Managing Urban Shallow geothermal Energy

Project number GeoE.171.006

D 6.1 Cross-cutting issues and capitalising on knowledge inside GeoERA

Final version

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General description of the deliverable in the application

The Knowledge Exchange Workshops intend to establish defined outreach activities. All workshops will consist of a presentation and discussion / active group work session and will be documented by minutes and photo protocols.

Version

Version	Description
08-10-2021	Initial version

List of abbreviations

Abbreviation	Full name
KEW	Knowledge Exchange Workshop

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1 INTRODUCTION

This report outlines the series of Knowledge Exchange Workshops (KEW) organized by MUSE together with other projects inside and outside of GeoERA, which were held between 2018 and 2021. Aim of the workshops was to exchange knowledge and discuss possibilities to harmonise methods and strategies in overlapping research topics. Furthermore, they intended to establish an institutional interface to other projects in the Geo-Energy Specific Research Topics (SRTs) and GeoERA themes Groundwater and Mineral Resources.

All workshops consisted of presentations and discussion / active group work sessions and were documented by minutes and photo protocols. A total of eight workshops were held between 2018 and 2021, hosted both online and in person. Theiyare listed in chronological order below:

1. Monitoring workshop - Essen, 2018
2. Temperature modelling workshop - Zagreb, 2019
3. Mapping workshop - Offenburg, 2020 (cancelled due to the pandemic)
4. GeoERA webinar - online, 2020
5. GeoERA webinar on stakeholder interaction – online, 2020
6. Shallow geothermal energy days - online, 2020
7. Mapping webinar with GEOCOND – online, 2021
8. GPS2021 – Geothermal session – online, 2021
9. GPS2021 – Side event urban geothermal session – online, 2021

An online annex including agendas; participation lists of lecturers and participants; and PowerPoint presentations for each KEW is available at the followink link:.

https://projects-gba.geologie.ac.at/index.php/s/bnptYm4a0NgUG0S

2 KNOWLEDGE EXCHANGE WORKSHOPS

2.1 Monitoring Workshop – Essen, 2018

Location: Essen, Germany

Date: November 29, 2018

Time: 11:00 –15:40 (CET)

Hosts: This Knowledge Exchange Workshop was co-organized by international projects GeoPLASMA-CE, GRETA and MUSE. The KEW was part of the German Geothermal Congress (DGK 2018).

Theme: Knowledge Exchange Workshop on environmental monitoring of Shallow Geothermal Energy Use.

Aim: The KEW addressed existing experiences and new approaches for environmental monitoring. It also aimed at discussing to what extent and how monitoring should be considered in licensing and management procedures of Shallow Geothermal Energy (SGE) installations and how monitoring can contribute to information systems and strategies for mitigation of (urban) heat island effects.

Content:

Existing experiences and new approaches for environmental monitoring were presented. Environmental monitoring of SGE installations is important to assess how multiple installations affect each other. This is vital for a quickly growing technology, especially in densely settled areas with presence of shallow groundwater bodies.

Block 1: 11:00 – 12:40 (CET)

The topics and case studies were presented as 15-minute presentations:

- Thermal impact assessment of groundwater heat pumps (GWHPs), **Alessandro Casasso & Arianna Bucci, Polytechnical University of Torino (GRETA);**
- The Cardiff Urban Geo Observatory, UK: monitoring of a shallow unconsolidated urban aquifer, **Gareth Farr, British Geological Survey (MUSE);**
- Monitoring the anthropogenic heat impact on a shallow aquifer in Vienna, **Cornelia Steiner, Geological Survey of Austria (GeoPLASMA-CE);**
- Thermal interaction of neighborly shallow geothermal systems: An example project from Dresden, Germany, **Tom Reinhardt, geoENERGIE Konzept GmbH (GeoPLASMA-CE);**
- Thermal interactions between neighboring shallow geothermal systems: challenges and possible solutions, **Henk Witte, Groenholland Geo Energy systems.**

Block 2: 14:00 – 15:40 (CET)

Based on case studies presented in the first session of the workshop, gaps and barriers to overcome, as well as approaches for harmonization of methods and concepts were discussed in the interactive second session of the workshop. The topics covered included:

