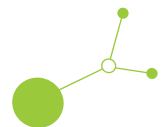
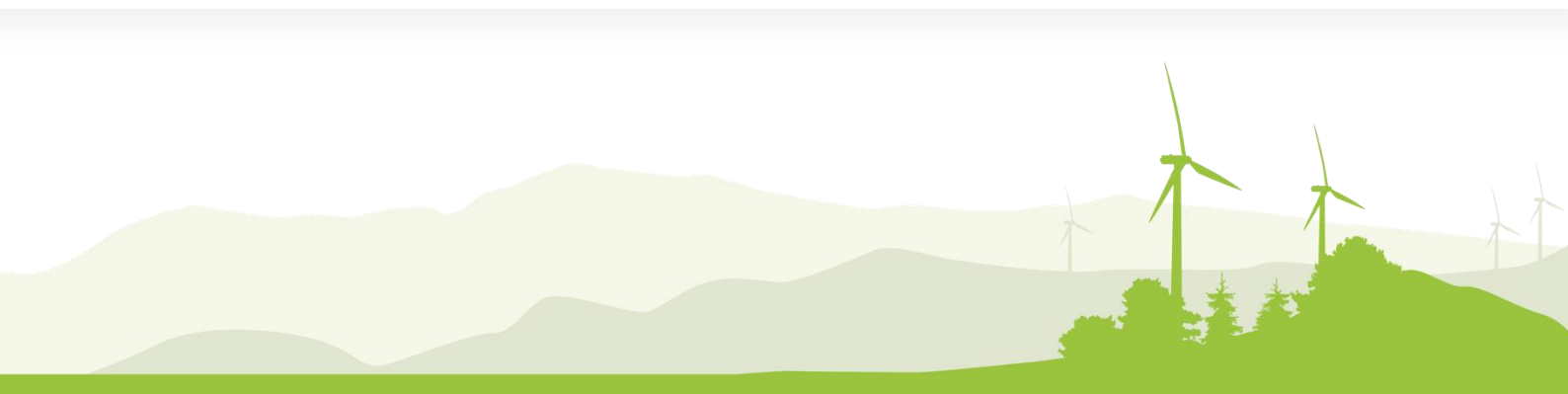


Transnational Action Plan with intervention set for geothermal reuse of abandoned hydrocarbon wells

TRANSGEO Deliverable 3.3.1



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D.3.3.1 TRANSNATIONAL ACTION PLAN WITH INTERVENTION SET FOR GEOTHERMAL REUSE OF ABANDONED HYDROCARBON WELLS

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Glossary / List of Abbreviations

Well (borehole, wellbore)	A well is a hole drilled into the ground, to produce or inject fluids from/to the subsurface or to explore the subsurface.
Active	A well that is currently in use. It either produces the resource for which it was constructed or a fluid (e.g., wastewater or gas) is injected through it
Inactive, shut - in	No production or injection of liquids or gases in a certain time span, which could be 3 - 12 months (no clear definition). Shut - in wells may have been removed from active service in anticipation of workover, temporary abandonment, or plugging and abandonment operations. Generally, the well condition is such that its utility may be restored by opening valves or by energizing equipment involved in operating the well. Shut - in status should begin three months after production, injection, disposal, or workover operations cease.
Partly (temporarily abandoned)	All the downhole (artificial) lift equipment and tubing is removed, and a cast iron bridge plug is set. A temporarily abandoned well can be put back in production. Temporary abandonment should be used when an operator is holding a wellbore in anticipation of future utilization, such as in an enhanced oil recovery project. This status should begin the day after the completion interval has been isolated from the wellbore.
(Permanently) abandoned (liquidated, suspended, decommissioned)	Setting of a bridge plug and cement on top of it, cut off of wellhead and reclamation of the land. Wells that have been permanently abandoned have been backfilled to the surface or cemented (with cement plugs from the surface). In most cases they are not suitable for geothermal purposes, especially not for closed loop or storage applications, but the information that can be obtained from them can be useful in the design of geothermal projects planned in their vicinity, provided that there is a suitable market.
Orphan well	There is no identifiable owner of a well.
Reuse, repurpose	The use of an oil or natural gas well for another purpose after production or drilling is finished. Multiple sections of a well can be cemented.
Workover	Any operation done on, within, or through the well after the initial completion (e.g., artificial lift installation, acid stimulation, scale and paraffin removal, hydraulic fracturing, sand control, etc.).
Recompletion	Activity intended to access a new source of supply from a reservoir that is accessible from an existing well with new/changed subsurface equipment. Well reuse could need a recompletion.
DBHE	Deep Borehole Heat Exchanger
BTES	Borehole Thermal Energy Storage
ATES	Aquifer Thermal Energy Storage



HE	Hydrothermal Energy
EGS	Enhanced Geothermal System
UTES	Underground Thermal Energy Storage
PTES	Pumped Thermal Energy Storage
MTES	Mine Thermal Energy Storage



Executive Summary

This **Transnational Action Plan with intervention set for geothermal reuse of abandoned hydrocarbon wells**, represents one of the final key outputs developed by the consortium of the project TRANSGEO - Transforming abandoned wells for geothermal energy production, which aims to foster a more targeted, market oriented and sustainable use of geothermal energy applications in Central Europe. To achieve this goal, 11 organizations from 5 Central European countries (Austria, Croatia, Germany, Hungary, and Slovenia) combined their expertise and practical experience to jointly compile concrete steps, recommendations and guidelines, which are intended to support both public and private stakeholders in advancing the ongoing energy transition in their regions. Furthermore, the document and its findings reflect, exclusively, the views of the authors.

The development of this document was primarily based on the findings and results presented in the **Transnational Strategy for the structural change of fossil fuel producing regions to geothermal**, whereby it was demonstrated that the 5 observed countries possess considerable potential for geothermal energy utilization through repurposing of abandoned hydrocarbon infrastructure. Significant constraint is, however, present due to legal, social, technical, environmental and financial gaps and barriers that either slow down or completely halt and complicate the utilization process. To address these identified shortcomings, a set of targets and steps has been defined and structured around 4 main Categories: legal, knowledge and social frameworks; technological opportunities; environmental impacts; and financing instruments.

In this context, each Category encompasses a range of Strategic Objectives, Priorities and Measures, including improvements to legislative and educational frameworks, strengthening technological readiness, promoting environmental protection and enhancing financial capacity and, together, these elements provide a structured approach and practical guidance for facilitating the reuse and employment of infrastructure remaining from former hydrocarbon production. A total of 43 Measures establish a pathway and create opportunities for future planning, strategic thinking and potential geothermal investments by utilizing abandoned hydrocarbon wells. Additionally, monitoring methods and risk mitigation actions represent further insurance for a timely and adequate implementation of the Transnational Action Plan.

Prepared within the project TRANSGEO, this document, together with the Transnational Strategy, does not carry binding authority. Its value lies mainly in its advisory role, providing steps and recommendations that can serve as a reference for future actions and foster positive changes at national, regional, and local levels in the Central European region. Finally, the content of both documents is intended as a voluntary guide for public and private stakeholders, to be implemented in accordance with their legal frameworks, expertise, personnel, financial resources and time related capacities.

The project TRANSGEO (<https://www.interreg-central.eu/projects/transgeo/>) is co - funded by the European Regional Development Fund through the Interreg Central Europe 2021 - 2027 program. The overall objective of the project TRANSGEO is to investigate the potential to transform abandoned hydrocarbon (natural gas and oil) wells into new sources of green geothermal energy. To reach this goal, the TRANSGEO partner organizations are providing new tools and knowledge to support communities and industries in the energy transition and to break down economic and technical barriers to well reuse.



1. Empirical background of the Transnational Action Plan

Geothermal energy is considered to be one of the most reliable and stable resources in the world. Unlike solar or wind power, its availability does not depend on weather conditions, making it highly suitable for continuous production of heating, cooling and electrical energy. Furthermore, geothermal energy reduces GHG emissions, contributes to long - term cost savings, supports regional and local energy independence, enables continuous sustainable development and use of more efficient technical solutions.

As an energy resource, geothermal energy is, usually, exploited through newly drilled wells and corresponding infrastructure, although recent research shows that a significant amount is hidden in the existing hydrocarbon systems. Drilled natural gas and oil wells, where end of production resulted with proper sealing, liquidation and abandonment of the field, contain either large underground aquifers of warm water or maintain adequate temperatures of the soil, which present quality predispositions for energy production and its use for heating, cooling, electricity and storage, as well as in sectors such as agriculture, industry, balneology, housing and other.

Furthermore, Central Europe is considered to be one of the largest geothermal regions, with significant potential being present due to diverse geological structures, sedimentary basins and tectonic features. Thereby countries such as Austria, Croatia, Germany, Hungary and Slovenia have varying levels of geothermal potential, with some areas actively using it for heating, cooling and electricity production, agriculture and balneology, mainly through newly drilled wells, while the utilization of geothermal energy from abandoned hydrocarbon infrastructure is underrepresented.

To tackle the existing barriers and foster further energy exploitation, one of the documents arising from the project TRANSCEO - Transforming abandoned wells for geothermal energy production is the **Transnational Strategy for the structural change of fossil fuel producing regions to geothermal**. This extensive document divided into 6 Chapters and covering the topics of strategic, legislative and legal frameworks, overall geothermal and well repurposing potential, environmental impacts and financing opportunities in 5 countries of the consortium (Austria, Croatia, Germany, Hungary and Slovenia) presents one of the first steps in transitioning away from traditional exploitation methods based on newly drilled wells towards the utilization of energy from abandoned hydrocarbon infrastructure.

In addition to being based on theoretical considerations, the Transnational Strategy also summarizes the main identified challenges and bottlenecks regarding the repurposing of hydrocarbon wells on country level and proposes several Strategic Objectives, Priorities and corresponding Measures for a smoother transition from fossil fuel based energy to geothermal resources. Divided into 4 main Categories (legal, knowledge and social frameworks; technological opportunities; environmental impacts; and financing instruments), the Strategic Objectives, Priorities and Measures are the main input for the development of this **Transnational Action Plan with intervention set for geothermal reuse of abandoned hydrocarbon wells**, whereby each of the Measures is elaborated in detail through activities, organizational and human resources, timeframes, estimated amounts, funding sources and expected outputs. Structured in this way, the Transnational Action Plan serves as a comprehensive and practical framework, offering guidance to public and private stakeholders in advancing the efficient, sustainable, and long - term utilization of geothermal energy from abandoned hydrocarbon wells in Central Europe and beyond.

Although developed as an extension of the Transnational Strategy and within the project TRANSCEO, the Transnational Action Plan, is prepared taking into consideration several EU strategic and planning documents, whereby its content is aligned with and follows concepts and approaches aimed at promoting geothermal energy, its utilization methods, technological innovations, long - term benefits, financing opportunities and overall efficiency. Related to the mentioned, the Transnational Action Plan complements the following EU level strategic frameworks and planning instruments:



- EU Strategy on Heating and Cooling (published in 2016, with an updated version titled EU Heating and Cooling Strategy planned in 2026)
- Green Deal Industrial Plan for the Net - Zero Age (published in 2023)
- Strategic Energy Technology (SET) Plan - Geothermal Implementation Plan (published in 2023)
- European Geothermal Action Plan (planned in 2026).

The most relevant policy document for this Transnational Action Plan is the European Geothermal Action Plan, which will be released in 2026 and used by EU authorities as investment - oriented guidance on geothermal energy. Through accelerating the deployment of various geothermal solutions across different applications, the European Geothermal Action Plan will shape regulatory and financial rules to build frameworks for geothermal exploitation, as well as its use in heating, cooling, electricity and storage. Once released, the document will focus on and contribute to the achievement of international targets such as reaching the 250 GW of geothermal capacity by 2040 on EU level, development of specific financial instruments to leverage private capital, fostering more efficient permitting procedures and better access to geological data, peer - to - peer learning to help governments develop national and regional roadmaps for removing barriers, acceleration of investments and building supply chains, growth of skilled workforce across the geothermal value chain, collection of market data and statistics to enable better energy modelling and inclusion of geothermal energy as one of the central pillars of a global energy transition (European Geothermal Energy Council, 2025). While addressing Europe's overall geothermal potential, the European Geothermal Action Plan will not be fully aligned with the objectives of this Transnational Action Plan. However, it can form a part of a broader set of recommendations aimed at enabling a more efficient, sustainable and climate neutral energy transition through the deployment of geothermal energy.

In addition, while existing policy documents primarily focus on utilizing geothermal energy through newly drilled wells, the Strategic Objectives, Priorities and Measures outlined in this Transnational Action Plan highlight the potential of repurposing abandoned hydrocarbon infrastructure as sources of geothermal energy. Since this approach is not yet widely recognised at higher policy levels, the Transnational Action Plan is intended primarily as practical guidance and a preparatory document for national, regional and local public and private stakeholders in their future plans and initiatives to harness the untapped potential of abandoned hydrocarbon wells in their regions. Considering that the document includes numerous Measures of varying complexity and difficulty, its implementation period is planned for 14 years, from 2026 to 2040. During this time, most Measures are expected to be completed or at least initiated, which strongly depends on the availability of organizational, human and financial resources as well as the realisation possibilities in the 5 countries of the consortium. Finally, as the Transnational Strategy, this Transnational Action Plan is the result of the collaborative efforts of the partner organizations involved in the project TRANS GEO, which consolidates their practical knowledge, expertise and experience in the development of a high quality guidance document, that could be widely applicable in the Central European region.

