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Deliverable D8.7

Production of Training Manual and Technical Brochure

(in English and national languages)

WP8 – T8.2

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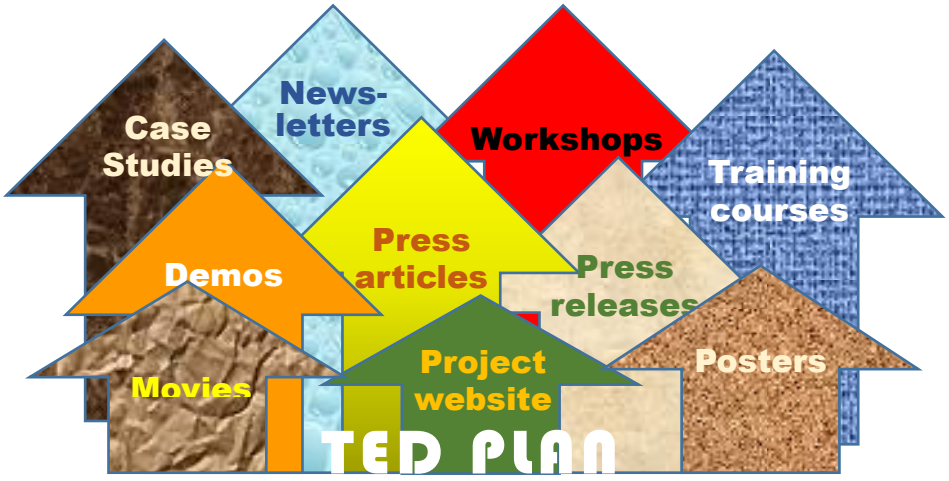
Lead beneficiary	**RGS - Romanian Geoexchange Society** (Romania)
Author	**Doinita - Iuliana Cucueteanu (RGS) + All the partners inputs**



Dissemination Level

PU	Public	**X**
CO	Confidential, only for members of the consortium (including the Commission Services)	
CI	Classified, as referred to in Commission Decision 2001/844/EC	

Document History

Version	Date	Authors	Description
REV 0	12/07/2023	D. Cucueteanu (RGS responsible)	D8.7 First / Draft document
REV 1	20/07/2023	Adriana Bernardi (Coordinator)	Commented / corrected / completed version
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REV 2	21/07/2023	Adriana Bernardi (Coordinator)	Final version reviwed
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Disclaimer

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This document was verified by the project Coordinator and was not submitted to an internal review because:

(a) its format and content were subject of a preliminary / initial debate in the Consortium with the occasion of the approval of the TED Strategy and the TED Plan already reported to EC – EASME in M6,

(b) its content is a synthesis of all partners inputs (manuals / translations) realized in the period covering M12 – M64.

The revision uploaded in EU – EASME in the REV 2 FINAL file exactly includes all the corrections, observations and suggestions made by the Coordinator.

Contents

Publishable summary

The **GEO4CIVHIC** D8.7 **Production of Training Manual and Technical Brochure** (in English and national languages) *is a public document delivered in the context of* ***WP8, Task 8.2 – Training program*** *due in M64 (July 31st, 2021).*

This document presents the Training Tool Package (TTP) of products for training purposes in the courses and workshops activities planned in the final period of time of the GEO4CIVHIC project and further dissemination of the scientific and technical results. The finalization of the TTP up to the end of July represents the condition for the training period of time that will be from August to November 2023.

D8.7 deliverable presents the TTP elaboration strategy, componence, responsibilities and management.

The elaboration of the Training Tool Package implied all the researchers / partners and requested a lot of managerial perseverance and rigour. The result of this work is represented by Training Manual formed by 7 Volumes, 2 Technical Brochures, a DSS User Manual and a Worker User Manual for the Application, all these 11 products being created in English language and their translation into 6 national languages (Italian, French, German, Spanish, Romanian and Greek), meaning a total of 77 products / files / training tools . All these products will be uploaded in the GEO4CIVHIC project website goo4civhic.eu.

Shortly, the **main conclusions** of the D8.7 presented at the end of this deliverable are related with the following:

1. The coronavirus pandemic impact.
2. The TTP creation was not explicitly provided in the GA.
3. The role of TTP in the training courses under T8.2 and as a valuable asset for ECoE network.

