D.6.1.1. Summary report on SWOT analyses

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Compiled by Annamária Nádor (MBFSZ), Ágnes Rotár-Szalkai (MBFSZ), Nina Rman (GeoZS), Tamás Megyes (InnoGeo), Miklós Babóczky (Mannvit), Lidia Balan (IGR)

with contributions from (in alphabetic order):

László Ádám (Mannvit), Natalia – Silvia Asimopolos (IGR), Albert Baltres (IGR), Zsuzsa Bálintné Vörös (MFA), Sabit Begić (FZZG), Ivana Bobovečki (ZARA), Attila Csanadi (InnoGeo), Tamas Ezsias (InnoGeo), Radu Farnoaga (IGR), Nóra Gál (MBFSZ), Péter Gyöpös (Mannvit), Boban Jolović (GSRS), Petra Kiss (Mannvit), Ivana Koletić (MINGO), Andrea Kranowszky Nagy (Terratechnik), Éva Kun (MBFSZ), Andrej Lapanje (GeoZS), Tamara Marković (HGI), Darko Milanković (MSK), Silvija Pavić (ZARA), Igor Relić (MSK), Ferid Skopljak (FZZG), Natalija Samardžić (FZZG), Dragana Šolaja (HGI), Teodóra Szőcs (MBFSZ), Anca-Marina Vijdea (IGR), Ana Vranjes (FMG),

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INTRODUCTION

Delivering the Transnational Danube Region Geothermal Strategy for the enhanced and sustainable use of geothermal energy for heating in the Danube region is one of the outputs of DARLINGe. Drafting this strategy needs clear and concise inputs on the state-of-art, which was extensively investigated in WP5 in the following main areas: potential geothermal reservoirs, current uses with highlight on best practices, heat market, available financing schemes, as well as overview of regulatory frameworks in the partner countries.

Based on the results of these activities, a detailed SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) was performed for each topic and by each partner from its own perspective. The present report summarizes the common main points of the individual SWOT analyses and thus highlights the existing strengths and opportunities to build on, as well as the weaknesses and threats to be tackled in the future.

RESERVOIRS	
STRENGTHS	**WEAKNESSES**
• Favourable geothermal conditions on the entire DARLINGe area, elevated subsurface temperatures • Geothermal heat production is possible from relatively shallow depths (<1000 m) • There is a possibility to produce >100 °C hot water in some smaller regions • Extensive and productive Upper Pannonian porous aquifers (BF reservoirs) with regional extension and favourable hydrogeological conditions • Most of the reservoirs store water of atmospheric origin, therefore they are renewable on a long term • Thermal waters of the BF reservoirs have low mineralization with TDS less than 1000 mg/l, especially in shallower depths. These chemical conditions are favourable for smooth operations (no corrosion, scaling) • Due to sufficient number of drillings and wells and long-term history of exploitation from the porous aquifers, geological and hydrogeological conditions of the basin fill sediments, and flow systems are well known at regional scales, therefore exploration risk is low • Large number of synchronized data among partner countries • Jointly developed, universally applicable methodology for reservoir delineation and characterization	• Uneven spatial distribution of drillings, wells and areas for geothermal explorations, as a consequence unequal geological and hydrogeological knowledge within the project area • Overexploited areas due to concentrated thermal water abstraction and lack of reinjection • Poor research on water balance and sustainable production levels, e.g. numerical simulation of exploitation is not a standard tool • Poor knowledge on actual quantity and quality status of geothermal aquifers • Low level of investigation and poor 3D geological knowledge of basement reservoirs (BM) (e.g. fractures, hydraulic parameters, etc.), therefore high exploration risk • Recharge of some reservoirs is unevenly distributed • Locally challenging chemistry exists (high TDS, gases, aggressiveness of the water), which may cause operational issues and increase operational costs • Location of heat demand and potential reservoirs are not overlapping in many cases • Low level on active investigation at present, most of data were obtained more than thirty years ago, revision of archive data is missing • Data reliability and data accessibility vary in wide range, especially at local levels, uncertain data mostly about reservoirs depths, geothermal fluid temperatures • Language barriers (concerning data - data are available mostly in original languages) • Potential future investors sometimes don't have access to documentation on previously conducted investigations • Lack of share of knowledge and cross-fertilization with petroleum sector to mutual advantage

