental assessment procedures and is aimed to provide a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation of projects, plans and programmes with a view to reduce their environmental impact. Public participation in decision-making should, above all, strengthen the quality of decisions and diminish the risks of unsuccessful investments. This is very important from point of view of co-financing programmes and essentially also to risk insurance, i.e. preparing reliable (low risk / highly advanced) geothermal resources development projects.

Threshold values or criteria when to start environmental assessments with public participation differ a lot from country to country and highly depend on the social-political environment and background. Nevertheless in Transenergy countries an environmental impact assessment is required for major geothermal projects, less regulated in Slovakia. Geothermal projects are not as often as other project, thus public is not so familiar with best available technologies, risks, significant issues and, above all, best practices. So, it is very important to increase public awareness about significant issues, public interest and what is sustainable management of geothermal resources. One of the most important issues of environmental impact that should be highlighted in public awareness is quality of discharged waste thermal water. The next following information should be the matter about overexploitation and the next energy efficiency.

3. SUSTAINABILITY OF GEOTHERMAL RESOURCES MANAGEMENT

Sustainability is reached when there is a favourable efficiency of resources exploitation and the real expenses are not postponed to the next generation. So, where to focus further efforts to reach short and long term sustainability? Based on our study of transboundary thermal aquifers between Austria, Hungary, Slovakia and Slovenia and during preparation of recommendation for transboundary thermal water management, we selected certain important indicators that could be observed to reveal the actual sustainability of transboundary thermal water management. We tried to use the “Lemano” idea and method (Lachavanne, J-B., Juge, R., 2009) and define 10 crucial indicators that would enable us to do a kind of benchmarking, i.e. to follow and compare the sustainability of geothermal resources management:

1) Monitoring status.

2) Best available technology.

3) Thermal efficiency.

4) Utilization efficiency indicator (capacity factor).

5) Balneological efficiency.

6) Reinjection rate.

7) Recharge of thermal aquifers.

8) Overexploitation.

9) Quality of discharged waste thermal water.

10) Public awareness.

All indicators have specific evaluation and then they are marked in five marks: very bad, bad, moderate, good and very good. The methodology of evaluation is described in Prestor, J., Nador, A., Lapanje, A., (2012).

(1) “Monitoring status”: The first and most important key indicator is a mandatory, unified and integrated monitoring monitoring. This monitoring should be implemented by the user and should consist of continuous recording of groundwater level or wellhead pressure, water temperature, yield and chemical composition or conductivity (Axelsson and Gunnlaugsson 2000).

"Monitoring status" can be upgraded in following successive levels:

a) Sporadic observations.

b) Monitoring of exploitation: Continuous measurements of discharge, piezometric level, temperature and regular water analysis (defined in the licensing contract).

c) Yearly report of monitoring results submitted by user and approved by granting authority.

d) Surveillance monitoring in non exploited observation well: Regular measurements of piezometric level.

e) Surveillance monitoring in non exploited observation well: Temporarily sampling of groundwater for chemical / isotopic analysis for global changes identification.

Indicator "Monitoring status" is marked as "good" when yearly report of monitoring results is submitted by concessionaire and approved by granting authority. If there is also additional monitoring in non exploited observation well, the mark is "very good",

(2) "Best available technology (BAT)": Encouragement of the "best available technology (BAT)" is proposed, as this will have a direct impact on decreasing the need for thermal water, increasing usage efficiency, mitigation of potential system failures, as well as diminishing environmental pollution. "Very good" managed geothermal wells should give following positive answers:

a) Well maintained wellheads which are isolated and protected from unfavourable weather conditions and unauthorised persons.

b) Materials installed in and above the well should be inert for aggressive water/gas mixtures and higher temperatures, while calcite scaling problems should be effectively mitigated by injecting inhibitors.

c) Installation should avoid areas of gas or water leakage and include the placement of a water release valve before the degassing unit at the wellhead.

d) Abstracted water is precisely and continuously following the water demand. If pumping is required computer-managed frequency pumps are recommended.

e) The exploitation system should be based on the principles of cascade use, with both computerised and individual phases controlled as much as possible. This can be achieved through the establishment of automatic and precise monitoring.

f) Supporting technical, lithological, hydrogeological and chemical documentation should be well-kept and regularly updated.

g) Specific yield of wells is not decreasing.

If more than three answers are not affirmative, the mark is "very bad".

(3) "Thermal efficiency": Although only very few of the users cool down their waste thermal water near to the mean annual air temperature (e.g. 12 °C), this should be followed by others. Higher "thermal efficiency" should lead to a reduction in the total amount of abstracted thermal water, as well as lower thermal and chemical pollution of the surface waters into which waste water is emitted. To indicate "very good" thermal efficiency, a value of at least 70 % utilization of available energy should be reached. This would mean, for example, if thermal water temperature at wellhead is 60 °C, then waste water should have a maximum temperature of 26.4 °C before being emitted to the environment, or 20.4 °C in case of a 40 °C wellhead water temperature. Adequate rate of thermal efficiency increments have to be foreseen and set up on mutual agreement to promote the BAT as priority instead of abstraction increment. If all abstracted water is re-injected then the thermal efficiency $\eta = 1$ is 100 %. If less than 30 % of thermal energy is abstracted, the mark of thermal efficiency is "very bad".

(4) "Utilization efficiency": Utilization efficiency indicator (capacity factor) is the ratio between average annual energy use and capacity. Utilization efficiency is "very good" if average energy use is greater than 30 % of the capacity. This is mainly important from the costs side of view and also to leave the available capacity to other eventual users. If average energy use is less than 15 % of the capacity, the utilization efficiency is "very bad".