As previously mentioned, the development of this Transnational Action Plan is grounded in the Transnational Strategy, which outlines the key geothermal potentials of the 5 countries of the consortium and provides a foundation for the detailed elaboration of the defined Strategic Objectives, Priorities and Measures. To ensure a clear understanding of the rationale behind this document, the following sections present a concise overview of the most significant characteristics of the 5 countries of the consortium, including legislative frameworks, geothermal and well repurposing potential, environmental standards and available financing instruments. This overview further emphasizes the importance of the Transnational Action Plan in facilitating future investments and promoting repurposing of abandoned hydrocarbon wells for geothermal energy utilization.



AUSTRIA

Topic	Summary	Key numbers/examples
Context and strategic direction	- Geothermal energy is increasingly recognised in national climate and energy strategies - Focus on expanding geothermal district heating in urban areas - Policy discussions aim to accelerate the deployment of deep geothermal heat	- The National Energy and Climate Plan (NEKP) includes geothermal heat development - Potential supply target: up to ~500.000 residential units
Resource and regional characteristics	- Main geothermal regions are located in the Vienna Basin and the Austrian Molasse Basin - Resources are mainly hydrothermal within sedimentary basin structures - Geothermal resources are well - suited for district heating applications	- Vienna Basin geothermal development is concentrated around the Vienna metropolitan area
Existing assets relevant to repurposing	- Long history of hydrocarbon exploration provides a large legacy well database - Significant infrastructure and geological data available from past oil and gas operations - Many wells require screening for integrity and technical suitability	- Vienna Basin: ~3.357 natural gas and oil wells - Austrian Molasse Basin: ~666 wells
Technology pathways and repurposing suitability	- DBHE and BTES appear most suitable among assessed repurposing technologies - Closed - loop technologies are preferred due to reduced groundwater interaction - Many wells are classified as unsuitable due to strict screening criteria and age	- Vienna Basin suitable wells: • DBHE: 255 wells (7,6%) • BTES: 234 wells (7,0%) • HE: 191 wells (5,7%) - Molasse Basin suitable wells: • DBHE: 73 wells (11,0%) • BTES: 64 wells (9,6%) • HE: 50 wells (7,5%)
Regulatory/ permitting/ governance	- Geothermal development is regulated mainly through the Mining Act and Water Rights Act - Multiple permitting procedures required depending on project type - Policy discussions ongoing to clarify geothermal regulatory framework	- Key laws: Mineralrohstoffgesetz (Mining Act) - Wasserrechtsgesetz (Water Rights Act)
Main environmental risks/impacts	- Potential groundwater contamination from poorly sealed wells - Integrity issues linked to ageing hydrocarbon wells - Environmental risks vary depending on technology (open vs. closed systems)	- Higher environmental interaction risk for open - loop systems (e.g., ATES, HE)
Mitigation and monitoring Measures	- Well integrity assessment before repurposing (logs, pressure tests) - Retrofitting or repair of casing and cement where necessary - Environmental monitoring during operation - Closed - loop systems reduce environmental interaction	- Integrity assessment required before reuse decisions



Financing landscape (public and private)	- National financing instruments supporting geothermal and renewable heat deployment - Transnational (EU) financing instruments supporting research and demonstration projects - Increasing availability of green financing instruments	- EU programs: Horizon Europe and Cohesion funding
Risk mitigation instruments	- Risk - sharing instruments proposed to reduce exploration and drilling uncertainty - Public support mechanisms under discussion to support geothermal investments	- Exploration risk mitigation schemes under development
Examples	- Development of geothermal district heating projects in the Vienna region - Increasing integration of geothermal energy into urban heat planning	- Vienna Basin projects under exploration and development

CROATIA

Topic	Summary	Key numbers/examples
Context and strategic direction	- Geothermal Potential Development Plan of the Republic of Croatia until 2030 (2023) - NRRP funding for exploration - Strong institutional role of Croatian Hydrocarbon Agency (data room)	- As part of the strategy to increase the geothermal share, the first steps were taken in 2018 through the new Hydrocarbon Exploration and Exploitation Act, the establishment of a centralised well data room, including geological and geophysical data
Resource and regional characteristics	- Croatian part of the Pannonian Basin (CPB) - Mura, Drava and Sava depressions	- CPB elevated geothermal gradient ($-0,049^{\circ}\text{C/m}$) - The Drava depression is the most prolific region of the CPB for geothermal development
Existing assets relevant to repurposing	- Numerous hydrocarbon exploration and production wells are located in CPB - 2D and 3D seismic data - Geothermal Virtual Data Room, which covers well data and geophysical (2D and 3D seismic data, magnetotelluric data) of the CPB	- Almost 4.000 wells were drilled until today - Most of these wells were drilled during the 1960s, 1970s and 1980s
Technology pathways and repurposing suitability	- The reuse potential of the 115 wells in the Croatian database, for the 5 reuse technologies - The highest suitable wells for reuse are for DBHE - Many wells are classified as uncertain due to strict criteria, but some may still be suitable after a detailed investor assessment	- Pannonian Basin suitable wells: • DBHE: 24 wells (20,8%) • BTES: 14 wells (12,2%) • HE: 17 wells (14,8%) • EGS: 10 wells (8,7%)



Regulatory/ permitting/ governance	- Main laws: • Hydrocarbon Exploration and Exploitation Act • Environmental protection legislation • Spatial planning legislation • Related ordinances (fees, reserves, technical standards) - Permits for the construction and utilization of subsurface facilities and equipment are required from the ministry responsible for energy, while permits for the construction of accompanying surface infrastructure (e.g., power plants) are required from the ministry responsible for construction - Public tender for exploration licence	- 5 - year exploration phase - Drilling and EIA required - Determination of reserves - Exploitation filed determination - Production licence (max 25 years) - Main bottlenecks: • Administrative complexity • Spatial planning alignment • Financial guarantees burden - Regulatory fragmentation (no unified geothermal framework)
Main environmental risks/impacts	- Groundwater contamination and induced seismicity - Surface disturbance: noise and traffic during drilling - Risks specific to repurposed wells, casing and cement degradation and legacy hydrocarbon contamination	- Many wells are old and their condition is uncertain, making technical adaptation challenging
Mitigation & monitoring Measures	- Mandatory environmental impact assessment - Well integrity assessment (logs and pressure tests) - Retrofit and repair before reuse - Reinjection of geothermal fluids - Monitoring (baseline and operational) - Decommissioning guarantees - Contingency planning	- The decommissioning guarantee must be valid for 180 days after the end of the exploration period
Financing landscape (public and private)	- National grants/subsidies: NRRP geothermal heating projects, state - supported preliminary exploration - Transnational (EU) financing instruments: National Recovery and Resilience Plan (NRRP), ERDF/Interreg, Horizon Europe - Development banks/guarantees: structured bank guarantees under licensing model - Blended finance: public exploration and private development model	- The value of approved projects is over 50.000.000 EUR from NRRP
Risk mitigation instruments	- Exploration phase without fees - Public co - funded exploration drilling (NRRP) - Geological risk reduction via Agency - led surveys - Mandatory bank guarantees structure	- The exploration phase lasts 5 years and can be extended twice by 6 months



Examples	- As of June 2025, 24 exploration licenses and 11 exploitation licenses for geothermal waters are active in Croatia - As of January 2026, 23 exploration and 13 exploitation fields for geothermal waters are active in Croatia - 4 preliminary exploration areas for district heating (2 of them expired) and 1 for geothermal exploration	- InnoGeoPot (HRZZ project, 2024 - 2028) - ongoing - NRRP geothermal drilling program (Velika Gorica, Zaprešić, Osijek, Vinkovci), whereby the drilling was successfully completed - Korenovo (near Bjelovar) development phase - Slatina 2, Legrad 1, Babina Greda 1 - exploitation licences (drilling/ preparatory phase)
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GERMANY

Topic	Summary	Key numbers/examples
Context and strategic direction	- Strong growth of near - surface geothermal since the 2000s - Government incentives support geothermal district heating and electricity - National strategy aims to expand geothermal deployment and reduce emissions	- Federal geothermal expansion plan in 2022 - Target: 50% climate - neutral heat by 2030 - 10 TWh geothermal heat and 100 additional projects planned
Resource and regional characteristics	- Three main geothermal regions in Germany - Large hydrothermal projects mainly in the South German Molasse Basin - The North German Basin hosts many hydrocarbon wells relevant for repurposing	- Main regions: South German Molasse Basin, Upper Rhine Graben, North German Basin - Temperature range: <25 °C (<400 m) shallow; 25 - 200 °C (>400 m) deep - Temperature gradient NGB: ~32 °C/km
Existing assets relevant to repurposing	- Legacy wells from natural gas and oil, coal, storage and mineral exploration - Many wells are old or abandoned and require careful screening - Data accessibility has been regulated under GeolDG since 2020	- Hydrocarbon exploration mainly from 1950s until 1980s - The majority of wells are old or abandoned with uncertain integrity
Technology pathways and repurposing suitability	- Several geothermal reuse technologies assessed - DBHE and BTES show the strongest suitability among technologies - Suitability varies between basins and depends on well condition	- North German Basin: • DBHE: 1.803 wells (60,6%) • BTES: 1.320 wells (44,4%) • HE: 999 wells (33,6%) • ATES: 721 wells (24,2%) • EGS: 462 wells (15,5%)



Regulatory/ permitting/ governance	- Geothermal development governed by federal mining law and water regulations - Exploration and production permits issued by State Mining Authorities - Permitting is often complex due to multiple approvals and public participation	- Main law: Bundesberggesetz (BBergG) - Exploration requires permits, production requires licences
Main environmental risks/impacts	- Well integrity issues represent the main technical and environmental risk - Potential impacts include groundwater contamination, seismicity and emissions - Risks vary by technology type	- ATEs: groundwater contamination risk - HE: reinjection required to avoid aquifer disturbance - EGS: induced seismicity risk
Mitigation and monitoring Measures	- Integrity testing and monitoring are required before geothermal production - Environmental impact assessments are often required - Retrofitting and repair may be necessary for older wells	- Integrity tests required before production - Monitoring of groundwater and seismicity
Financing landscape (public and private)	- Geothermal projects funded through public subsidies, loans and transnational (EU) financing - Support programs exist for district heating and geothermal heat pumps	- National subsidies and credit schemes for deep geothermal (>400 m) - Transnational (EU) financing instruments and development bank loans
Risk mitigation instruments	- Risk - based financing instruments support geothermal exploration and drilling - Insurance schemes and loans available for geothermal projects	- Exploration risk insurance and loans introduced since 2025
Examples	- Several geothermal projects are under development in Germany, mainly for district heating	- Large - scale geothermal projects in the Molasse Basin and Upper Rhine Graben

HUNGARY

Topic	Summary	Key numbers/examples
Context and strategic direction	- Strategic planning for geothermal energy began in the late 1950s - Several national strategies support geothermal deployment - Transnational (EU) co - financed programs support geothermal development - Geothermal energy is used mainly for heat production - National strategy aims to significantly increase geothermal use and reduce natural gas dependence	- Hungary Renewable Energy Utilization Action Plan 2010 - 2020 - National Energy Strategy 2030 in 2011 - National Geothermal Strategy in 2024 - Geothermal baseline in 2024: 6,4 PJ, including 3,1 PJ heat production - Target: 12 - 13 PJ by 2030 - Expected gas replacement:



		0,5 - 0,7 billion m ³ by 2030
Resource and regional characteristics	- Strong geothermal potential linked to the geological characteristics of the Pannonian Basin - Reservoirs are mainly associated with Mesozoic carbonates and Upper Pannonian sandstones - Region well explored due to extensive hydrocarbon exploration history - Data availability exists, but accessibility is limited	- Key reservoirs: Mesozoic carbonates, Upper Pannonian sandstones
Existing assets relevant to repurposing	- Large hydrocarbon exploration legacy provides numerous wells - Many abandoned wells could potentially be repurposed for geothermal uses - Most abandoned wells are older than 30 years - Documentation and accessibility of well data are limited	- 1.157 geothermal wells - 8.000+ hydrocarbon wells - 2.258 abandoned wells deeper than 400 m
Technology pathways and repurposing suitability	- Multiple repurposing technologies are considered feasible - DBHE and BTES appear among the most promising pathways - HE exploitation is also possible - EGS potential exists but is limited	- Estimated reusable hydrocarbon wells: • DBHE: 679 wells, 0,917 PJ heat (10,1%) • BTES: 10,2% • ATES: 1,1% • HE: 249 wells, 2,017 PJ heat (3,7%) • EGS: (33 wells) 0,5%
Regulatory/permitting/governance	- Multiple legal instruments govern geothermal development - Mining legislation provides the main legal framework - Dedicated regulatory bodies oversee exploration and production - Exploration and production licensing procedures exist but require refinement - Repurposing oil wells for geothermal use is not prohibited	- Act LXIV of 2022 modifying earlier legislation - Act XLVIII of 1993 on Mining (geothermal subchapter) - Exploration licence duration: 4 years - Production licence: up to 35 years, renewable once - Regulatory bodies: SARA, Geothermal Energy Commission
Main environmental risks/impacts	- Limited reinjection of geothermal water leads to environmental and reservoir sustainability issues - Reinjection sometimes occurs at excessively high temperatures - Decreasing reservoir pressure due to insufficient reinjection - Potential gas emissions from abandoned wells converted for geothermal use	- Lack of reinjection: Szentes, Nagyatád - High - temperature reinjection: Békéscsaba, Szeged - Reservoir pressure decline: Szentes