OPPORTUNITIES	THREATS
• Geothermal developments based on proven potentials: In each partner countries potential geothermal reservoirs exist to be used for heating. These reservoirs are delineated, characterized and their resources are roughly estimated. • Available data and knowledge serve as a good basis for further and more detailed investigations • Possibility to predict the best potential areas and provide guidelines for various types of geothermal use • More precise 3D spatial delineation of geothermal reservoirs, harmonised over regions and countries • Existing database for further cross-checking and confirmation • To get new information from international knowledge exchange and data harmonization • Applying new methods in geothermal exploration (3D seismic interpretations and 3D geological models, 3D flow and heat transport modelling etc.) • Possibilities of using state of the art and innovative exploration technologies	• Resource is "invisible" (underground) and therefore there is lack of understanding why to invest in research • Geothermal groundwater body delineation and characterization in accordance with WFD have not yet performed in most of the countries • High costs of new data acquisition (deep seismics, special chemical investigation…) • Exaggerating estimation of geothermal potential without sound verification • High cost of investigation of the basement rocks • Risk of unsuccessful drilling, especially into the basement reservoirs (BM) • CH production as concurrent use of the deep subsurface • Potential interaction with drinking water aquifers • Technical failure in reinjection in porous media • Large regional systems, therefore unfavourable conditions may impact distant areas • Under special geological conditions (e.g. salt layers) possible subsidence of the terrain during water pumping • Lack of monitoring: not sufficient info on production at regional level • CH_4 content can be a danger for explosion • Low interest in exploration exists in new regions with not- yet identified potential (without existing wells)

CURRENT UTILIZATION	
STRENGTHS	**WEAKNESSES**
• Knowledge on wells' status mostly proves their stable operational capacity for several decades • 767 identified geothermal objects with water of >30 °C prove large potential • As much as 51% of wells have temperature >50°C, favourable for various uses (space heating and sanitary hot water, industry, greenhouse heating, balneology and recreation, fish farming) • Almost 30% of objects are already used for various heat productions (space and water heating, greenhouse heating...) • No need for large storage of the energy source (like oil or gas operated systems) • Established contacts with service providers, manufacturers, users, stakeholders and authorities in the region result in mostly good knowledge on site ownership and licensing status • Detailed databases on well characteristics and operation exist in some countries • Production information (groundwater level, temperature, yield, chemistry) generally exists at regional scales • Good examples of direct utilization practice exist in all countries showing that cascade systems are energy efficient • Experience in wells' completion, operation and mitigation of operational issues (scaling, gases, TDS ...) has extensively increased over decades of thermal water use • Special chemical composition of water supports also balneological use besides the heat production • Mostly, there is sound knowledge on environmental impacts (positive or negative) of geothermal utilization and no subsidence is reported due to thermal water abstraction in the project area	• Backup energy resource is essential and electricity is needed to run heat exchangers and pumps • Restricted access to wells due to sometimes unclear property rights • Decrease in utilization in last decades due to weak request or investors' bankruptcy/insolvency in Romania • Some places (e.g. urban areas) it is very difficult (and expensive) to establish pipelines between wells and heat-user site (ownership, land access) • Lack of communication and poor knowledge sharing among users, professionals and authorities • Huge lack of skilled personnel in exploration and exploitation • About 70% of wells are older than 30 years. Generally, ageing of geothermal wells reduces their productivity, their condition is mostly unknown due to lack of proper testing. • Poor technical design of some wells requires large maintenance work shortly after operation • Poor reliability and non-uniformity of data due to absence of centralised database on wells and /or exploitation in some countries and limited access to it make it harder to elaborate realistic development strategies • In some countries limited documentation on wells, exploitation and in all countries missing info on changes (reports are missing or confidential) • Lack of adequate monitoring (even if established it is not uniformed or systematic) provides poor control over actual exploitation and status of aquifers • Authorities rarely check and evaluate e reported data • Hydraulic interaction between production wells due to their proximity may result in conflicts