Abbreviations

DSS	Decision Support System
ECoE	European Centres of Excellence in shallow geothermal application in civil and historical buildings
GA	Grant Agreement
GEO4CIVHIC	Most Easy, Efficient and Low Cost Geothermal Systems for Retrofitting Civil and Historical Buildings
H&C	Heating and Cooling
M[nn]	Month [nn]
RGS	Romanian Geoexchange Society
T[n.n]	Task [n.n]
TTP	Training Tool Package
TED	Training, Education and Dissemination
WP	Work Package

1. Introduction

The lead partner of WP8, T8.1, T8.2 and T8.3 is **Romanian Geoexchange Society RGS** but the Training Tool Package is a result of all the consortium partners contribution.

The elaboration of the Training Tools Package – TTP was **implicitly** included in the task **T8.2 – Training Program** that formally should start in M35 according to the project Gant Graph. However, due to the:

(i) The complexity of the project and therefore of the TTP;
(ii) The need for the start of the courses to have been preceded by the completion of the TTP;
(iii) The experience from previous projects,

the concern for the development of the TTP started as early as M12, at the management meeting in Malta. This is where the debate on the TTP started and led to the first concrete decisions in M18 - Dublin, namely:

- Proposal / decision on the complete componence of the TT package;
- Proposal / decision on the structure and content of the Training Manual;
- Proposal / decision on authors and authorship responsibilities for each piece of TTP;
- Proposal / decision on the translation aspects and responsibilities;
- Proposal / decision on the scientific and linguistic verifications of each piece of TTP;
- Proposal / decision on editing technical procedure;
- Proposal / decision on the Gantt graph of the TTP elaboration.

The debates on these issues were significantly hampered by the impossibility to evolve on demo-cases during the pandemic period and resumed after the first post-pandemic meeting, in M42 - September 2021 in Padova.

In Padova, the debates arrived at final decisions, the preliminary “ideas” became a complete set of rules in the TTP elaboration and the Gant graph became final working plan. The most important decision was on the final list / content of all necessary pieces of the Training Tool Package.

All the pieces of TTP are uploaded in the GEO4CIVHIC website geo4civhic.eu.

2. Synthesis table of TTP components elaborated according GA provisions

In M42 Padova the consortium partners took the final decision on the components of the Training Tools Package that should be finalized before the training course beginning. The synthesis of these components is presented in the table below. It contains the complete list of TTP components that were finalized up to the end of July 2023 and were uploaded in the GEO4CHIVHIC website as they were developed / completed. The elaboration matrix above the TTP components offer a synthetic general picture of the stage of development of each piece of the TTP.

TRAINING TOOLS Manuals / Volumes / Brochures	**NAME** Of the Training Tool	**TRAINING TOOLS CONTENT**
TRAINING MANUAL		
1. Training Manual - VOLUME 1 - EN	**Energy needs and technical solutions for efficient buildings**	According to the recent policies regarding energy use in buildings and the need for retrofit strategies to move toward zero (or nearly-zero or plus) energy buildings, the aim of the GEO4CIVHIC project is to foster the retrofitting of civil and historical buildings by facilitating the installation, reducing costs and increasing efficiency of the different components through shallow geothermal systems. In particular, policies concerning the reduction of buildings' energy needs should be supported by proposing strategies that integrate ground source heat exchangers with other renewable energy sources. The main goal is to raise awareness on the potential energy saving achievable with optimal sizing and limited impact on the urban environment.
2. Training Manual - VOLUME 1 – 6 languages	Same as [1] translated in 6 national languages (6 files)	
3. Training Manual - VOLUME 2 - EN	**Geology and mapping**	This manual focusses on the role of geology on the geothermal closed loop systems design and feasibility. To help the operators and planners a facility tool method has been developed in the GEO4CIVHIC Project, in order to choose the best drilling methods to realize ground heat exchange probes and make available a fast preliminary approach to evaluate the feasibility and estimate the costs of ground heat exchanger probes. In particular, a method to create a guidemap, called "Drillability" was developed. "Drillability" is understood as as a predictive tool of the most suitable drilling methods and related borehole heat exchanger types for a given underground, with the estimated installation time in function of the rig and drilling technique types and the local geological constrains. The mapping method proposed, was verified and validated by comparison with the measured drilling times and costs, considering the specific techniques applied in the real pilot sites of the GEO4CIVHIC project. The drillability maps at local scale, compared with the data collected on-site, such as drilling times and costs, considering the specific techniques applied in the real pilot sites of the GEO4CIVHIC project, prove that the methodological approach is reliable and extendable to other sites. The local maps can be even more detailed and updated depending on the availability and distribution of affordable geological information about the subsoil assessment. The most suitable drilling technology for shallow geothermal applications in a given geological context plays a key role in the techno-economic evaluation of shallow geothermal solutions. The installation costs are one of the main constraints to the wider application of shallow geothermal heat exchangers and are due mainly to the drilling time and fees. Drillability maps at European and municipal scale are proposed as a guideline for drillers and ground source heat pump designers. The former summarizes the most suitable drilling technology based on lithology and borehole heat exchangers type, whilst the latter provides an insight in the ground thermal properties and the installation timing/costs. In the GEO4CIVHIC Project, a database correlating drilling technique to rock types, time needed to drill a borehole at 100 m depth and drilling costs, was created. Local drillability features are compared to in situ real data in four test sites. The 4 test sites information, show a good agreement between local maps, obtained by bibliography information and thermal properties database built in the project, and real site conditions, validating the innovative methodology proposed.
4. Training Manual – VOLUME 2 – 6 languages	Same as [3] translated in 6 national languages (6 files)	
5. Training Manual - VOLUME 3 - EN	**Drilling methodology, machines and heat exchangers**	This volume deals with new drilling methods developed during the project. One of the main targets was to create a compact and easy to use and transport drilling system that can fit inside existing buildings for retrofitting vertical heat exchangers. The focus is on the development of different components for a functioning vertical geothermal system. Besides the elaboration of a drilling system including a drilling machine and drill head, a new GEO4CIVHIC coaxial vertical heat exchanger system and appropriate grouting materials are presented. In the framework of the GEO4CIVHIC project, the industrial partners developed together with input of the scientific partners a novel versatile and compact drilling rig. The machine is low weight and small dimensioned and therefore able to reach areas which are difficult
6. Training Manual - VOLUME 3 – 6 languages	Same as [5] translated in 6 national languages (6 files)	