Mitigation and monitoring Measures	- Well integrity inspection required before repurposing - Safety precautions are necessary when inspecting abandoned wells due to accumulated gases - Documentation quality varies significantly across wells - Some potentially productive aquifers were not originally perforated or assessed	- Integrity testing cost: 100.000 - 500.000 EUR per well
Financing landscape (public and private)	- Multiple national and transnational (EU) funding programs support geothermal projects - Transnational (EU) financing instruments complemented by national programs - Funding available for district heating, geothermal heat pumps and infrastructure modernization	- Swiss - Hungarian Program: 5.000.000.000+ HUF grants - Horticultural geothermal development: 50.000.000.000 HUF program - Home Renovation Program: 73.000.000.000 HUF - Jedlik Ányos Energy Program: 450.000.000.000 HUF total, 42.000.000.000+ HUF for geothermal projects
Risk mitigation instruments	- Public support schemes exist to reduce geothermal exploration and drilling risks - Subsidies available for the first geothermal production wells - Additional support provided for converting unused hydrocarbon wells to geothermal use	- Jedlik Ányos Program: 10.000.000.000 HUF for drilling risk reduction - Subsidy per project: 40.000.000 - 1.000.000.000 HUF
Examples	- Several geothermal district heating and pilot projects demonstrate geothermal deployment in Hungary	- Szeged Geothermal District Heating Project (95% of 27.000 apartments served) - Szentlőrinc Geothermal Heat Plant (3,1 MW) - Zugló District Heating Project (under construction) - Miskolc District Heating Project - WeHEAT closed - cycle geothermal pilot



SLOVENIA

Topic	Summary	Key numbers/examples
Context and strategic direction	- National Energy and Climate Plan (2021 - 2030) recognises geothermal potential, but implementation remains limited - Development mainly driven by pilot projects and private investors - Policy focuses on reinjection systems and repurposing abandoned hydrocarbon wells	- 1 geothermal district heating system (Lendava) - 10 hydrothermal sites without reinjection, 2 developing reinjection
Resource and regional characteristics	- Highest geothermal potential in NE Slovenia (Pannonian Basin) with cross - border aquifers shared with Hungary - SE Slovenia and other basins (Ljubljana, Celje) are less explored but show elevated geothermal gradients	- NE Slovenia: 150 - 200 °C at ~4 km depth - Resource base: 957 EJ (3 km) / 2.597 EJ (5 km) - SE Slovenia stored heat: ~6,8 EJ
Existing assets relevant to repurposing	- Several abandoned hydrocarbon wells identified as candidates for geothermal pilot projects - National geothermal database maintained by the Geological Survey of Slovenia (GeoZS) - Pilot projects testing reuse technologies are already underway	- ~250 wells drilled in Slovenia - Si-Geo-Electricity pilot geothermal plant in an abandoned natural gas well
Technology pathways and repurposing suitability	- Most wells are classified as uncertain and require detailed technical assessment before reuse - ATES, DBHE and BTES show the strongest relative suitability - DBHE considered favourable due to limited groundwater interaction	- Pannonian Basin: • ATES: 2 wells (0,8%) • DBHE: 2 wells (0,8%) • BTES: 2 wells (0,8%) • HE/EGS: 0 wells (0,0%)
Regulatory/ permitting/ governance	- Geothermal activities are regulated through multiple laws and permitting routes - Three exploration pathways: mining - based, water - based and geothermal electricity concession - Regulatory fragmentation and administrative complexity remain key barriers	- Main laws: Mining Act (ZRud - 1), Water Act (ZV - 1), Environmental Protection Act (ZVO - 2) - Exploration phase: up to 25 years - Production licence: maximum 25 years
Main environmental risks/impacts	- Risks include groundwater contamination, induced seismicity and drilling impacts - Repurposed wells may present integrity issues due to ageing infrastructure - Old wells may contain casing or cement degradation	- Many wells are old with uncertain integrity, complicating reuse
Mitigation and monitoring Measures	- Environmental impact assessment required - Well integrity assessment and retrofitting before reuse	- Decommissioning guarantees required and valid 180 days after the exploration period



	- ReInjection and continuous monitoring recommended	
Financing landscape (public and private)	- Public funding supports geothermal pilot projects and district heating development - Transnational (EU) financing instruments support cross - border geothermal cooperation and research - Private investors are involved mainly in pilot and demonstration projects	- NRRP funding for geothermal pilots and district heating - Transnational (EU) programs: Interreg, Horizon Europe - Project value: ~1 - 3 million EUR
Risk mitigation instruments	- Public co - financing of exploration and geological surveys - Mandatory financial guarantees for well decommissioning - Technical risk mitigation through integrity testing and reinjection	- Standard exploration period: 5 years (extendable twice by 6 months)
Examples	- Several geothermal pilot and research projects are underway - Limited but growing development pipeline	- Si-Geo-Electricity pilot project - Danube GeoHeCo (2024 - 2026) - Lendava geothermal district heating system - 1 exploration licence and 34 exploitation licences active in 2025



2. Strategic Objectives and Priorities with Measures for well repurposing in Central Europe

Action plans are generally defined as detailed roadmaps and decision - making tools, which outline specific steps needed to achieve a goal or complete a project, breaking down larger objectives into smaller, manageable tasks with assigned responsibilities, timelines and planned indicators of success. The core purpose of every action plan is to provide tailored solutions, recommendations and advice for addressing challenges in specific areas, as well as to offer practical guidance for mitigating potential risks and minimizing the negative impacts of planned projects or investments. Finally, the true value of every action plan is reflected in the detailed elaboration of its Strategic Objectives, Priorities and corresponding Measures, whereby only the latter are considered an obligatory component of the document.

As mentioned, the **Transnational Action Plan with intervention set for geothermal reuse of abandoned hydrocarbon wells** is a practical extension of the **Transnational Strategy for the structural change of fossil fuel producing regions to geothermal**, with the aim of providing specific knowledge, practical advice and focused steps on utilization of geothermal energy through repurposing abandoned hydrocarbon wells. To ensure transparency and usability, the Transnational Action Plan follows the structure of the Transnational Strategy, dividing its content into Categories, corresponding Strategic Objectives and Priorities, as well as clear and in detail elaborated Measures required for a successful achievement of energy and climate targets in Central Europe.

Related to the above and in line with the Transnational Strategy, this Chapter contains detailed, tailored and practical solutions divided as follows.

Table 1: Distribution of the Strategic Objectives, Priorities and Measures per Category

Categories	Strategic Objectives	Priorities	Measures
Legal, knowledge and social frameworks	3	6	16
Technological opportunities	1	4	10
Environmental impacts	1	4	10
Financing instruments	1	3	7
Total	6	17	43

As evident from Table 1, a total of 6 Strategic Objectives, 17 Priorities and 43 Measures were defined as potential answers and recommending steps for tackling the challenges and bottlenecks highlighted in the Transnational Strategy. Thereby, some of the most significant barriers with the highest impact on transnational level and common in the 5 countries of the consortium are considered to be lack of a uniformed regulatory environment for licensing procedures, outdated education programs and insufficient qualified human resources, low quality of existing well data and limited access to the same, unknown status and structure of the wells and fields in general, risk of surface and subsurface contamination and negative impacts on the environmental components during investment implementation, as well as lack of adequate financial support and risk mitigation Measures for geothermal and well repurposing investments.

In line with the above, the following sections provide a detailed elaboration of all Strategic Objectives, Priorities and Measures defined in the Transnational Strategy, which are structured according to the 4



aforementioned Categories: legal, knowledge and social frameworks; technological opportunities; environmental impacts and financing instruments.

CATEGORY 1: LEGAL, KNOWLEDGE AND SOCIAL FRAMEWORKS

Strategic Objective 1:
Clear, efficient and sustainable
regulatory frameworks

Priority 1.1 Simplify, coordinate and modernize policy frameworks	
Measure 1.1.1 Clarify well and land ownership, usage rights, liability and responsibilities	
Activities	- Conducting a comprehensive review of existing national and regional regulations regarding land and well ownership, usage rights, liability and responsibilities - Identifying gaps, overlaps and inconsistencies between national and regional regulations - Collecting and verifying land and well ownership records - Developing a clear registry or database of wells with associated ownership and usage rights - Preparing guidelines with defined liabilities and responsibilities for the wells, including information on ownership, usage rights, purposes of use, maintenance obligations, safety requirements, insurance requirements, problem solving in cases of accidents, damages or misuse and dispute resolution processes - Establishing working groups and frameworks for resolving potential conflicts over ownership, usage rights and liabilities - Organizing workshops or consultations for stakeholders to clarify roles, responsibilities and expectations - Periodic reviewing and updating of ownership, usage rights, liabilities and responsibilities to reflect changes in regulations, as well as revising the prepared guidelines accordingly
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Public and private companies (geothermal, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy) - Legal advisors and consultants
Timeframes	- From 2026 until 2030
Estimated amount (EUR)	- From 3.000.000 EUR to 7.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Updated national regulations regarding ownerships, user rights, liability and responsibilities for the wells - Educated national, regional and local stakeholders regarding well ownership, usage rights, liability and responsibilities - Prepared guidelines with possibilities for revisions due to changes in regulations



Measure 1.1.2 Coordinate and unify policies across jurisdictions	
Activities	- Collecting and reviewing all existing policies, regulations and guidelines across different jurisdictions - Identifying gaps, overlaps and inconsistencies between national and regional policies, regulations and guidelines - Preparing a comparative report highlighting conflicting or areas needing alignment - Identifying key actors in each jurisdiction (authorities, agencies, companies, other) responsible for the implementation of the policies, regulations and guidelines - Seeking feedback from relevant stakeholders and adjusting policies, regulations and guidelines accordingly - Developing monitoring and evaluation indicators to track policy adoption and effectiveness - Periodic reviewing and updating of policies, regulations and guidelines on national, regional and local levels based on new legislatives and stakeholder feedback - Establishing communication channels or networks, as well as organizing periodic meetings and work sessions to share updates, lessons learned and align policies, regulations and guidelines on different levels
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Legal advisors and consultants
Timeframes	- From 2026 until 2030
Estimated amount (EUR)	- From 1.000.000 EUR to 5.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Aligned national, regional and local policies, regulations and guidelines - Established communication channels and networks for sharing information, changes and updates on the policies, regulations and guidelines
Measure 1.1.3 Ensure the alignment of new legislation and regulations with EU and national energy transition goals	
Activities	- Analysing current national laws and regulations related to energy transition, geothermal energy and well repurposing - Identifying gaps, inconsistencies or areas where the new policies do not follow the EU and national goals - Engaging stakeholders to discuss the priorities, barriers and potential impacts of new legislation - Setting up committees and working groups to discuss the priorities, barriers and potential impacts of new legislation, as well as ensure the alignment of the same with the existing EU and national regulations - Preparing draft legislation or regulatory proposals that integrate EU and national energy transition targets, including the use of geothermal energy from abandoned hydrocarbon wells - Ensuring coherence of the draft legislation with existing EU and national laws, market rules and technical standards



	- Organizing public consultations to gather feedback and supplement the draft legislation according to public opinion, as well as inform about the new legislation and energy transition targets - Setting clear timelines for implementation, reporting and monitoring of the new legislation - Establishing reporting systems and conducting periodic reviews and updates of the legislation according to changes on EU and national level
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Legal advisors and consultants
Timeframes	- From 2026 until 2030
Estimated amount (EUR)	- From 3.000.000 EUR to 7.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Newly prepared legislation on geothermal energy transition, geothermal energy and well repurposing aligned with EU and national energy goals
Measure 1.1.4 Adjust national and regional strategic and planning documents for fostering geothermal energy use from repurposed wells	
Activities	- Reviewing existing national and regional strategies and planning documents on the topics of development, energy, climate, renewable energy sources, heating, cooling, electricity and other, relevant for geothermal energy and well repurposing - Establishing a working group to map the missing points of geothermal energy from repurposed wells in the observed national and regional documentation - Adjusting the observed documentation with the content covered in the Transnational Strategy and Transnational Action Plan (project TRANS GEO), with special focus on the challenges, Strategic Objectives, Priorities and Measures for well repurposing - Assessing more realistic resources (organizational, human, financial) and timeframes needed for repurposing abandoned hydrocarbon wells on national and regional levels - Integrate well repurposing into existing spatial and development documentation to ensure its future potential usability - Organizing public consultations to gather feedback and supplement the documentation according to public opinion, as well as inform about the additions in the documentation - Conducting periodic reviews and updates of the documentation according to on field changes and achievement of the set targets
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Public and private companies (geothermal, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy) - Legal advisors and consultants