	(stealing water from each other), also due to poorly or non-defined license areas • Production information (groundwater level, temperature, yield, chemistry) is very heterogeneous among sites and countries • Difficulties in system operation due to low quality level of construction works, non-appropriate maintenance, unsolved operational issues (degassing of CO_2 and/or CH_4, carbonate and silica scaling, corrosion, clogging, over-exploitation) • Bathing and balneology without energy use is still very common (24% of objects) • Low thermal efficiency due to high temperature of waste thermal water (even >30 °C) • Too few cascade use systems, even mixing with cold water instead of applying another heat extraction cycle prior to emission in surface waters • Inappropriate discharge of usually highly mineralized thermal waste water into surface waters causes environmental impacts, there is lack of monitoring of these effects
OPPORTUNITIES	**THREATS**
• Any water temperature above average annual groundwater temperature is a potential benefit to the user • Emerging direct-heat-use sector and tourism with many potential users in the vicinity of existing wells • New technologies provide opportunities to precisely control extracted and discharged thermal water by tailor-made monitoring systems • Evaluation of regional effects of exploitation should be a basis for planning further geothermal development in an environmentally-friendly way • Recognition of underdeveloped sites has been made within the project	• Long-term safe operation of existing wells are threatened by unknown number of illegal geothermal wells which produce water without licences • Little reinjection (5% of wells) already impacts the environment locally or regionally (drawdowns, outflow water temperature changes, ecosystems are affected), also with transboundary effects • No long-term user-site strategies of (sustainable) exploitation exist (e.g. lack of definition of maximum allowed production, maximum allowed drawdown in a well) • Slow decision-making on introduction of new technologies • Land use conflicts with other uses

area and shows great potential • Efficiency of utilization systems by applying cascade use, co-generation, abstraction adjusted to demand, reinjection… • Inactive wells can be used instead of drilling new wells to support the development • Licensed reserved (unused) abstraction amounts can be allocated to existing or new users (including hydrocarbon exploring wells) to promote further development • Benchmark evaluation can be used as a tool to support more efficient and sustainable exploitation of water and heat on a user, or regional level	• Very few educations programs on exploration and exploitation exist, resulting in lack of skilled technical managers and professionals • Difficulties to modify or adjust existing utilization systems • High allowed thresholds of waste thermal water chemistry and temperature do not support reinjection • In some countries no 3D protection zones are delineated around producing sites

HEAT MARKET	
STRENGTHS	**WEAKNESSES**
• Large heat demand at various temperatures near towns with high density of inhabitants, at industrial zones, shopping centres, building sector and agricultural areas • The density and number of cities with operating district heating system is high	• District heating systems are obsolete, they need fundamental renovations • Systems are designed for high temperature inlet water and not suitable to accommodate lower temperature thermal water • The use of geothermal sources in district heating is uncommon in large parts of the project area • Only few systems with sizeable heat demand are identified in the project area • Settlement infrastructure not favourable: many small rural villages scattered around and only few large cities • Poor energy performance of the buildings (lack of insolation) ask for bivalent system (additional sources) • Lack of integrated approach, knowledge and qualified manpower
OPPORTUNITIES	**THREATS**
• Best examples, lighthouse projects in district heating, individual space heating, agricultural, balneological utilizations • Development of resource parks • Industrial sector as a prosperous new player • Innovative and cheaper technologies, increased competitiveness • With geothermal heating the income remains in the region • Large number of district heating systems with and yet without geothermal energy may be switched to geothermal • Increased collaboration with other technologies and in cross cutting actions dealing with energy efficiency	• Lack of interest from users if other heating systems are (or seem) cheaper • There is a trend of dispatching from the DH network

FINANCES	
STRENGTHS	**WEAKNESSES**
• Regularly available, not repayable direct subsidy schemes in all DARLINGe countries • Regularly available, not repayable indirect subsidy schemes (e.g. combined with agricultural use) in some DARLINGe countries • Regularly available low interest loans in some DARLINGe countries with normal interest– • Financial risk decreased in many perspective zones by results of former geothermal explorations • Low operational and maintenance costs • Experienced tender writing companies (writing of subsidy tender applications, project management, full administration)	• Long, extensive, and expensive project development period (especially licensing and subsidy administration) • Expensive licenses and running fees in some countries (e.g. Slovenia) • High upfront investment cost coupled with high geological risk at the beginning, in case of unsuccessful drilling the private investor will lose its own capital and must pay back the already received subsidy too • Competitive disadvantage: in other renewable energy projects almost all project risks can be eliminated in the preparation phase before the significant part of the investment becomes necessary • More investment is needed (e.g. expensive drillings) than for other renewable sources (e.g. biomass) • It is hard to get financing for the first well as there is a chance for unsuccessful drilling • In many cases available support schemes are available only for a restricted type of beneficiaries • Available support schemes have limited subsidy amount, in many DARLINGe countries it is a relative small amount • Limited access to European development funds, especially for non-EU-member states • Lack of any type of risk mitigation/insurance funds in DARLINGe countries, • Lack of any type of operational support schemes in DARLINGe countries, • Lack of an institutional body offering business consulting and guidance for the geothermal investors