		to access. A modular design with separation of the mast from the basis of the drilling machine allows further mobility. The rig design allows for several degrees of freedom in such a way to drill multiple boreholes without changing its position. In addition, the machine has been equipped with a low emission engine which reduces the pollutant emission reduction. Furthermore, a new compact, rotation-vibration drilling head, drill strings and drill rods and lost bits have been designed. This can be used in combination with the new drilling rig and especially deployed in urban areas which are difficult to reach, including inside buildings and cellars. The machine is capable of drilling boreholes for installation of conventional borehole heat exchangers (BHE), e.g. double U, as well as coaxial ones as developed within GEO4CIVHIC. Two different types of drilling heads can be fitted using a patented method developed during previous Cheap-GSHP project or the new developed Vibro-Drill method. With the newly developed co-axial BHE, enhanced designs of two types of metallic fittings were created. The drilling performance of the equipment and the BHE were tested in different conditions with varying soils and rocks from unconsolidated sands to granites. For this purpose, different demo and test sites in Italy, Germany, Ireland and Malta were used with variation in quantity of engines and unbalances for vibration as well as variation in frequency and used fluid. The impact of the combined effect of grouting and pipe thermal conductivity on the borehole thermal efficiency has been analyzed for single U-tube and coaxial configurations. A parameter study with numerical simulations has been conducted to improve the thermal performance. Regarding the grouting process of BHE, this volume shows lab-experiments which were carried out for the purpose of manufacturing satisfactory cement grouts with a real in-situ application. It describes the definition of the best grouting mix and the process. A further chapter deals with the adaption of well point techniques and their evaluation to be used as geothermal heat exchanger systems. For that purpose, a pilot site has been built and tested. As a supplement to the drilling of BHEs, different studies about horizontal and very shallow heat exchangers have been carried out. The scientific partners used field tests and monitoring methods as well as theoretical approaches to gain parameters from various systems and collected an exemplary inventory list for existing very shallow solutions.
7. Training Manual - VOLUME 4 - EN	**Geothermal heat pumps technology**	The heat pump is a key technology improved in the GEO4CIVHIC project. It represents the core of the ground source heat pumps technologies together with the GHEs (Ground Heat Exchangers). In this volume, its operation, together with all the issues connected to the refrigerant choice and the system configuration, is described. First of all, how a heat pump works is illustrated, clarifying how the performance of the machine can be calculated. Then, an analysis of the working fluids, i.e. the refrigerants, will be done, focusing on their Global Warming Potential (GWP) and on the necessity to find fluids not contributing to (or less contributing) to the Greenhouse Gas emissions (GHG). Then, the attention is moved to the possible refrigeration cycle configurations, taking into account the basic, regenerative, economizer, sub- and trans-critical and cascade cycles, which are the main innovative solutions developed in the project so as to widen the applicability of heat pumps to different retrofit scenarios. At the end, the five types of heat pumps developed in the project and evaluated in real conditions in the case studies are described. The relative operating conditions and performance are shown as defined by the current standard EN 14511, when applicable, and in the design conditions, since three heat pumps work in a different range of temperatures with respect to standard conditions, as they have been addressed to high temperature emission systems.
8. Training Manual - VOLUME 4 – 6 languages	Same as [7] translated in 6 national languages (6 files)	
9. Training Manual - VOLUME 5 - EN	**Sizing GSHP and hybrid technologies**	Heat pumps are a mature technology that can be coupled with renewable energy to deliver low-carbon heating and cooling. Thus, they have been identified as a key enabling technology to decarbonize buildings' space conditioning toward achieving NetZero goals. In this volume, it was tried to explain briefly some of the activities carried out during the GEO4CIVHIC project concerning analytical methods for evaluating the thermal interference between geothermal systems installed close to each other, guidelines for a customized thermal response test (TRT), tools for pre-design, sizing and monitoring the shallow geothermal systems, synergy with other hybrid, renewable energy sources (RES) technologies, and control strategies, as well as studying various types of case studies built in the project in terms of energy and economics, and environment. Finally, there is a practical exercise to /test the readers and the document closes with the main conclusions.
10. Training Manual - VOLUME 5 – 6 languages	Same as [9] translated in 6 national languages (6 files)	
11. Training Manual - VOLUME 6 - EN	**Environment and standards**	The use of ground source heat pumps in the built environment provides significant benefits in the decarbonisation of heating and cooling in the built environment. Specifically, GHSPs provide a low visual impact solution to facilitate such decarbonisation in the dense