Timeframes	- From 2031 until 2035
Estimated amount (EUR)	- From 2.000.000 EUR to 6.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Adjusted, revised and newly prepared national and regional strategic and planning documents with additions on the topics of repurposing abandoned hydrocarbon wells for geothermal energy utilization
Priority 1.2 Streamline permitting procedures for well repurposing	
Measure 1.2.1 Create One - Stop - Shop (OSS) permitting systems for well repurposing	
Activities	- Mapping potential needs, missing points and current bottlenecks in the permitting system - Creating a solution in form of a unique, “all in one place” system for easier permit issuing - Defining the scope of work, roles and responsibilities of the One - Stop - Shop (OSS), as well as information sources for its services - Legally establishing a One - Stop - Shop (OSS) according to the relevant procedures, with defined location, work plan, human resources and finance plan - Involving information sharing, application forms, documentation templates, contacting points and expert help to foster permitting procedures for well repurposing - Digitalising of the system with services such as application submission, document upload, status tracking, expert help and easy data exchange - Organizing trainings for the selected experts operating in the One - Stop - Shop (OSS) to ensure quality service and timely information sharing - Organizing workshops and trainings for public and private stakeholders in order to present the newly established system, its performances, possibilities and build capacity - Continuously improving the performances of the One - Stop - Shop (OSS) in line with the gathered feedback from the users, as well as technological progress
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Public and private companies (consultancy, IT)
Timeframes	- From 2036 until 2040
Estimated amount (EUR)	- From 4.000.000 EUR to 14.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Created central information system in the form of a One - Stop - Shop (OSS) for shortening permitting procedures and improving the value chain



	- Trained experts, as well as public and private stakeholders on the functionalities, benefits and usability of the One - Stop - Shop (OSS)
Measure 1.2.2 Introduce fast - track approval for projects meeting well integrity verification and safety criteria standards	
Activities	- Establishing technical criteria for well assessment, including integrity, safety standards and environmental risk thresholds - Creating a checklist for evaluation of the defined technical criteria - Reviewing current permitting laws to allow accelerated approval procedures for wells meeting the technical criteria - Amending the national regulations to recognise and allow fast - track procedures - Establishing contact points for technical criteria evaluation and carrying out fast - track procedures - Digitalising the approval process by implementing automated eligibility checks, document validation and status tracking - Training experts on the criteria and approval process to ensure maximum effectiveness of the service - Developing manuals and guidance documents for potential applicants with step - by - step instructions on the fast - track approval procedures - Inserting the fast - track as service provided via the developed One - Stop - Shop (OSS) to increase its efficiency and digitalisation level
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Public and private companies (consultancy, IT)
Timeframes	- From 2036 until 2040
Estimated amount (EUR)	- From 2.000.000 EUR to 8.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Established contact points for carrying out faster approval procedures for investments meeting technical criteria - Developed guidance documents and expert trainings for fast - track approval procedures - Updated One - Stop - Shop (OSS) by inserting fast - track approval procedures as additional service



Strategic Objective 2:
Deeper knowledge and
competences

Priority 2.1 Educate and train well reuse experts and workforce	
Measure 2.1.1 Develop educational programs at secondary, university and postgraduate levels to create quality geothermal workforce in well reuse	
Activities	- Analysing the current curricula in secondary schools and universities with mapping of the needs, potentials and possible improvements in the fields of geothermal energy utilization and well repurposing - Improving the existing or development of new courses covering the topics of renewable energy sources, geothermal energy and well repurposing - Defining learning programs and outcomes based on field research, market needs and practical experience - Developing learning modules with interdisciplinary topics: geology, mining, mechanical and electrical engineering, environmental science and energy policy - Conducting simulation - based trainings and workshops for well repurposing techniques and geothermal system optimisation - Fostering applied learning by implementing collaborative projects between international and national universities and developing labs for knowledge exchange, peer learning and joint research - Develop master and postdoctoral programs focused on geothermal technology and well repurposing innovations - Ensuring further practical use of postdoctoral studies and results for improving the process of well repurposing - Creating a certification program for technical staff (project designers, engineers, drillers, technicians, energy experts, consultants) - Organizing continuous professional development and lifelong learning courses for technical staff (project designers, engineers, drillers, technicians, energy experts, consultants) - Promoting geothermal energy and well repurposing careers in secondary schools through seminars, open days and educational fairs - Publishing educational materials, videos and e - learning modules for students at all levels, as well as organizing competitions, hackathons and case study analyses focused on geothermal energy utilization through well repurposing
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Secondary schools - Universities and faculties - Science and research institutions
Timeframes	- From 2030 until 2040
Estimated amount (EUR)	- From 5.000.000 EUR to 20.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Improved curricula in secondary and higher education with topics related to geothermal energy and well repurposing



	- Developed tailored courses and interdisciplinary learning modules based on practical facts - Introduced modern education methods, such as simulations, applied and project learning - Integrated postdoctoral studies and results into practical operation - Established programs for lifelong learning and capacity building for technical staff
Measure 2.1.2 Facilitate and encourage research and development programs, including joint industry - academic research on well reuse	
Activities	- Analysing the current research and development programs focused on geothermal energy utilization and well repurposing to identify potential bottlenecks and lacking points - Establishing practice - based research centres or innovation hubs focused on well repurposing and geothermal energy utilization - Fostering collaboration between universities, faculties, institutes and industry to develop more practice - based research programs, projects and on field solutions - Organizing hands - on workshops and education for students in cooperation with industry on topics related to well repurposing (site assessment, well testing, technological solutions, safety and environmental management) - Establishing partnerships with industry for student internships and work - based learning - Enabling practice - based postdoctoral programs in collaboration with industry, as well as organizing workshops and trainings for knowledge exchange and peer learning - Fostering industrial mentorship programs for students and researchers - Enabling the use of postgraduation studies and results on field (assessment models, digital technologies, research data, feasibility studies) and their joint further development through academia - industry cooperation - Potentially cooperating with utility companies to ensure broader use of geothermal energy systems based on repurposed wells (heating, cooling, electricity, district heating, storage)
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Universities and faculties - Science and research institutions - Public and private companies (geothermal, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy)
Timeframes	- From 2030 until 2040
Estimated amount (EUR)	- From 5.000.000 EUR to 20.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Established centres and innovation hubs for geothermal research and fostering partnerships between academic and industry sectors - Developed practice - based training programs, internships and work - based learning for students



	- Increased number of mentorship programs in relevant companies for knowledge exchange and on field learning - Wider use of the developed postdoctoral studies and results on field
Priority 2.2 Enhance collaboration between experts	
Measure 2.2.1 Build a network of experts to accelerate and enable geothermal well reuse	
Activities	- Identifying key experts in the fields of geothermal energy, well engineering, energetics, mechanical and electrical engineering in public and private sectors with relevant experience - Developing a centralised public database of experts with profiles, expert areas and contact information and establishing a formal network - Developing online platforms for knowledge exchange and further networking consisting of international and national experts in geothermal energy and well repurposing - Organizing discussion forums, panel discussions and conferences to present the latest regulatory, research, technological, practical and on field changes and solutions - Organizing public discussions on regulatory, technical and economic aspects of geothermal well repurposing - Participation on international networks and knowledge hubs to gather additional experience and foster peer learning - Organizing site visits (international and national) to repurposed geothermal sites to gather additional practical knowledge and enable further networking - Identifying potential pilot investments and participating on transnational and national well repurposing projects to expand the scope of the network - Supporting well repurposing projects through advisory, research, consultations and document development - Continuous expanding and upgrading of the networks' connections, members and projects to strengthen its references and impacts
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Public and private companies (geothermal, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy) - Non - profit organizations
Timeframes	- From 2036 until 2040
Estimated amount (EUR)	- From 2.000.000 EUR to 15.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Established (inter)national network of experts with diverse knowledge, experience and practical connections for fostering well repurposing investments, as well as offering service and capacity building to public and private stakeholders



Measure 2.2.2 Promote cross - border best - practice exchange through regional forums	
Activities	- Organizing geothermal forums as an extension of the network to present best practice cases on repurposing abandoned hydrocarbon wells in cross - border countries - Organizing national site visits to repurposed geothermal sites to gather additional practical knowledge - Organizing regional peer learning activities and trainings with stakeholders to promote and accelerate exchange of know - how, on field experience and joint technology innovation - Documenting gathered information through different mediums and knowledge repositories, as well as presenting the lessons learned on geothermal forums - Collaborating on cross - border projects to identify common barriers, propose innovative solutions and foster further well repurposing in the cross - border regions - Promoting additional cross - border partnerships between different public and private stakeholders to enable development of pilot investments
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Public and private companies (geothermal, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy) - Non - profit organizations
Timeframes	- From 2036 until 2040
Estimated amount (EUR)	- From 1.000.000 EUR to 4.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Established cross - border regional forums for gathering additional knowledge, practice and experience on well repurposing, as well as enhancing opportunities for future development of pilot investments

Strategic Objective 3:
Favourable social and market conditions

Priority 3.1 Enhance stakeholder trust and social acceptance	
Measure 3.1.1 Raise awareness and knowledge among relevant stakeholders on the geothermal potential of repurposed hydrocarbon infrastructure	
Activities	- Identifying and mapping key stakeholders relevant for well repurposing investments - Organizing round tables, workshops and seminars to present the possibilities, challenges, benefits, potential use, technological



	opportunities, financing instruments and best practices of well repurposing for geothermal energy use (either separate or within the One - Stop - Shop (OSS)) - Developing clear, evidence - based communication materials (brochures, brief, infographics, short videos, posters) to foster additional awareness raising and information sharing - Launching dedicated webpages with news on best practices, technological innovations, potential pilot investments and financing opportunities for well repurposing - Organizing consultations and Q&A sessions with experts to help raise interest, inform about the risks and benefits and foster community engagement - Organizing site visits for interested public and private stakeholders to successfully repurposed wells to demonstrate their use and economic feasibility in practice - Continuous reporting via webpages, media and awareness raising about the changes, news, progress and future plans regarding potential pilot investments in well repurposing
Implementers	- Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 1.000.000 EUR to 4.500.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Developed clear and practical communication materials for further dissemination - Increased awareness and knowledge level of stakeholders regarding the possibilities of well repurposing - Increased public interest for well repurposing investments
Measure 3.1.2 Mandate early and ongoing transparent stakeholder consultation with affected communities	
Activities	- Identifying community public and private stakeholders and their interests, concerns and potential influence on well repurposing investments - Preparing an engagement plan outlining consultation objectives, methods and potential outcomes - Fostering ongoing engagement of the community public and private stakeholders through joint investments planning, information sharing, awareness raising and support activities (consultations, Q&A sessions) - Preparing communication materials with adjusted language, visibility and content for all stakeholder groups - Preparing clear and accessible communication materials highlighting news, progress and updates on potential pilot investments - Establishing channels (AI supported webpages, social media, contact points) for timely information sharing and feedback collection - Offering support services via the established One - Stop - Shop (OSS) - Publishing annual reports with organized support activities and public feedback for transparency



Implementers	- Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 1.000.000 EUR to 4.500.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Established channels and comprehensive support services for community public and private stakeholders - Raised awareness and transparency among the public regarding well repurposing investments - Engaged community public and private stakeholders in well repurposing investments through joint planning and timely information sharing
Measure 3.1.3 Introduce community benefit agreements	
Activities	- Identifying regional and local communities and their priorities, needs and potential benefits from well repurposing investments - Drafting of standardised frameworks with outlined benefits, roles and responsibilities, financial resources and timeframes - Ensuring clear and transparent community feedback and input through workshops, focus groups and support services - Facilitating negotiations and communication between different types of community stakeholders to ensure transparent, fair and engaging agreements - Setting realistic and trackable activities, targets and Measures in the created agreements, with indicated responsibilities for monitoring and reporting - Developing agreements for further joint development of well repurposing projects, with emphasis on the needs, expectations and risk mitigation of all parties
Implementers	- Regional and local authorities (regions, counties, cities, towns, municipalities) - Regional and local energy agencies - Regional and local development agencies - Public and private companies (geothermal, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy) - Legal advisors and consultants
Timeframes	- From 2036 until 2040
Estimated amount (EUR)	- From 1.000.000 EUR to 3.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Created transparent, clear and engaging agreements for community public and private stakeholders highlighting the needs, benefits,



	responsibilities, risks and mitigation Measures in well repurposing projects
Priority 3.2 Create favourable market conditions	
Measure 3.2.1 Develop an integrated online platform for matching supply and demand of repurposed wells and proposing cost - effective geothermal reuse methodologies	
Activities	- Defining members on the supply and demand side of the geothermal value chain - Preparing databases with information on the members on the supply and demand side, their needs and methods for engagement - Developing a unified online platform for matching purposes, with user friendly interface, search possibilities and AI driven communication tool - Regularly updating and upgrading of the performances, services and functionalities to ensure timely, relevant and quality information sharing - Merging the online platform with other online tools and platforms to ensure maximum efficiency and boarder service delivery - Expanding the functionalities to feasibility assessments to select the most suitable and cost - effective methodology for well repurposing - Pilot testing of the beta version of the online platform to gather feedback, identify errors and improve its functionalities - Finalising of the online platform and its performances and public presentation of the same to interested parties (separately or within workshops and awareness raising events) - Organizing tailored training sessions for members of the supply and demand side to demonstrate the operability of the online platform - Introducing the online platform as one of the tools and services provided by the One - Stop - Shop (OSS)
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Public and private companies (geothermal, well operators, project design, drilling, engineering and technical, consultancy, IT)
Timeframes	- From 2026 until 2032
Estimated amount (EUR)	- From 4.000.000 EUR to 14.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Developed tailored online platform supported by modern digital technologies for matching supply and demand side - Enabled feasibility assessments of well repurposing projects for potential investors - Expanded usability of the online platform through merging with existing digital technologies and One - Stop - Shop (OSS) - Ensured wider use of the online platform through regular training sessions, system upgrades and public presentations