OPPORTUNITIES	THREATS
• Ambitious NREAP and Europe2030 climate and energy targets will put pressure on decision makers to create a favourable political and administrative environment to encourage investment into development of geothermal (RES) projects • Growing interest of investors, municipalities for renewables, • Lower risk for investment into projects targeting the well-known porous media reservoir • Higher rate of possible EU-funds, especially for new-comers and for accession countries in the future (SRB, BH) • Lobbying for funding in future RDI programs (e.g. FP9) • Establishing geological risk mitigation schemes • Establishing operational support schemes • Promote calls for district heating and agricultural use • Learn from good examples for effective financial support schemes in several European countries (The Netherlands, Iceland, France) • Clear information on investment and operational costs to be provided to public to prevent misconception on actual costs in comparison to other energies • Experience in production and selling of geothermal gases for industrial use (CO_2) or co-generation of heat (CH_4) thus increasing the economy of the project • Decreasing of specific investment costs by applying co-generation of power and heat • Geothermal energy is connected to the tourism, health system and agriculture, thus geothermal projects can be incorporated into larger investments in these fields • Cheaper labour costs, drilling costs in the region • Reducing licensing fees for the use of geothermal water in heating systems	• Unfair competition with regulated and low fossil (natural gas) prices in some countries • Regulated DH prices in some countries (e.g. Hungary) • Other energy sources (nuclear, fossil) have priorities in national energy strategies • Financial markets have shown a poor understanding of geothermal development projects and tend to overestimate resource risk • Low-interest of the financial sector for investment in geothermal energy, projects are still not bankable in the exploration phase due to geological risk • Lack of capital especially at project start • Very limited financial resources for the users to renew or further develop the existing systems • Lack of the knowledge about financial supporting mechanisms at EU level • Decisions on selection of projects to be funded take too long time • Little or no national funding of basic research to identify new potential • A large number of fees for the use of thermal water, often with double taxation (water fee, mining royalty)

NATIONAL REGULATORY FRAMEWORK	
STRENGTHS	**WEAKNESSES**
• Partner countries are either EU members, or are in accession, which means that they are obliged to adopt relevant EU regulatory framework (especially Water Framework Directive, RES Directive) • Geothermal resources are state owned • Exploration, use and protection of geothermal energy is included in national legislations • The construction and operation of thermal wells require authorizations in all partner countries; • Authorities are interested in adopting better regulations • Authorities support participation in international projects that can contribute to harmonization of the national laws with EU regulations • Geothermal energy is implemented into national energy strategies and National Renewable Energy Action Plans	• In all partner countries the regulatory framework for exploiting geothermal resources is particularly complex. The procedures for obtaining a concession / license for the exploitation of geothermal resources are regulated by several laws/acts. It is often unclear what regulations should be followed • Non-harmonised water and mining sector requirements and procedures • There is no clear distinction between the competences of different authorities • Different interpretations of regulations by different authorities • Because of the vague interpretation, laws are often subject to change • Laws often far from reality, many exemptions • In some countries data collection is hampered by regulations for data protection; • Non existing by-law documents for geothermal water reinjection • Geothermal resources protection are regulated on low level • In national strategies/policies, geothermal energy has a low priority • Legislation is not based on expert opinion, but is often influenced by political lobbying • Licence and/or its content is not public in some countries
OPPORTUNITIES	**THREATS**
• Develop policy recommendations for decision makers with respect to geothermal energy and renewable contributions in future national, regional (Danube Region) and EU energy landscape • Improve, or prepare new laws and make a faster and more transparent licensing system • Make a more transparent and coherent regulatory framework based on good examples • Make a guide for investors/potential	• Lack of political engagement, passivity of decision-makers, bureaucracy • Frequent changes in regulations • Slow adoption of laws and implementing acts • Impossibility to apply regulations in practice • Due to the complexity of the regulatory framework, potential investors and project operators can be demotivated to start a geothermal project;

users about legal procedures for obtaining permits on exploration and use geothermal energy • Prioritizing geothermal energy in energy strategies and policies at all levels of government in the country	• Long duration of licensing procedure