- Activities of the Polish Geological Institute –National Research Institute in mapping and monitoring of shallow geothermal energy, **Maciej R. Kłonowski, Polish Geological Institute (MUSE);**
- The role of hydraulic models in the evaluation process of geothermal use of Alpine aquifers: Example of the touristic centre Davos, Switzerland, **Peter Huggenberger, University of Basel (GRETA);**
- Geothermal use of an Alpine aquifer –pilot study Davos, **Stefan Scheidler, University of Basel (GRETA);**
- Connecting shallow geothermal resources to the Internet of Things**, Fabian Boettcher, Technical University of Munich (GRETA);**
- GEOENVI: Tackling the environmental concerns for deploying geothermal energy in Europe, **Philippe Dumas, European Geothermal Energy Council**.

2.2 Temperature modelling workshop - Zagreb, 2019

Location: Zagreb, Croatia

Date: 23rd – 24th January 2019

Time: Day 1: 13:00 - 17:00; Day 2: 9:00 - 12:00 (CET)

Hosts: GeoERA-MUSE and HotLime

Theme: Temperature modelling

Aim: The aim of the workshop was to share methodological skills for the development of temperature models for the estimation of the geothermal potential for shallow and deep use. The focus was on questions concerning the preparation of input data (corrections of bottom hole temperatures) and the practical implementation with different model approaches, as well as dealing with uncertainties.

Content:

Day 1: January 23, 2019

A variety of topics were discussed including on day one:

- **Thorsten Agemar (Leibniz Institute of Applied Geophysics)**, Preparation of input data such as Corrections of Bottom Hole Temperatures;

- **Thorsten Agemar (Leibniz Institute of Applied Geophysics),** Methods of geostatistical temperature modelling;
- **Gregor Goetzl (Geological Survey of Austria),** Methods of conductive temperature modelling;
- **Hans Veldkamp & Maartje Struijk,** Temperature Modelling using the methodologies developed at the TNO (for shallow and deep subsurface).

Day 2: January 24, 2019

- **Gregor Goetzl & Cornelia Steiner (Geological Survey of Austria),** Temperature modelling focusing on the applications for shallow geothermal energy.
- Break out session for a detailed discussion about temperature modelling as a tool in deep and shallow geothermal applications.

2.3 Mapping workshop - Offenburg, 2020

Location: Offenburg, Germany

Date: March 4, 2020 (**cancelled due to COVID-19 pandemic**)

Time: 12:00 –17:00 (CET)

Hosts: EU projects GeoERA-MUSE and GEO4CIVHIC. The workshop was planned to be held within the framework of GeoTHERM expo & congress 2020. Due to the COVID-19 pandemic it was cancelled last minute.

Theme: Spatial plans and mapping of shallow geothermal energy for energy planning and environmental management.

Aim: The motivation of conducting the KEW was to discuss the EU decarbonization strategies for the period 2021 to 2030 which offers opportunities for a significant increase of shallow geothermal use. Decarbonization strategies which will favor shallow geothermal energy use will increase pressure on planners and authorities. Spatial planning and environmental management tools will therefore be needed to regulate the increase in shallow geothermal energy development.

The focus of the KEW was to discuss:

- The purposes of spatial plans and how to meet the requirements of the addressed target groups;
- Contents of mapping and interfaces to meet the requirements of energy planning and environmental management.

In the workshop, new challenges, novel concepts, as well as the need for harmonizing the process of shallow geothermal mapping would have been discussed. The workshop wanted to address researchers, as well as users of maps related to shallow geothermal energy use. The agenda for Session 1 of the KEW included eight short presentations conducted by experts in their chosen field.

The planned topics included:

1. **C. Steiner (Geological Survey of Austria)**: Mapping of urban areas in the GeoERA project MUSE;
2. **E**. **Di Sipio (University of Padua)**: Geothermal mapping as a tool to develop an interface to facilitate shallow geothermal plant feasibility assessment by non-expert users: the Geo4Civhic experience;
3. **J. Epting (University of Basel):** City-scale solutions for the energy use of shallow urban subsurface resources - Bridging the gap between theoretical and practical resources
4. **M. Fuchsluger (Geological Survey of Austria)**: Resource mapping focused on energy planning for GeoPLASMA-CE and MUSE;
5. **J. G. Fritsche (Geological Survey of Hessen, Germany)**: Mapping and publication of geothermal data in the federal state of Hessen, Germany;
6. **S. Rumohr (Geological Survey of Hessen, Germany)**: Fact sheets for utilisation of near-surface geothermal energy with borehole heat exchangers
7. **D. Bertermann (GeoZentrum Nordbayern)**: Very Shallow Geothermal Potentials of Bavaria;
8. **F. Boettcher (Technical University of Munich)**: Mapping of potentials for the thermal use of groundwater in the area of Munich, Germany.