12. Training Manual - VOLUME 6 – 6 languages	Same as [11] translated in 6 national languages (6 files)	urban environments and historical centres. This volume considers the environmental impacts associated with the installation and operation of shallow geothermal systems, demonstrating methodologies to assess these impacts at the construction stage, the operational phases of a GSHP in the context of a lifecycle approach focussed on the new drilling, heat exchanger and heat pump technologies developed as part of the GEO4CIVHIC project. The volume reviews the process of design and installation of shallow geothermal systems in the context of current national and European standards, as well as reviewing the importance of licensing and operating systems where these are located in close proximity, by presenting examples and methodologies for preventing thermal interference. The volume also includes a calculation of the levelised cost of Energy (heat or cold) from GSHPs with an example (capex – opex and end of life costs).
13. Training Manual - VOLUME 7 - EN	**Historical and World Heritage Buildings**	This volume aims to prove the viability and the opportunity offered by retrofitting historical buildings through installation and applicati Ground-Source Heat Pumps (GSHPs). The systems developed in the two projects Cheap-GSHPs and GEO4CIVHIC are minimum invasive ar not put any additional risk to historical buildings construction or architectural elements insuring at the same time limited environm impact, operations efficiency, low noise emissions and reduction of operating costs. In this volume the basic principles, barriers, approaches and procedures, as well as the legislation at the base of the application of geothe to historical buildings are described. Two European projects, Cheap-GSHPs and GEO4CIVHIC were focused on numerous historical buildin case studies selected intentionally as relevant real or virtual demonstrators. The successful experience achieved through the applicati historical sites selected to demonstrate the applicability and performance of geothermal to historical building the projects is shown to in the use of this renewable source for other historical sites, including UNESCO designated ones both within and outside Europe. In this volume, it is demonstrated how the use of geothermal energy systems facilitates the balancing effort between heritage signifi-cance and conservation as well as the installation of sustainable energy infrastructures, allowing suitable solutions to be identified. Finally, the results demonstrated that GSHPs are often among the best solutions to match the requirements of sustainable energy with the integrity and authenticity of the Cultural Heritage and its buildings, both in their interior and exterior features. In addition, the GSHP solutions found during the two projects, as they include a large portion of underground elements (i.e. the BHE field), have minimum visual impact, especially when compared with air source chillers and gas boilers, which include external elements (outer units or chim-neys), which alter the appearance of the building envelope.
14. Training Manual – VOLUME 7 – 6 languages	Same as [13] translated in 6 national languages (6 files)	
BROCHURES		
15. Technical Brochure - EN	**GEO4CIVHIC Technical Brochure**	The Technical Brochure intends to overall present the approach on the TTP and briefly present the structure and the content of the 7 volumes of the Training Manual. It is intended to be used as a general project presentation document and also as an accessible and concise training tool on the shallow geothermal energy applications to be used in workshops, webinars etc.
16. Technical Brochure – 6 languages	Same as [15] translated in 6 national languages (6 files)	
17. Historic Building Brochure - EN	**GEO4CIVHIC Historic Buildings Brochure**	The HB Brochure is presenting in a concentrated manner the research results in GEO4CIVHIC implemented in all the historic buildings / demo sites / UNESCO site in the project.
18. Historic Building Brochure – 6 languages	Same as [17] translated in 6 national languages (6 files)	
USER MANUALS		
19. DSS User Manual - EN	**GEO4CIVHIC DSS for geothermal retrofit - User Manual**	The DSS document represents the user manual of the web-based Decision Support System developed in the project. The instructions for managing the user account, creating and configuring projects and easily following the different steps of the calculation process is clearly and simply presented. The flexibility of the tool, which adapts to different levels of user expertise is also shown. Finally, the document gives indications for the users to interpret the results provided by the website.
20. DSS User Manual – 6 languages	Same as [19] translated in 6 national languages (6 files)	
21. APP User Manual - EN	**Application for support on field for workers on geothermal field - User Manual**	"Application for support on field for workers on Geothermal field - User manual", is a document whose aim is to simplify and support the work of designers and GSHE installers and, in consequence to foster the retrofitting of civil and historical buildings by facilitating installation, reducing costs and increasing efficiency of the different components through shallow geothermal systems.
22. APP User Manual – 6 languages	Same as [19] translated in 6 national languages (6 files)	