Measure 3.2.2 Foster reuse of hydrocarbon wells by local heat market needs assessment and integration in urban planning	
Activities	- Conducting comprehensive local heat demand mapping and needs assessment - Identifying major heat consumers on local level and analysing their seasonal heat demand profiles and future projections - Using the IT tool for well assessment (project TRANSSEO), for identification of wells with the biggest potential usability in different sectors - Prioritising wells with the highest geothermal repurposing potential using the IT tool for well assessment (project TRANSSEO) and creating (pre)feasibility studies for technical, social and financial assessments, as well as heating potentials - Estimating CAPEX and OPEX for well repurposing and connection to existing heating networks - Presenting the results of the studies to local communities to gain interest and potential co - financing - Incorporating geothermal well repurposing zones and fields into local spatial and expansion plans - Developing local energy transition roadmaps with focus on well repurposing offering a step - by - step process and enabling quality decision - making - Periodical updating of the existing spatial and expansion plans in line with on field changes
Implementers	- Regional and local authorities (regions, counties, cities, towns, municipalities) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions
Timeframes	- From 2031 until 2040
Estimated amount (EUR)	- From 2.000.000 EUR to 7.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Developed (pre)feasibility studies for wells with the highest geothermal potential, with detailed heat demand assessments and potential use in local communities - Updated local spatial and expansion plans with geothermal well zones and fields for future energy utilization - Established step - by - step decision - making process on well repurposing for local stakeholders
Measure 3.2.3 Support scaling - up of the geothermal reuse market through development of district heating systems and related infrastructure	
Activities	- Including district heating networks in national, regional and local strategic frameworks and planning documents - Conducting regional and local heat demand mapping and analysing of geothermal supply - Identification of areas with higher district heating potential near abandoned hydrocarbon wells



	- Creating (pre)feasibility studies for assessment of district heating integration into regional and local networks - Analysing regulatory, administrative, technical, environmental and financial conditions for establishing a district heating network - Development of solutions and engineering designs based on filed analysis, as well as regional and local requirements - Integrating geothermal district heating systems into regional and local networks through installation of distribution infrastructure and smart monitoring solutions - Ensuring compliance of the systems with regulatory requirements, environmental and safety standards - Encouraging possible private sector funding through presenting benefits, cost effectiveness and development possibilities - Organizing awareness raising events for regional and local stakeholders to inform about the functionalities, long - term benefits and costs of connecting to the district heating systems - Continuous public promotion of geothermal district heating based on repurposed abandoned hydrocarbon wells through presentations, consultations, short videos, best practices and site visits - Training of experts and developing technical guidelines for management and maintenance of the district heating systems - Developing reports on risk mitigation and monitoring of the systems' performances, costs and malfunctions - Regular updating of the systems based on monitoring results
Implementers	- National, regional and local authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Public and private companies (geothermal, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy) - Legal advisors and consultants
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 12.000.000 EUR to 60.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Integrated plans for district heating development in national, regional and local strategic frameworks and planning documents - Created (pre)feasibility studies for needs assessment and cost effectiveness of district heating integration - Trained experts on management and maintenance, as well as public and private stakeholders on the characteristics of geothermal district heating systems - Integrated and operative geothermal district heating systems based on repurposed wells, aligned with the relevant regulations, environmental and safety standards



CATEGORY 2: TECHNOLOGICAL OPPORTUNITIES

Strategic Objective 4:
Accelerated innovation in well
reuse

Priority 4.1 Improve data and information access	
Measure 4.1.1 Develop open - access database of candidate and reused hydrocarbon wells by upgrading TRANSSEO IT tool for well assessment	
Activities	- Standardising, validating and integrating additional datasets from Central Europe and other regions - Maintaining and upgrading of the existing database and IT tool for well assessment (project TRANSSEO) with continuous updates and technical support and/or integrate the database into other European databases - Transitioning from static to dynamic data entry - Further promoting of the IT tool for well assessment (project TRANSSEO) on international and national events to gather additional users - Inserting the IT tool for well assessment (project TRANSSEO) as service provided via the developed One - Stop - Shop (OSS)
Implementers	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy, IT) - Non - profit organizations
Timeframes	- From 2026 until 2033
Estimated amount (EUR)	- From 1.000.000 EUR to 6.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding - Public private partnerships
Outputs	- Harmonized transnational open - access visualization of hydrocarbon wells suitable for geothermal use - Increased investment readiness of geothermal projects - Improved decision - making support for policymakers and developers by provided suitable data - Updated One - Stop - Shop (OSS) with additional digital features
Measure 4.1.2 Require public disclosure of well integrity testing, seismic monitoring and water quality data	
Activities	- Drafting guidelines, aligned with existing directives, for mandatory disclosure of subsurface data with defined minimum datasets, standardised data formats and links to open - access databases, as well as risk assessment procedures - Considering confidentiality and commercial sensitivity concerns and support authorities and operators in implementation



Implementers	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy) - Non - profit organizations
Timeframes	- From 2032 until 2036
Estimated amount (EUR)	- From 1.000.000 EUR to 6.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Established legally binding public disclosure requirements in all participating countries - Standardised datasets, improved transparency of the data and public trust - Enhanced risk assessment and mitigation capacity
Measure 4.1.3 Develop screening tools to identify and assess suitable wells, using digital technologies	
Activities	- Reviewing and upgrading of the criteria catalogue (project TRANS GEO) with economic feasibility and reservoir indicators, as well as scoring/ranking of wells - Updating of the IT tool for well assessment (project TRANS GEO) with additional data based on field changes and new research - Developing of new or upgrading of the existing digital technologies (e.g., IT tool for well assessment (project TRANS GEO)) with screening modules and additional assessment functionalities
Implementers	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, land and water management, utility, project design, drilling, engineering and technical, consultancy, IT) - Non - profit organizations
Timeframes	- From 2026 until 2028
Estimated amount (EUR)	- From 2.000.000 EUR to 12.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding - Public private partnerships
Outputs	- Advanced digital screening tool as ranking and decision support system for well repurposing that leads to an increased pipeline of viable geothermal projects - Upgraded IT tool for well assessment (project TRANS GEO) with new, on field data, screening modules and advanced functionalities - Reduced technical and financial risks for potential investors and developers through a wider use of the existing digital solutions or development of adjusted screening tools



Priority 4.2 Develop new downhole technologies	
Measure 4.2.1 Design new and innovative casing repair technologies	
Activities	- Reviewing of the existing technologies and identifying gaps for geothermal application (e.g., high temperature, corrosion, scaling) - Developing innovative solutions such as advanced composite liners, expandable tubulars, nanomaterial - based sealants, self - healing materials and smart casing systems with embedded sensors - Testing of the developed solutions and technologies in the laboratory through simulations, developing prototypes and performing field trials - Creating of technical standards and commercialisation on international and national markets
Implementers / stakeholders of the measure	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical)
Timeframes	- From 2028 until 2035
Estimated amount (EUR)	- From 3.000.000 EUR to 15.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding - Public private partnerships - Venture capital
Outputs	- Advanced casing repair technologies adapted to geothermal conditions - Validated materials and engineering solutions with improved durability and safety - Reduced cost and technical barriers to repurposing hydrocarbon wells - Extended lifetime and safety of hydrocarbon and geothermal wells - Strengthened European industrial competitiveness in geothermal technologies
Measure 4.2.2 Pilot new closed - loop geothermal retrofit technologies, including plug - and - play downhole heat exchanger systems	
Activities	- Identifying promising closed - loop geothermal systems (e.g., vacuum - insulated pipes with superior insulation, polyethylene - based pipes for low - cost deployment) - Evaluating the suitability of the closed - loop systems for well reuse - Adapting the systems for different well conditions and optimising their thermal performance - Developing plug - and - play systems for given conditions - Developing pilot prototypes of closed - loop systems and supporting their commercialisation on international and national markets
Implementers	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical)
Timeframes	- From 2028 until 2035



Estimated amount (EUR)	- From 8.000.000 EUR to 30.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding - Public private partnerships
Outputs	- Demonstrated closed - loop geothermal retrofit technologies in real well conditions - Structured performance data on efficiency, cost and operational reliability - Developed replicable deployment models for different geological settings - Reduced technical and financial risks for geothermal retrofits - Accelerated market uptake of closed - loop geothermal solutions
Measure 4.2.3 Test geothermal reservoir stimulation techniques in suitable wells	
Activities	- Performing pilot tests of geothermal reservoir stimulation techniques that allow high heat and/or power production with minimised risk of environmental impacts from low to intermediate permeable geothermal reservoirs - Identifying suitable wells and reservoirs for the pilot tests - Selecting appropriate stimulation techniques and executing stimulation operations with appropriate risk assessment - Monitoring of the pilot testing and identification of risk mitigation Measures - Continuous monitoring of the testing process, reporting of the results to public and private stakeholders and creating practical guidelines for future simulation procedures
Implementers	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, IT)
Timeframes	- From 2030 until 2040
Estimated amount (EUR)	- From 10.000.000 EUR to 20.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding - Public private partnerships
Outputs	- Demonstrated geothermal reservoir stimulation techniques - Improved heat extraction performance and economics of stimulated geothermal wells - Validated risk mitigation and monitoring protocols - Increased technical feasibility of geothermal projects in low - permeability reservoirs - Enhanced public acceptability through transparent monitoring and reporting - Scalable best - practice guidelines for safe geothermal well stimulation



Priority 4.3 Integrate digital monitoring	
Measure 4.3.1 Deploy fiber - optic sensing for real - time well performance, well integrity and induced seismicity monitoring	
Activities	- Defining monitoring requirements for retrofitted wells (e.g., temperature, flow, casing integrity, seismicity) - Designing installation approaches for fiber - optic sensing in existing wells (permanent and retrievable systems) - Deployment of installation approaches in pilot projects - Continuous monitoring of the results and identification of critical points - Establishing risk mitigation Measures and safety protocols - Reporting on the gathered data and improvement of the sensing system in cases of deviations
Implementers	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, IT)
Timeframes	- From 2030 until 2035
Estimated amount (EUR)	- From 2.000.000 EUR to 15.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding - Public private partnerships
Outputs	- Developed fiber - optic sensing systems in repurposed geothermal wells - Improved operational safety and efficiency of geothermal systems - Reduced risk of well failure and environmental impacts - Established standards and best practices for smart geothermal monitoring
Measure 4.3.2 Use predictive digital twins to optimize energy extraction and system design	
Activities	- Defining digital twins for repurposed hydrocarbon wells including surface and subsurface systems - Developing models for real - time and predictive simulation of the digital twins that are able to integrate monitoring data for model calibration - Piloting of the digital twins for different geothermal reuse technologies including open and closed systems - Testing of the digital twins on actual pilot projects for determination of limitations and further improvement - Installing smart monitoring and management functionalities to review the digital twins' performances
Implementers	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, IT)
Timeframes	- From 2030 until 2040



Estimated amount (EUR)	- From 3.000.000 EUR to 15.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding - Public private partnerships
Outputs	- Developed operational digital twins for different geothermal well repurposing technologies - Improved efficiency and performance of geothermal installations - Reduced operational risks and maintenance costs through predictive analytics - Enhanced decision support systems and investment confidence - Digitalized geothermal energy systems with smart monitoring and management options
Priority 4.4 Facilitate related technological breakthroughs	
Measure 4.4.1 Develop solutions for reinjection problems in difficult geology	
Activities	- Performing research and development on declining/low injectivity of geothermal reinjection wells - Developing of solution options and pilot testing for different geological settings - Recording of the tested data and identifying critical points for diverse geological structures - Implementing anti - scaling and advanced reservoir management solutions to avoid injectivity decline and stimulation methods to improve/recover injectivity - Developing of sampling technologies for abandoned wells - Developing step - by - step guidelines for reinjection bottlenecks in complex geological structures
Implementers	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, chemical)
Timeframes	- From 2030 until 2037
Estimated amount (EUR)	- From 2.000.000 EUR to 15.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding - Public private partnerships
Outputs	- Developed innovative reinjection solutions tailored to challenging geological conditions - Improved injectivity and reservoir sustainability - Reduced scaling, clogging and operational downtime - Validated pilot demonstrations across multiple geological settings - Created best - practice guidelines and standards for reinjection in geothermal systems



Measure 4.4.2 Develop highly efficient heat pump technologies to enable heat utilization of low and medium enthalpy geothermal energy potential	
Activities	- Reviewing of current heat pump technologies and identifying efficiency gaps for geothermal sources (e.g., high power, high temperature) - Developing and demonstrating modular, scalable heat pumps with high efficiency tailored for different deep geothermal systems - Testing of the developed solutions and recording of the results - Further improvement of the solutions based on recorded data
Implementers	- Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, manufacturing)
Timeframes	- From 2033 until 2040
Estimated amount (EUR)	- From 2.000.000 EUR to 15.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding - Public private partnerships
Outputs	- Developed highly efficient heat pump systems tailored for low - and medium - enthalpy geothermal energy - Increased utilization of low - and medium - temperature geothermal resources - Reduced primary energy consumption and GHG emissions in heating systems