(5) The "balneological efficiency" is "very good" when the abstracted volume of water is not higher than the minimum amount required, but ensuring that pool water does not have to be disinfected.

(6) "Reinjection rate" is "very good", where at least 60 % of abstracted water can be returned into the aquifer. In open systems, only non-treated thermal water can be returned into the aquifer. Indeed, even though reinjection is already a legal requirement it currently takes place at very few sites. However, due to the positive effect on aquifer hydraulic conditions and environmental pollution mitigation, reinjection should be required for all non-treated thermal water, where geological and hydrogeological conditions are favourable. Completely no reinjection on the interested area is marked as "very bad".

(7) "Recharge of thermal aquifers – status of water balance assessment" can be developed in following successive cumulative levels (from "very bad" to "very good"):

a) Not assessed.

b) Critical level point is defined (not based upon measurements on the location but from other available data / locations).

c) Critical level point is defined (based upon average yearly minimum level value from previous years on the location).

d) Critical level point is defined (Renewable and available volume of water is assessed + Critical point of abstraction is defined - Study made on the base of old / regional data and knowledge).

e) Renewable and available volume of water is assessed + Critical point of abstraction is defined and critical level point is defined - Study made and updated on the base of actual measurement.

(8) “Overexploitation” is very well managed when none of following statement is affirmative:

a) Significant decreasing of piezometric level showing that new equilibrium could not be reached.

b) Decreasing suitability of water quality or temperature caused by the abstraction.

c) Decreasing of groundwater availability.

d) Impact on dependent ecosystems is significant.

e) Soil subsidence caused by the abstraction.

Overexploitation is “very good” managed when none of above problems is present and “very bad” when more than three of those problems are to be solved.

(9) The “Quality of discharged waste thermal water” is very good when at least 95 % of samples of abstracted volume of water meet the required normative. The mark is “very bad” if less than 70 % of water doesn’t meet the requirements.

(10) “Public awareness”: Very good “Public awareness” requires free accessible regularly updated information at least about following indicators:

a) Quality status of waste water.

b) Quantity status (overexploitation).

c) Energy efficiency.

d) BAT use.

e) Monitoring.

Data for evaluation of these indicators are partly collected through the obligations *from Water Framework Directive, Directive on the promotion of the use of energy from renewable sources, national obligations on emissions monitoring* and also following the EGEC recommendations for geothermal resources management. More detailed data are not freely accessible, especially for individual wells and users. Nevertheless, benchmarking shall be performed on the level of legal entity that should have available data from the monitoring and reporting obligations. Each individual user can also compare only his own data on the level of legal entity and take his own decisions or promotions to improvements and contribution to the legal entity success.

In the following table (Table 1) there are test results presented from the geological entity “Ptuj-Grad+Mura Formation” in Slovenia. Data on quality of discharged waste thermal water were not included. From this example it can be concluded that on the selected area there are three the most significant issues to solve in the further geothermal resources management: (1) yearly reports of monitoring results have to be submitted by user and approved by granting authority, (2) critical level points of the abstracted wells have to be defined at least from other available data or locations, and (3) public should get free accessible information, at least of quality status of waste water.

Table 1: Example for reporting the sustainability of geothermal resources management.

	Ptuj-Grad+Mura Fm. in SI	Points %	Descriptive mark
1	Monitoring status	0	Very bad
2	Best available technology	50	Medium
3	Thermal efficiency	75	Good
4	Utilization efficiency	100	Very good
5	Balneological efficiency	100	Very good
6	Reinjection rate	25	Bad
7	Recharge of thermal aquifers	0	Very bad
8	Overexploitation	25	Bad
9	Quality of discharged waste thermal water	?	
10	Public awareness	0	Very bad

? – data not collected and evaluated

3. CONCLUSIONS

In the frame of Transenergy project effectuated on the Pannonian basin area between four neighbouring countries Austria, Hungary, Slovakia and Slovenia we were able to prepare a comprehensive overview of barriers that should be addressed in coming years to make quicker steps towards stable highly developed geothermal resources on that area.

The barriers are seen through the Water Framework policy implementation in four neighbouring countries and also through the unanimous views on existing geothermal regulation in these countries. It is clearly proved that high level of cooperation between exploitation right holders and licence authorities and also high level of public awareness is indispensable.

The issues that shall be the most carefully observed in the next years because they should have the most important role in the decision making process and investments in further geothermal resources development are: 1) monitoring, permitting and reporting, 2) best available technology use and utilization efficiency, 3) recharge of thermal aquifers and overexploitation and 4) re-injection development.

In the frame of Transenergy project we developed benchmarking indicators to compare sustainability of geothermal resources management for any interested entity. This can help at making decisions how and where to advance over the most significant regulatory and financial barriers and to start reliable - low risk and highly advanced - geothermal resources development projects.

Nevertheless, the most significant geothermal energy progress for all four countries is assured by the high expert knowledge that was developed about natural system and also tools that were developed (e.g. conceptual and numerical models). But anyway, it is essential to provide that this knowledge will be included in the integrated management of geothermal resources.

Last but not least, we also prepared questionnaire survey that should stimulate the sectors to reconsider some questions and answers about regulatory and financial barriers and to make the improved survey regularly using the database provided on the Transenergy project web page (http://transenergy-eu.geologie.ac.at).

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