The agenda for Session 2 included a panel discussion. Part 1 of the panel discussion included: feedback on the contents presented in Session 1 and the identifying of further topics to be discussed in Part 2 of the panel discussion.

2.4 GeoERA webinar - online, 2020

Location: Online Webinar

Date: November 9 - 13, 2020

Hosts: GeoERA

Aim: The webinars provided an insight into the current research projects of GeoERA and included external perceptions from guest speakers to highlight the relevant links between geosciences and their sectors.

Content: The GeoERA Webinar series comprised of a series of five sessions held online November 9 - 13, 2020. The sessions focused on how geoscience and subsurface information can help address the UN sustainable development goals and the targets set forth by the European Green Deal. All GeoERA projects presented highlights of their work in the session of their respective theme.

- Session 1 – Monday, November 9, 2020

Theme: GeoERA – Geological Service for Europe.

An overarching session on the grand challenges faced by society and how geoscience can play a key role in addressing them.

- Session 2 – Monday, November 9, 2020

Theme: Information management

- Session 3 – Tuesday, November 10, 2020

Theme: Raw Materials

- Session 4 – Thursday, November 11, 2020

Theme: GeoEnergy

Session of projects about decarbonization and the role of the subsurface in the transition, including deep and shallow geothermal energy. The presentation of MUSE covered current barriers and challenges of shallow geothermal energy in Europe.

- Session 5 – November 11, 2020Theme: Groundwater Resources

2.5 GeoERA webinar on stakeholder interaction - online, 2020

Location: Online Webinar

Date: November 10, 2020

Hosts: GeoERA projects MUSE, Geoconnected, HIKE, EuroGeoSurvey

Aim: This online workshop aimed at exchanging ideas on targeted stakeholder communication and offered a discussion rounds and hands-on trainings on drafting a targeted communication strategy.

Content: The workshop addressed all GeoERA project leads and interested project team members on targeted communication in the context of:

- Setting up a communication strategy (MUSE)
- Digital communication (Geoconnected)
- Communication with policy makers (EuroGeoSurveys)

The detailed program is listed below:

Introduction session

- Welcome address and introduction to the workshop (Serge van Gessel, HIKE)
- Principles of stakeholder interaction – the MUSE's stakeholder interaction guideline (Gregor Goetzl, MUSE)
- Digital stakeholder interaction – experiences from GeoConnected (Renata Barros, Geoconneced)
- Interaction with policy makers (Patrick Wall, EGS Secretariat)

Interdisciplinary session

- Plenary discussion and experience sharing on stakeholder interaction – short statements by the participants (moderation Serge van Gessel, HIKE)

Break out group workshops

- Room 1: Setting up a stakeholder interaction strategy (Gregor Goetzl)
- Room 2: Digital stakeholder interaction (Renata Barros)
- Room 3: Interaction with policy makers (Patrick Wall)

Closing plenary

- Feedback from the break out groups and conclusions (Serge van Gessel)

2.6 Shallow Geothermal Energy Days - online, 2020

Location: Online Workshop

Date: December 4, 9 & 11, 2020

Time: 10:00 - 12:00 (CET) each day

Hosts: This event was organised by the European Geothermal Energy Council (EGEC), the Renewable Heating and Cooling Platform (RHC-ETIP), GEOTRAINET and Geothermal-DHC COST action, with the support of the GeoERA-MUSE project, EuroGeoSurveys, GEOCOND project and EHPA.

Theme: Shallow Geothermal Energy

Aim: The of the “European Shallow Geothermal Energy Days” is connecting policy makers, scientists and professionals to discuss ways to boost the market uptake of geothermal heat pumps and underground thermal energy storage.

Content:

Friday, December 4

- Session 1: Policy and market session: Seize the Renovation Wave to decarbonize heating and cooling;
- Session 2: Panel discussion - The expected and potential role of shallow geothermal energy in the “European Green Deal”.