CATEGORY 3: ENVIRONMENTAL IMPACTS

Strategic Objective 5:
Environmentally - protective
and sustainable well
repurposing

Priority 5.1 Ensure knowledge of environmental status and potential impacts prior to reuse	
Measure 5.1.1 Conduct environmental impact assessment	
Activities	- Determining possible legacy pollution and legacy emissions - Performing the general environmental impact assessment for planned workover, exploration and later production activities, with special focus on well repurposing - Developing environmental impact assessment reports relevant for future pilot investments



Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local authorities (regions, counties, cities, towns, municipalities) - Regional and local energy agencies - Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, consultancy)
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 1.000.000 EUR to 4.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Prepared detailed environmental impact assessment reports for future well repurposing investments
Measure 5.1.2 Conduct baseline well integrity assessment	
Activities	- Assessing the suitability of the well for repurposing and energy extractions - Analysing the well integrity, including revision of casings, cement and other components to determine the degradation level, identify structural weakness and potential leaks - Performing cementing and sealing technologies to mitigate possible leakage - Retrofitting or replacing aging infrastructure to properly handle the expected geothermal fluid properties, temperatures and pressures - Repairing the well's conditions (if possible) for future repurposing - Developing final reports on well integrity assessments, with included correction actions (if applicable)
Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, consultancy)
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 2.000.000 EUR to 6.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Performed detailed well integrity assessments - Improved conditions of the wells suitable for repurposing



	- Created reports on well integrity assessments highlighting the performed correction actions
Priority 5.2 Protect land, water and ecosystem prior to field operations	
Measure 5.2.1 Restore habitat and remediate pollution	
Activities	- Identifying challenges related to protection of biodiversity, habitat restoration, remediation of contamination, solid waste, wastewater management and well integrity - Developing guidelines with recommendations on overcoming the identified challenges and included risk mitigation Measures - Preparing the potential investment according to the recommendations and with consideration of risk mitigation Measures - Communicating with public and private stakeholders to foster transparency, information sharing and engagement - Engaging relevant stakeholders into the process of protecting environmental components to ensure quality feedback, diverse expertise and divide responsibilities
Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Universities and faculties - Science and research institutions - Non - profit organizations
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 2.000.000 EUR to 4.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Prepared pilot investments according to environmental protection recommendations and risk mitigation Measures - Achieved higher quality of pilot investments with consideration of safety standards for diverse environmental components - Engaged public and private stakeholders into the process to ensure wider opinion and knowledge sharing
Measure 5.2.2 Mitigate noise and light pollution	
Activities	- Preparing and implementing noise and light management plans - Identifying noise sources, operational periods, emission levels and minimum distances from sensitive receptors (e.g., residential areas and ecologically sensitive zones) - Using low - noise equipment, including sound - insulated attachments and enclosed or covered machinery - Applying active noise reduction Measures, such as silencers, noise containment structures, noise protection hoods and pump mufflers - Restricting high - noise activities to daytime hours, avoiding nighttime, early morning periods and other sensitive time windows - Regular maintaining of machinery and equipment to ensure optimal operation and minimize noise emissions - Immediate repairing of faults, leaks or damaged components that may lead to increased noise levels



	- Using lighting only where strictly necessary, supported by motion sensors and time - controlled operation aligned with working hours - Installation of energy - efficient LED lighting with a warm spectrum and low luminance to reduce ecological impact - Application of directional lighting design, ensuring that light is directed downward and away from sensitive receptors - Installation of glare protection and light shielding systems, including covers, light grills and reflectors to prevent light spill and skyglow
Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, consultancy)
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 1.000.000 EUR to 7.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Prepared plans for noise and light management - Implemented innovative noise and light reduction Measures on pilot sites to protect the flora and fauna
Measure 5.2.3 Avoid gas emissions and apply safe management protocols	
Activities	- Conducting risk assessments for potential gas release scenarios - Reviewing well integrity, casing condition and historical records of gas presence - Developing gas management plans defining responsibilities, alarm systems, clearance levels, action thresholds and evacuation routes - Installing fixed and portable gas detectors calibrated for expected gas species - Implementing continuous atmospheric monitoring around the wellhead and inside the well - Deploying temporary gas capture or control systems (e.g., gas scavenging units, flaring or vent capture systems) when gas release is anticipated - Using closed or semi - closed process systems to minimize fugitive emissions - Using low - emission equipment, high - integrity seals and leak - tight connections, as well as replacing degraded components promptly - Maintaining effective pressure control and well control practices, minimizing unnecessary flaring - Establishing an emergency response plan, including evacuation routes, muster points and coordination with emergency services - Providing regular trainings to experts in gas emergency response, rescue and first aid, as well as ensuring the availability of emergency equipment - Ensuring compliance with applicable regulatory requirements, obtaining necessary permits and implementing incident reporting procedures



Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, consultancy)
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 2.000.000 EUR to 8.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Developed gas management and emergency response plans for dealing with critical situations - Installed innovative technical solutions and implemented methods for gas emission mitigation
Priority 5.3 Protect the environment during well workover	
Measure 5.3.1 Ensure workover operational plan to manage hydrogeological and geo - mechanical risks	
Activities	- Conducting studies specifically addressing hydrogeological and geo - mechanical risks - Reviewing existing geological, hydrogeological and historical drilling data to identify site - specific risks - Identifying environmentally sensitive zones, including freshwater aquifers, permeable or unconsolidated formations and faulted/fractured intervals - Establishing operational limit values, trigger levels, emergency thresholds and clear abort criteria for high - risk situations - Ensuring compliance with permit conditions and regulatory environmental requirements, including monitoring obligations - Determining baseline groundwater conditions, including groundwater levels, flow direction, hydraulic gradients and water quality parameters - Ensuring safe handling, storage, disposal and reuse of produced or contaminated fluids - Maintaining strict pressure control to avoid overpressure in sensitive formations - Monitoring pressure conditions, fluid losses/gains, borehole deformation and structural integrity throughout operations - Using appropriate sealed storage containers to prevent spills, leaks, as well as soil and groundwater contamination - Maintaining documentation of critical situations and reporting in line with the permit conditions
Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, consultancy)
Timeframes	- From 2026 until 2040



Estimated amount (EUR)	- From 2.000.000 EUR to 8.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Established procedures for hydrogeological and geo - mechanical risk management - Implemented innovative risk mitigation technologies and methods
Measure 5.3.2 Conduct well repair or retrofit to avoid leakage and isolate well from swelling formations	
Activities	- Performing comprehensive well integrity diagnostics prior to repurposing to localize leakage pathways and determine root causes - Carrying out pressure testing to isolate well sections and quantify leak rates - Perforating casing at identified leakage or swelling zones to enable targeted remediation - Cementing using appropriately designed cement slurries to seal leakage pathways - Using specialized ductile or flexible cement systems in swelling formations to accommodate formation movement and prevent cracking - Using inhibited fluid systems during retrofit operations to stabilize swelling formations - Applying under - reaming techniques where necessary to enlarge the borehole and provide adequate annular space for cementing or liner installation - Installing or upgrading cathodic protection systems to prevent electrochemical corrosion - Applying corrosion inhibitors where required to protect casing and annular space from corrosive fluids - Establishing long - term integrity monitoring aligned with the well's new operational purpose
Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, consultancy)
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 5.000.000 EUR to 20.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Developed and performed comprehensive diagnostics prior to repurposing - Established methods and procedures for well repairing and retrofitting



Measure 5.3.3 Limit sound and light disturbance by insulating the site and operating during daytime	
Activities	- The elaboration of this Measure has been done within the Priority 5.2 Protect land, water and ecosystem prior to field operations and corresponding Measure 5.2.2 Mitigate noise and light pollution. - Further elaboration on this topic is, therefore, not needed.
Implementers	
Timeframes	
Estimated amount (EUR)	
Funding sources	
Outputs	
Priority 5.4 Protect the environment during system operation	
Measure 5.4.1 Reinject produced fluids to avoid subsidence, scaling, gas/radionuclide release and waste processing	
Activities	- Implementing reinjection to maintain reservoir pore pressure and prevent land subsidence - Monitoring reservoir performance and ground deformation using precision monitoring systems and adjusting injection rates where necessary - Injecting antiscalant chemicals to prevent mineral precipitation in surface and subsurface equipment - Maintaining temperatures above critical saturation thresholds to prevent scaling - Applying pH control Measures to increase mineral solubility and reduce scale formation risks - Monitoring scaling indices and conducting periodic inspections of pipelines and well components - Conducting regular radiological monitoring of filters, scales and surface equipment to identify potential accumulation of naturally occurring radioactive materials - Managing contaminated materials in accordance with hazardous waste regulations - Collecting, analysing and properly disposing of sludge or solid residues, classifying and managing waste streams based on chemical and radiological characteristics - Maintaining documentation and traceability of fluid treatment and waste handling processes
Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, consultancy)
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 2.000.000 EUR to 10.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks



	- EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Established methods and procedures for reinjecting fluids to avoid different outbursts from repurposed wells
Measure 5.4.2 Conduct appropriate monitoring/inspection and maintenance to detect and prevent leaks and other potential environmental impacts	
Activities	- Installing and operating fiber - optic sensing systems to continuously monitor temperature anomalies and mechanical stress along the well - Implementing continuous annular pressure monitoring to detect unexpected pressure changes indicating potential barrier failure - Utilizing digital monitoring platforms and predictive analytics such as digital twin models to compare real - time operational data with expected performance and trigger early warnings of integrity issues - Conducting regular well logging to assess casing thickness, corrosion, internal damage and cement bond quality - Carrying out mechanical integrity tests at defined intervals to confirm pressure containment performance before continued operation - Implementing corrosion management programs, including monitoring and optimization of corrosion inhibitors and inspection of corrosion resistant materials - Conducting routine inspection, servicing and functional testing of wellhead equipment and safety - critical components - Performing scale removal and workover operations where necessary to prevent wellbore restriction and pressure build - up - Establishing and implementing groundwater monitoring programs to detect potential migration of geothermal fluids, gases or radionuclides - Deploying seismic monitoring systems to track induced micro - seismicity and adjust operational parameters where required - Installing perimeter air quality monitoring systems to detect potential gas leaks and enable immediate corrective actions
Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Public and private companies (geothermal, geological, mining, well operators, project design, drilling, engineering and technical, consultancy)
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 2.000.000 EUR to 10.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other) - Private sector funding
Outputs	- Established risk mitigation procedures and steps for adequate and transparent monitoring and maintenance of the repurposed wells to prevent outbursts



CATEGORY 4: FINANCING INSTRUMENTS

Strategic Objective 6:
Favourable financial conditions
for well reuse

Priority 6.1 Ensure long - term repurposing investments through the use of EU financing instruments	
Measure 6.1.1 Create targeted grant programs for well repurposing at EU level	
Activities	- Proposing well repurposing as one of the priority topics in future financing frameworks, periods and programs - Advocating for dedicated transnational (EU) financing programs specifically targeting well repurposing for geothermal energy - Proposing specific calls within existing programs, which already support deep geothermal projects under renewable energy categories, with focus on well repurposing - Developing eligibility criteria for well repurposing projects with emphasis on possible applicants (public and private stakeholders) - Designing programs addressing key barriers such as high upfront costs, technical uncertainties and exploration risks - Structuring funding instruments to support a variety of project phases from feasibility studies through construction to operation - Ensuring adequate budget allocations for a variety of activities related to well repurposing - Developing more investment - oriented funding programs and calls, supporting repurposing works and operativity of the systems - Organizing working groups for developing manuals and guidelines on the financing programs, as well as promotion of the same - Continuous upgrading of the established financing programs in line with EU legislative changes, market needs and on field consultations
Implementers	- EU institutions and organizations - National authorities and institutions (ministries, departments, agencies) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Legal advisors and consultants
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- Not applicable
Funding sources	- Not applicable
Outputs	- Established dedicated transnational (EU) financing programs and calls for well repurposing - Expanded eligibility criteria within newly prepared financing programs and calls, with emphasis on activities, costs and applicants - Increased number of investment - oriented programs and calls for well repurposing



Measure 6.1.2 Establish a well repurposing community in Central Europe	
Activities	- Creating of an organized community of different stakeholders focused on well repurposing across the 5 partner countries and broader region - Promoting the creation of value chain - based international and national clusters - Developing governance structure with regular meetings, working groups and communication channels - Developing of the decision support web interface, promoting data sharing and creating a shared knowledge platform, best practice database and member directory - Organizing annual conferences and technical workshops for relevant stakeholders - Establishing of sub - groups for specific topics (legal/regulatory, technology, environmental protection, financing) - Enabling joint project development and consortium building in future investments
Implementers	- EU institutions and organizations - National authorities and institutions (ministries, departments, agencies) - Regional and local authorities (regions, counties, cities, towns, municipalities) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, utility, project design, drilling, engineering and technical, consultancy, IT) - Non - profit organizations
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 500.000 EUR to 1.500.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Established formal well repurposing community involving different public and private stakeholders - Organized annual conferences and continuous membership expansion - Developed joint projects focused on well repurposing in Central Europe and beyond
Measure 6.1.3 Foster transnational project collaborations for EU funding (including community - led initiatives)	
Activities	- Encouraging and facilitating the development of projects applying for transnational (EU) financing instruments - Providing matchmaking between potential partners across countries - Organizing partnering events and project development workshops for establishing partnerships - Creating guidelines for applying to EU programs (Interreg, LIFE, HORIZON, I3, other) - Supporting community - led initiatives such as energy cooperatives and citizen groups to participate in projects