3. Description of the TTP components and their elaboration

3.1 Training Manual – 7 Volumes

The Training Manual is the basic tool within the TTP, being intended for the training of the stakeholders with a **high level of knowledge** in the field of H&C shallow geothermal energy as energy engineers, designers, installers, drillers, constructors etc.

At the same time, the Training Manual was planed as a specialized tool for the use in the training activity by the network of 4 **European Centres of Excellences for shallow geothermal application in civil and historical buildings** in Spain – UPV, Italy – UNIPD, Germany – FAU and Romania – RGS.

The stakeholders taken into consideration for all the training solutions (courses, workshops, demonstrations, site visits etc.) were the following:

- Shallow geothermal specialists: Geologists, Manufacturers for GSHP Equipment, GSHP applications designers, GSHP Researchers
- Constructors, architects, building, structural and H&C engineers, technicians, installers
- Energy and Environment Agencies
- Historical buildings and Monument protection specialists
- Regulatory authorities in energy and H&C
- Local authorities and energy decision makers at local, regional and national level
- Real estate investors and funding institutions
- Lawyers (specialised in environment, construction)
- Ecologists, opinion formers, media
- Building owners representatives, general public interested in energy savings and ecology
- Undergraduate and PhD students (especially in ECoE training system).

Since the first debates at the beginning of the project, the consortium decided the following ideas regarding the Training Manual approach:

a. **The Training Manual includes 7 VOLUMES**, each of them focused on a different aspect of the domain of shallow geothermal technology. This approach (radically different from the correlation between CHAPTERS and WPs followed in previous EU projects, for example in Cheap-GSHPs) aimed at:
   (i) improving coherence and eliminating redundancies between volumes,
   (ii) easing access to the information sought by a given user,
   (iii) allowing the inclusion in each volume not only of the GEO4CIVHIC scientific results but also of previous information / data / research results obtained in the research activities developed in previous projects (as Cheap-GSHPs, GEOTRAINET, REGEOCITIES etc.),
   (iv) each volume should become a treasurer as complete as possible of knowledge / research results from the different components of the shallow geothermal field.

b. **The volumes AUTHORS and RESPONSIBLE AUTHORS.** Because of the large number of individual researchers with direct contribution in the realization of the research activity in GEO4CIVHIC project and consequently of the manual volumes (more than 70) and of the numerous partners in consortium (19), the decision was to assign each volume to one or two partners as VOLUME COORDINATOR(S) / RESPONSIBLE AUTHOR(S) that had the full responsibility on the volume content up to the finalization of the English version.

The finalized English version included also the scientific and linguistic verifications of each volume (the responsibilities are presented in chapters 4 and 5) and the corresponding iterations resulted after the respective suggested observations and corrections (if any).