Wednesday, December 9

- Innovative and good practices of shallow geothermal energy across Europe and abroad.

Friday, December 11

- Research and innovation session: Breakthroughs in shallow geothermal technologies.
- Part 1: Financing research projects - 10:00 to 11:00.
- Part 2: Research on Life Cycle Assessment of geothermal - 11:00 to 12:30.

Tuesday 15th December 2020 - Side event

- GEOTRAINET Annual General Meeting

2.7 Mapping webinar with GEOCOND, online 2021

Location: Online Webinar

Date: May 10, 2021

Time: 15:00 – 16:30 (CET)

Hosts: GeoERA-MUSE and GEOCOND projects

Theme: Novel approaches in shallow geothermal resource mapping

Aim: This webinar presented findings of two recently accomplished projects addressing mapping for shallow geothermal energy applications. The EU project GEOCOND addressed new and enhanced materials for BHE pipes and grout for improved efficiency and economy of shallow geothermal installations. The work in this project also included the generation of pan-European maps of relevant ground parameters. The national

Austrian project GEL-SEP addressed the integration of shallow geothermal energy into interactive heat supply maps at various scales of resolutions between a community and individual building level.

Content:

The webinar consisted of two talks detailed below:

- **Adela Ramos Escudero (University of Cartagena) & Burkhard Sanner (UbeG GbR):** Large scale, pan-European resource mapping –results from the EU project GEOCOND.
- **Martin Fuchsluger & Cornelia Steiner (Geological Survey of Austria):** The application of g-functions in shallow geothermal resource mapping for the project GEL-SEP (Austria).

2.8 GPS2021 – Geothermal session – online, 2021

Location: Online Workshop

Date: June 8, 2021

Time: 16:00 – 18:00 (CET)

Hosts: Geological Survey Organizations in Europe (BRGM, GBA, GSB and EGS) and the U.S.A. (USGS)

Theme: Bridging geothermal energy to the next level in the United States and the European Union.

Aim: The GPS2021 was a five-day event discussing the topic of subsurface management and its essential role for planning a sustainable future above ground. Live sessions addressed a different aspect of geoscience-related subsurface use, management, planning, and policy, comparing and learning from innovative science and experiences of both sides of the Atlantic Ocean.

The session about Geothermal energy aimed at providing transatlantic views on the future of geothermal energy, including: the expected opportunities, prevailing challenges, and the anticipated role of Geological Survey Organizations. In this context, attention is paid to the research and innovation roadmaps of the United States Department of Energy, the U.S. Geological Survey and EuroGeoSurveys as well as to showcasing latest research activities inside these organizations. This session addressed policy makers, regulators, interest groups and other stakeholders dealing with the use of geothermal energy.

At present, geothermal energy used for electricity production, heating, cooling and seasonal heat storage still accounts for a small proportion of the global energy market production. The transition of the energy industry into the production of low carbon renewable energy paves way for geothermal energy to become a key player in the upcoming decades. To enter the “geothermal decade” as proposed by the European Geothermal Energy Council, still several technological as well as socio-economic barriers needs to be addressed by policy makers and research.

Content:

The workshop included seven talks from a variety of speakers from the United States and European Geological Surveys. Topics covered included the role of geothermal energy in the energy transition; geothermal research and innovation at Geological Surveys from a transatlantic view; and research needs to address barriers for further development of the technology. The list of speakers and presentation titles are shown below:

- Future of US Geothermal, **Lauren Boyd (US Department of Energy);**
- Innovation & momentum for deep geothermal in Europe, **Gerdi Breembroek (Chair of the Implementation on Deep geothermal, SET Plan);**
- Role of Geological Survey Organizations for the future, **Erick Burns (United States Geological Survey);**
- Geothermal energy –an important aspect of subsurface resource management, **Serge van Gessel (EuroGeoSurveys);**
- Technical challenges in the US: High-Temperature Resources, **Doug Blankenship (USDOE & Sandia National Lab);**
- The development of high-temperature geothermal energy in mainland France: a technological and societal challenge, **Mariane Peter-Boire (BRGM–France)**
- Technical challenges in the US: Low-Temperature & Underground Thermal Energy Storage Resources, **Colin Williams (USGS);**
- Managing urban shallow geothermal energy –the GeoERA MUSE project, **Cornelia Steiner (Geological Survey of Austria):**

Online link to the documentation of the event: https://www.gps2021.org/material

2.9 GPS2021 Side Event - Urban Geothermal energy - online, 2021

Location: Online Workshop

Date: June 14, 2021

Time: 16:00 – 18:30 (CEST)

Hosts: GeoERA MUSE

Theme: Urban geothermal energy use with a special reference to shallow subsurface application - New horizons and challenges.