	- Building capacity of smaller organizations to engage in transnational cooperation - Developing project concept pipelines eligible for upcoming calls - Sharing successful project examples and lessons learned to foster partnership growth - Using the well repurposing community as collaboration facilitator
Implementers	- EU institutions and organizations - National authorities and institutions (ministries, departments, agencies) - Regional and local authorities (regions, counties, cities, towns, municipalities) - Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Public and private companies (geothermal, geological, mining, well operators, utility, project design, drilling, engineering and technical, consultancy, IT) - Non - profit organizations
Timeframes	- From 2026 until 2040
Estimated amount (EUR)	- From 1.000.000 EUR to 3.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Prepared project proposals eligible for upcoming calls with included community - led initiatives - Enhanced knowledge transfer and capacity building for smaller organizations - Established and strengthened cooperation between public and private stakeholders
Priority 6.2 Broaden the portfolio of financing instruments on national and regional level	
Measure 6.2.1 Introduce innovative public funding programs for environmental remediation and well testing	
Activities	- Establishing of dedicated national financing programs targeting early - stage well repurposing activities with high risk and limited private sector interest - Cooperating with regional and local authorities to assess their needs and requirements, as well as including their input into national financing programs - Creating funding for environmental site cleanup and contamination remediation - Reducing investor risk by providing verified well condition information and insurance options - Supporting geophysical surveys and resource confirmation reducing geological risks - Providing grants for feasibility studies, impact assessments and preliminary engineering works - Designing programs that de - risk early stages enabling private investment in later phases



	- Building on existing national financing programs offering repayment bonuses and capital support
Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local authorities (regions, counties, cities, towns, municipalities) - Regional and local energy agencies - Public and private companies (consultancy, banks, insurance, financial advisors)
Timeframes	- From 2027 until 2040
Estimated amount (EUR)	- From 3.000.000 EUR to 10.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Created innovative national financing programs for well repurposing covering all phases of the investment - Enabled risk mitigation with investment insurance options
Measure 6.2.2 Initiate national and regional funding mechanisms for well repurposing	
Activities	- Creating comprehensive national and regional support schemes for well repurposing projects covering multiple project phases and needs - Establishing capital grant programs for construction and infrastructure - Developing concessional loans with favourable interest rates - Creating risk - sharing mechanisms such as loan guarantees and exploration insurance for mitigating drilling and technical failures - Implementing feed - in tariffs or heat purchase agreements providing long - term revenue certainty - Providing tax incentives such accelerated depreciation, investment tax credits or property tax exemptions - Providing information and guidance on the financing instruments via the established One - Stop - Shop (OSS)
Implementers	- National authorities and institutions (ministries, departments, agencies) - Regional and local authorities (regions, counties, cities, towns, municipalities) - Regional and local energy agencies - Public and private companies (consultancy, banks, insurance, financial advisors)
Timeframes	- From 2027 until 2040
Estimated amount (EUR)	- From 3.000.000 EUR to 10.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Established comprehensive national and regional financing mechanisms



	- Enabled financial benefits in forms of guarantees, loans and tariffs for well repurposing projects
Priority 6.3 Attract private sector investments	
Measure 6.3.1 Educate potential investors on well repurposing for geothermal energy production	
Activities	- Developing and implementing investor education and engagement programs showcasing well repurposing opportunities and addressing risk perceptions - Creating investment promotional materials presenting technical feasibility, economic models and returns - Developing standardized financial models and investment analysis tools for well repurposing - Presenting successful case studies demonstrating commercial viability, as well as sharing good practices and benchmarking - Addressing specific investor concerns about technology risk, geological uncertainty and market risks - Engaging private equity firms, infrastructure funds, pension funds and family offices interested in sustainable investments - Providing clear information on support programs, risk mitigation mechanisms and revenue models - Providing continuous educational and informational services via the established One - Stop - Shop (OSS)
Implementers	- Regional and local energy agencies - Regional and local development agencies - Universities and faculties - Science and research institutions - Public and private companies (consultancy, banks, insurance, financial advisors)
Timeframes	- From 2027 until 2035
Estimated amount (EUR)	- From 500.000 EUR to 3.000.000 EUR (per country)
Funding sources	- National, regional and local grants, subsidies and incentives - National development banks - EU funds and banks (ERDF, Cohesion, Innovation, EIB, other) - EU programs (Interreg, LIFE, HORIZON, other)
Outputs	- Organized engagement events and capacity building for investors - Enabled information sharing and addressed investors' needs
Measure 6.3.2 Facilitate private sector investment and Public - Private Partnerships (PPPs)	
Activities	- Creating frameworks and specific mechanisms attracting private capital into well repurposing projects - Developing PPP structures, with public sector often focusing on infrastructure/risk and private sector on operations/efficiency - Designing BOT (Build - Operate - Transfer) and similar models appropriate for geothermal projects - Providing public co - financing reducing private sector risk exposure - Offering loan guarantees, insurance mechanisms and first - loss capital - Creating green financing instruments (green bonds, sustainable loans) for well repurposing projects



	- Structuring Energy Service Company (ESCo) models for financing, building and operating systems - Addressing regulatory barriers to private investments identified in previous analyses
Implementers	- National authorities and institutions (ministries, departments, agencies) - National development banks - Regional and local authorities (regions, counties, cities, towns, municipalities) - Regional and local energy agencies - Public and private companies (geothermal, geological, mining, well operators, utility, project design, drilling, engineering and technical, consultancy, IT, banks, insurance, financial advisors) - Legal advisors and consultants
Timeframes	- From 2028 until 2040
Estimated amount (EUR)	- Not applicable
Funding sources	- Not applicable
Outputs	- Established Public - Private Partnerships (PPPs) for fostering well repurposing projects - Providing innovative financial benefits and initiatives to foster additional collaboration between public and private stakeholders



3. Systematic monitoring and evaluation of the Transnational Action Plan implementation

As the recommendations of the Transnational Action Plan are prepared for a longer time period, more precisely from 2026 until 2040, it is essential to adequately monitor and report about the progress of the various Measures indicated in the document. Also, after the conclusion of the project TRANSGEO, ongoing monitoring of the Transnational Action Plan implementation becomes essential to ensure that the Strategic Objectives, Priorities and Measures continue to support the geothermal transition in former fossil fuel regions. The monitoring process will be implemented through the evaluation of the detailed Measures and their outputs, as well as the set timeframes for their realization and help track the overall progress of geothermal activities, identify new developments at national and regional levels and provide a consistent basis for updating the Transnational Action Plan in the coming years.

Future monitoring will be carried out voluntarily by the consortium of Parties who sign the TRANSGEO Cooperation Agreement. These parties may be the original Partner institutions and Associated Partners that contributed to the activities, deliverables and results of the project TRANSGEO, as well as other organizations and institutions who commit to long - term support of the project's goals through signing of the Cooperation Agreement, Letters of Commitment and Letters of Intent. These organizations and institutions are not bound by regulations, but share an interest in maintaining the knowledge base and keeping the Transnational Action Plan relevant and up to date. These individuals and institutions ensure continuous advancement through awareness of and sharing within the network new legislative and legal frameworks, as well as market situations. Specific routes to new knowledge may include annual geothermal energy statistics from national offices, statements or reports from state organizations responsible for managing active wells, mandatory annual reporting on geothermal facilities submitted to relevant authorities and announcements or newsletters from national geothermal associations and clusters that provide insight into new projects and market dynamics. Monitoring and reporting will contribute to the improvement of the Transnational Action Plan implementation and will ensure flexible alignment of the original project goals with the evolving reality of well reuse and geothermal energy development.

To ensure sustained alignment among all organizations, the consortium will establish a working group (consisting of National Coordinators and Technical Committees) which will develop a detailed monitoring plan, organize progress meetings and prepare a yearly monitoring report, with a detailed elaboration of the achieved Measures covering information on the implemented activities, used resources, needed time and realized outputs. Also, in cases of yet not implemented Measures, the report will contain separate sections with indicated reasons for not achieving the set targets, as well as future plans for their realization. Furthermore, this concise document will summarize legal, technological, environmental and financial developments in each participating country, highlight new projects and regulatory changes and assess progress towards the broader goals of geothermal transformation. The report will be used internally to inform the voluntary network about the progress of the Transnational Action Plan implementation, but may also be made publicly accessible to support broader international, national, regional and local stakeholders to foster transparency, policy planning and public awareness efforts. Over time, this ensures that the project TRANSGEO remains both functional and visible internationally and nationally without requiring substantial permanent resources.

Through voluntary collaboration and structured reporting centred around a framework of implementing the Transnational Action Plan, the document evolves into a long - term knowledge hub that supports data - driven decision - making, early identification of geothermal opportunities, planning of repurposing activities and potential follow up initiatives at the EU level. This ensures also that the project results remain impactful even after the formal end of the project and that the foundational work continues to benefit the Central European countries and their efforts towards a sustainable energy transformation.



As mentioned, monitoring of the Transnational Action Plan is essential to ensure that the goals are achieved efficiently, transparently and sustainably, whereby this is feasible through the cooperation, knowledge and joint effort of the designated organizations and individuals. To ensure a high quality and strong monitoring process, the following recommendations are to be considered:

- **National Coordinators**
 - Each participating country should appoint a formally recognized national coordinator responsible for data collection, reporting and liaison with the Technical Committee.
 - Coordinators' roles should be established in a way that they ensure and dedicate time, resources and accountability for the respective tasks.
- **Technical Committee**
 - Establishing a Technical Committee composed of national, regional and local representatives.
 - Responsibilities of the Technical Committee would imply coordinating monitoring, validating reports, standardizing methodologies and proposing corrective actions.
- **Standardized monitoring indicators and reporting**
 - Defining SMART indicators (Specific, Measurable, Achievable, Relevant, Time - bound) for each Measure.
 - Using digital platforms or reporting systems for real - time data consolidation, cross - country comparison and transparency.
- **Stakeholder engagement and risk management**
 - Organizing workshops, technical trainings and consultations for public and private stakeholders for ensuring an effective implementation of the defined Measures.
 - Monitoring risks and hindering points (legal, organizational, financial, time) in order to adequately and timely apply risk mitigation actions and ensure a smooth implementation of the document's recommendations.
- **Continuous improvement**
 - Using monitoring data to adapt the document's targets and activities, improve resource allocation and implement lessons learned, all within the continuous improvement of the EU framework.

As mentioned, the Transnational Action Plan defines coordinated steps to promote the sustainable and efficient repurposing of hydrocarbon wells for geothermal energy production across Central Europe. The document focuses on 4 Categories: legal, knowledge and social frameworks; technological opportunities; environmental impacts; and financing instruments, whereby for each Category, a range of clear and actionable Measures has been proposed to achieve the intended targets. Given that the proposed Measures involve activities of varying complexity and resource requirements, it is realistic to anticipate potential obstacles, bottlenecks and implementation challenges. Therefore, the establishment of comprehensive risk management actions is essential to not only mitigate these challenges, but also proactively prevent any barriers to the successful implementation of the defined Measures and Transnational Action Plan in general.

To ensure quality risk mitigation and timely response to potential obstacles in the implementation, the following Table shows actions for each defined Measure, with elaborated activities and defined monitoring periods.



Table 2: Risk mitigation actions for the Transnational Action Plan implementation

Strategic Objective 1: Clear, efficient and sustainable regulatory frameworks		
Priority 1.1 Simplify, coordinate and modernize policy frameworks	Measure 1.1.1 Clarify well and land ownership, usage rights, liability and responsibilities	Legal document reviews and registry updates, annual compliance audits and public registry logs, verification databases Monitoring period: yearly
	Measure 1.1.2 Coordinate and unify policies across jurisdictions	Policy alignment matrices compared yearly against baseline, progress via signed inter - jurisdictional agreements and joint policy workshop minutes Monitoring period: yearly
	Measure 1.1.3 Ensure the alignment of new legislation and regulations with EU and national energy transition goals	Legislative tracking logs, KPI with a number of aligned laws enacted, verification by legal experts' reports Monitoring period: 5 years
	Measure 1.1.4 Adjust national and regional strategic and planning documents for fostering geothermal energy use from repurposed wells	Assess via document revision counts pre/post - implementation, track changes through version controlled plans and approval timestamps, review audits Monitoring period: 5 years
Priority 1.2 Streamline permitting procedures for well repurposing	Measure 1.2.1 Create One - Stop - Shop (OSS) permitting systems for well repurposing	System launch dates and usage stats, ongoing tracking through permit processing, time reductions via dashboards for status displays of applications, average processing time and queue length Monitoring period: yearly
	Measure 1.2.2 Introduce fast - track approval for projects meeting well integrity verification and safety criteria standards	Pre - qualification tracking identifies projects meeting criteria, monthly expedited permit counts, quarterly third - party certification audits Monitoring: yearly
Strategic Objective 2: Deeper knowledge and competences		
	Measure 2.1.1 Develop educational programs at secondary, university and postgraduate levels to create	Track enrolment/completion numbers in programs, use certification counts and graduate employment rates in geothermal roles



Priority 2.1 Educate and train well reuse experts and workforce	quality geothermal workforce in well reuse	Monitoring period: yearly
	Measure 2.1.2 Facilitate and encourage research and development programs, including joint industry - academic research on well reuse	Funded projects, publications and patents, progress via annual research and development output reports and collaboration agreements Monitoring period: semi - yearly
Priority 2.2 Enhance collaboration between experts	Measure 2.2.1 Build a network of experts to accelerate and enable geothermal well reuse	Network membership growth and active engagements, platform logins, events attended and knowledge - sharing outputs prepared, annual engagement surveys Monitoring period: semi - yearly
	Measure 2.2.2 Promote cross - border best - practice exchange through regional forums	Forums held and participants present, post - event surveys and documented adopted best practices, quarterly adaptation surveys Monitoring period: yearly
Strategic Objective 3: Favourable social and market conditions		
Priority 3.1 Enhance stakeholder trust and social acceptance	Measure 3.1.1 Raise awareness and knowledge among relevant stakeholders on the geothermal potential of repurposed hydrocarbon infrastructure	Campaign metrics (e.g., attendees registered, materials distributed, website visits, social media reach), pre/post surveys on knowledge levels, media monitoring Monitoring period: yearly
	Measure 3.1.2 Mandate early and ongoing transparent stakeholder consultation with affected communities	Consultation sessions logged and feedback incorporated, participation rates and resolution logs, meeting minutes with participants, feedback documentation Monitoring period: yearly
	Measure 3.1.3 Introduce community benefit agreements	Agreements signed and benefits delivered, annual fulfilment audits, contract registry, community satisfaction surveys Monitoring period: yearly
	Measure 3.2.1 Develop an integrated online platform for matching supply and demand of repurposed wells and proposing cost - effective geothermal reuse methodologies	Platform development milestones and user transactions, user satisfaction surveys Monitoring period: yearly
	Measure 3.2.2 Foster reuse of hydrocarbon wells by local heat	Database of assessment reports, monitoring of geothermal



Priority 3.2 Create favourable market conditions	market needs assessment and integration in urban planning	integration in zoning plans, approval documentation, surveys of developer interest Monitoring period: yearly
	Measure 3.2.3 Support scaling - up of the geothermal reuse market through development of district heating systems and related infrastructure	Infrastructure projects funded/built, energy output from new systems, construction progress reports, energy production/consumption data, customer growth tracking Monitoring period: yearly
Strategic Objective 4: Accelerated innovation in well reuse		
Priority 4.1 Improve data and information access	Measure 4.1.1 Develop open - access database of candidate and reused hydrocarbon wells by upgrading TRANSSEO IT tool for well assessment	Database usability, effectiveness and access stats, quarterly data quality audits, maintained and upgraded existing database and IT tool for well assessment (project TRANSSEO) Monitoring period: yearly
	Measure 4.1.2 Require public disclosure of well integrity testing, seismic monitoring and water quality data	Submission tracking, yearly compliance audits, standardization checks, publication logs Monitoring period: yearly
	Measure 4.1.3 Develop screening tools to identify and assess suitable wells, using digital technologies	Number of upgrades of the criteria catalogue (project TRANSSEO), reservoir indicators and scoring/ranking of wells, version tracking, increased number of reused code bases, completed projects Monitoring period: yearly
Priority 4.2 Develop new downhole technologies	Measure 4.2.1 Design new and innovative casing repair technologies	Prototypes developed and tested, field trial success rates, research projects submitted, prototype development records, patent tracking Monitoring period: 5 years
	Measure 4.2.2 Pilot new closed - loop geothermal retrofit technologies, including plug - and - play downhole heat exchanger systems	Pilots launched and performance data recorded, energy yield metrics, pilot project database, durability monitoring, cost/maintenance logs Monitoring period: 5 years
	Measure 4.2.3 Test geothermal reservoir stimulation techniques in suitable wells	Pilot tests of geothermal reservoir stimulation techniques, stimulation test logs, seismic



		monitoring, production increase measurements, data archive Monitoring period: yearly
Priority 4.3 Integrate digital monitoring	Measure 4.3.1 Deploy fiber - optic sensing for real - time well performance, well integrity and induced seismicity monitoring	Recommendations based on best practices, fiber - optic sensing, installation logs, real - time monitoring data, system availability, incident reports Monitoring period: 5 years
	Measure 4.3.2 Use predictive digital twins to optimize energy extraction and system design	Model development specifications, real - time validation results, optimization recommendations, performance improvement measurements Monitoring period: 5 years
Priority 4.4 Facilitate related technological breakthroughs	Measure 4.4.1 Develop solutions for reinjection problems in difficult geology	Solutions prototyped and tested, reinjection efficiency rates, research project documentation, pilot re - injection test results, injection sustainability data, number of wells used for reinjection, effectivity of reinjection Monitoring period: 5 years
	Measure 4.4.2 Develop highly efficient heat pump technologies to enable heat utilization of low and medium enthalpy geothermal energy potential	Efficiency gains in pilots, deployment numbers, prototype development documentation, pilot installation, recorded performance data, efficiency improvement measurements Monitoring: 5 years
Strategic Objective 5: Environmentally - protective and sustainable well repurposing		
Priority 5.1 Ensure knowledge of environmental status and potential impacts prior to reuse	Measure 5.1.1 Conduct environmental impact assessment	Number of assessments completed per project, approval rates and mitigation plans implemented, documentation database, compliance reports Monitoring period: yearly
	Measure 5.1.2 Conduct baseline well integrity assessment	Assessments logged pre - reuse, pass/fail rates and remediation follow - up, post - remediation testing Monitoring period: yearly
	Measure 5.2.1 Restore habitat and remediate pollution	Site restoration metrics, pre/post environmental sampling, restoration activity logs, biodiversity surveys



Priority 5.2 Protect land, water and ecosystem prior to field operations	Measure 5.2.2 Mitigate noise and light pollution	Monitoring period: yearly Compliance logs during operations, log of neighbour complaints, continuous measurements from noise/light monitoring stations, reports on the effectiveness of mitigation Measures
	Measure 5.2.3 Avoid gas emissions and apply safe management protocols	Monitoring period: yearly Emission monitoring data, zero - incident targets via sensors, greenhouse gas emission monitoring protocols, methane/CO ₂ sensors, incident reports
Priority 5.3 Protect the environment during well workover	Measure 5.3.1 Ensure workover operational plan to manage hydrogeological and geo - mechanical risks	Monitoring period: yearly Plans approved and executed, risk incident reports prepared, work plan approvals, risk assessment documentation, post - work reviews
	Measure 5.3.2 Conduct well repair or retrofit to avoid leakage and isolate well from swelling formations	Monitoring period: yearly Post - repair integrity tests, leak detection logs, repair work orders, post - repair testing
	Measure 5.3.3 Limit sound and light disturbance by insulating the site and operating during daytime	Monitoring period: yearly Actions are provided under Priority 5.2 Protect land, water and ecosystem prior to field operations, Measure 5.2.2 Mitigate noise and light pollution
Priority 5.4 Protect the environment during system operation	Measure 5.4.1 Reinject produced fluids to avoid subsidence, scaling, gas/radionuclide release and waste processing	Monitoring period: yearly Reinjection volumes vs. production, subsidence monitoring, production/re - injection volume logs, mass balance calculations
	Measure 5.4.2 Conduct appropriate monitoring/inspection and maintenance to detect and prevent leaks and other potential environmental impacts	Monitoring period: yearly Scheduled inspections logged, leak prevention effectiveness, preventive maintenance schedule, completion logs, performance trends
Strategic Objective 6: Favourable financial conditions for well reuse		
	Measure 6.1.1 Create targeted grant programs for well repurposing at EU level	Monitoring period: yearly Programs launched and funds allocated, projects financed, program launch documentation published, grant application



Priority 6.1 Ensure long - term repurposing investments through the use of EU financing instruments		processing, funding disbursement logs Monitoring period: yearly
	Measure 6.1.2 Establish a well repurposing community in Central Europe	Community events and members, engagement metrics, community platform membership, event participation, collaboration outcomes Monitoring period: yearly
	Measure 6.1.3 Foster transnational project collaborations for EU funding (including community - led initiatives)	Joint projects submitted and approved, partnership documentation prepared, successful awards, securing funding Monitoring period: yearly
Priority 6.2 Broaden the portfolio of financing instruments on national and regional level	Measure 6.2.1 Introduce innovative public funding programs for environmental remediation and well testing	Programs initiated, funds disbursed and tests completed, program launch documentation, grant approvals, expenditure tracking, results documentation Monitoring period: yearly
	Measure 6.2.2 Initiate national and regional funding mechanisms for well repurposing	National and regional financing mechanisms established, applications approved, legal documentation for mechanisms launched, leverage tracking Monitoring period: yearly
Priority 6.3 Attract private sector investments	Measure 6.3.1 Educate potential investors on well repurposing for geothermal energy production	Sessions held and materials distributed, investor interest surveys, educational session documentation, tracking interest Monitoring period: yearly
	Measure 6.3.2 Facilitate private sector investment and Public - Private Partnerships (PPPs)	PPPs formed and investments tracked, capital raised, PPP framework documentation, investment agreements, capital flow tracking, project results Monitoring period: yearly

Finally, monitoring of the Transnational Action Plan involves establishing clear, measurable objectives and key performance indicators (KPI), setting up a structured monitoring framework with assigned responsibilities, standardized reporting and regular transnational and cross - border coordination. It requires collecting data from reliable sources, using digital platforms for transparency and conducting periodic evaluations or audits to assess progress. Engaging public and private stakeholders provides ground - level insights, while digital technologies help track indicators in real time. The process should be continuous, collaborative and adaptable, incorporating lessons learned to ensure effective implementation and long - term impact across all participating countries and levels.



4. Concluding remarks

The transition from fossil to geothermal energy presents a significant investment into clean, more resilient and sustainable future. Through policy support, phased implementation, stakeholder collaboration and targeted infrastructure development, geothermal energy has the potential to become a reliable cornerstone of national renewable energy portfolios. Exploited either through newly drilled wells or repurposing old, dilapidated infrastructure, it is a reliable and inexhaustible energy resource used for heating, cooling, electricity and storage purposes. In these terms, with a long history of natural gas and oil production, Central Europe possesses a largely untapped asset: thousands of abandoned or underutilized wells that can be repurposed for geothermal energy production. Leveraging this existing infrastructure presents a cost-effective, lower risk investment to accelerate renewable heat and power deployment, while supporting the overall climate and energy transition goals. It is well known that reusing abandoned wells reduces upfront drilling costs, shortens development timelines and minimizes environmental disturbance compared to greenfield geothermal projects, as well as provides an opportunity to revitalize former fossil fuel sites, preserve skilled jobs and strengthen national, regional and local economies.

TRANSGEO, as a project focused on advancing geothermal energy utilization, provides concrete proposals, practical solutions and strategic recommendations aimed at accelerating and strengthening the reuse of abandoned hydrocarbon infrastructure for geothermal purposes. Bringing together 11 partner organizations from 5 countries, the consortium has developed a wide range of technical, digital, assessment and decision-making tools among which is this **Transnational Action Plan with intervention set for geothermal reuse of abandoned hydrocarbon wells**, which outlines a structured intervention framework for the geothermal repurposing of abandoned hydrocarbon wells, including clearly defined steps and Measures to support the revitalization of unused infrastructure across the Central European region.

Complementing the previously developed **Transnational Strategy for the structural change of fossil fuel producing regions to geothermal**, this document serves as a practical guidance framework for both public and private stakeholders, by establishing a strong foundation for future investments in well repurposing and sustainable energy development. Based on the identified challenges and bottlenecks at both transnational and national levels, the core of this document consists of Strategic Objectives and Priorities and is supported by detailed Measures divided into 4 main Categories: legal, knowledge and social frameworks; technological opportunities; environmental impacts; and financing instruments, as well as their detailed elaboration through activities, organizational, time and financial resources and potential outputs.

With validity extending until 2040, the Transnational Action Plan presents a broad range of practical Measures, beginning with amendments in legal frameworks and administrative procedures, improvements in education systems and market accessibility, as well as technological advancements through open data registries and digital solutions. It also addresses environmental protection through safety actions, emission reductions and mitigation of environmental disturbances, while promoting financial support with international networking, joint project applications and the mobilisation of private capital. By identifying potential implementers, funding sources and indicative budget allocations, the Measures provide a comprehensive roadmap for future repurposing of abandoned hydrocarbon infrastructure for geothermal energy at both transnational and national levels.

Finally, as this document has been developed by the consortium of the project TRANSGEO, it does not carry legal obligation at national levels, but serves, mainly, as a reference framework that identifies existing gaps and outlines the first steps towards a structured transition from a fossil-based energy model to a geothermally driven future in Central Europe.



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