Aim: The GeoERA project MUSE organized this side event of GPS2021 dedicated to urban geothermal energy. This workshop aimed at providing transatlantic views on the future of managing geothermal energy in urban areas. Special attention was paid on the inputs of Geological Survey Organizations on data assessment, governance and management. This session addressed researchers, local authorities and other stakeholders dealing with the use of geothermal energy in urban areas.

Urban areas are key focus areas for climate change mitigation and the transitioning energy industry. Shallow geothermal energy will become an important technology for providing space heating and cooling for buildings and other city infrastructure and supply low temperature heat storage. Deep geothermal energy may play an important role for supplying conventional district heating systems and the cogeneration of electricity. Using shallow geothermal energy in urban conglomerates offers great opportunities and challenges at the same time when it comes to the interaction with groundwater bodies or the use of the surface and subsurface space.

Content:

The workshop included six short presentations covering a range of topics including:

- Overview of legal framework for shallow geothermal use in Europe **(Maciej R. Kłonowski, Polish Geological Institute -National Research Institute, Poland);**
- Exploring the need for an adaptive management concept in urban shallow geothermal use **(Alejandro Garcia Gil, Geological Survey of Spain);**
- The significance of groundwater and underground infrastructures to shallow geothermal system **(Yu-Feng F. Lin, University of Illinois at Urbana-Champaign, United States);**
- Recent and planned USGS research on thermal energy storage and low-temperature geothermal energy **(Erick Burns, U.S. Geological Survey, United States);**
- Resource maps -important inputs for management decisions **(Cornelia Steiner, Geological Survey of Austria);**
- Case study Munich: Investigation of urban groundwater temperatures and the development of a groundwater management tool for the thermal use **(Kai Zosseder & Fabian Boettcher, Technical University of Munich, Germany).**

A panel discussion was held at the end of the workshop with the aim of discussing new horizons and challenges for the use of geothermal energy in urban areas.

Online link to the documentation of the event: https://www.gps2021.org/material

3 SUMMARY AND CONCLUSIONS

In the framework of GeoERA MUSE eight knowledge exchange events took place. One event was already planned but needed to be cancelled in the last moment due to the emerging CoViD-19 pandemic. As the pandemic occurred in the final 18 months of GeoERA MUSE, most activities needed to be shifted to virtual space. Moreover, large physical workshops in cooperation with external organisations and initiatives, like the "Shallow Geothermal Energy Day event 2020" in Barcelona in cooperation with the European Geothermal Energy Council and the Renewable Heating and Cooling Platform needed to be cancelled. In the framework of this event, a workshop with the International Hydrogeological Association (IAH) could not take place.

Nevertheless, the KEWs organized by MUSE addressed relevant aspects of managing urban shallow geothermal, such as:

- Environmental monitoring of shallow geothermal energy use and its impact on shallow groundwater bodies
- Temperature measurements and temperature modelling
- Resource assessment and resource management in urban areas
- Mapping approaches for shallow geothermal
- Stakeholder interaction
- The European shallow geothermal market and recent developments

In total, the accomplished activities reached more than 300 stakeholders from R&D (inside and outside of GeoERA), local communities and authorities as well as sectoral agencies and service providers dealing with shallow geothermal energy use. Various collaborations with other EU research projects, such as GRETA (Interreg), GeoPLASMA-CE (Interreg), GEOENVIE (H-2020), GEOCOND (H-2020), Geo4CIVHIC (H-2020) were initiated. The highlight of knowledge exchange was achieved during the GPS 2021 event by involving colleagues from the US (USGS, Geological Survey of Illinois) into shallow geothermal energy use in urban areas.

4 ANNEX

An online annex including agendas, participation lists of lecturers and participants; and PowerPoint presentations for each KEW is available at the following link:

https://projects-gba.geologie.ac.at/index.php/s/bnptYm4a0NgUG0S