The volumes **responsible authors** decided by the partners consortium were the following:

- VOLUME 1 – UNIPD
- VOLUME 2 – UNIPD
- VOLUME 3 – FAU
- VOLUME 4 – UNIPD and GALLETTI
- VOLUME 5 – UPV
- VOLUME 6 – GEOSERV
- VOLUME 7 – CNR and UNESCO

This assignment made the responsible partners' work more complicate but, at the same time, brought more **consistency and quality** to the final products.

Corresponding to the greater or lesser dependence on the results in the scientific research carried out in the demo-sites, the 7 volumes were completed sooner or later, which allowed a better phasing of the consecutive activities (editing and translation), making the whole chain of activities in TTP elaboration easier. Thus, this approach proved to be a **good managerial decision**.

The content of each volume is shortly presented in the table included in chapter 2 and is reflected in a suggestive way in the **volume's names** as follows:

- VOLUME 1 – Building energy loads
- VOLUME 2 – Geology and mapping
- VOLUME 3 – Drilling methodology, machines and heat exchanges
- VOLUME 4 – Geothermal heat pumps
- VOLUME 5 – Sizing GSHP and hybrid technologies
- VOLUME 6 – Environment and standards
- VOLUME 7 – Historical and world heritage buildings

Before starting the elaboration of the training manual, the task manager RGS presented in the M42 (Padova management meeting) the proposed **PROCEDURE for the elaboration of the Manual's volumes** which presented in detail all the writing rules from the chapter structure to the picture quality, table format and font size. The requirement of brevity and balance of the information included in each volume was also foreseen in the elaboration procedure. The procedure was discussed and approved in M42 and became the **working tool in the elaboration of the 7 manuals**. In this situation all the 7 volumes written in English language were elaborated in a unitary approach according the rules set by the procedure.

At the end of the elaboration process in English, the volumes were edited by RGS also in a unitary approach and format (chapter 5). The edited volumes were distributed to the partners responsible for translation (chapter 6).

Under the paradigm presented above, the Training Manual is equally useful as a whole and as individual volumes in very targeted training courses.

3.2 Technical Brochure and Historical Buildings Brochure

The Technical Brochure and the HB Brochure are at the same time **concise training tools** within the TTP, being intended for the training / workshops for beginners / stakeholders with an incipient level of knowledge in the field of H&C shallow geothermal energy as potential users / public deciders / students etc, and with the second aim to be a tool for dissemination of the technical results in any future occasion.

The Technical Brochure includes concise presentations of all the main aspects of the H&C shallow geothermal technology being an efficient introductory document.

The HB Brochure focus on the requests and results obtained in the rehabilitation of historic building.

The two Brochures were elaborated by the Project Coordinator as a synthesis in English language and, after the editing, were translated in 6 national languages being important assets / components of TTP.

3.3 DSS User Manual

The DSS **User Manual** elaborated by **TECNALIA** within the TTP is intended for the training process regarding the use of DSS that aims to provide with a rapid pre-project assessment. The objective of the decision support tool is to perform a pre-engineering cost and impact analysis to convince building owners to install GSHP systems.

The final purpose of the DSS is to facilitate pre-design discussion around the installation of a GSHP in a retrofit project in an urban environment. This decision support tool serves on one side, for decision makers to understand the benefit of investing in GSHP and, on the other hand, for GSHP experts to contract projects with this technology. The DSS will also have an educative value for other stakeholders of energy renovation. The user of the DSS tool is not expected to have expert knowledge in geothermal energy.

3.4 Support on field for workers User Manual

This user manual **elaborated by RED** is linked to the activity developed in GEO4CIVHIC project – the task “Development of an Application for support in situ workers on Geothermal field”, whose aim is to simplify and encourage the work of designers and GSHE installers.

The objective of fostering the retrofitting of civil and historical buildings can be achieved, on the one hand, by improving drilling machines and methodology, optimising GSHE design and materials, and using more compact and hybrid HPs for high and low-temperature terminals and on the other hand, creating a set of software tools developed in order to provide a holistic engineering solution to optimise the installation and operation of GSHPs. This is the achieved goal of the Drillability App described in this user manual.

4. Scientific and linguistic verification

The first three steps in the elaboration of the volumes component of the Training Manual are the following:

Writing the documents in English language, in the final version of content and in the format set in the elaboration procedure by WP8 – T8.2 responsible partner (RGS). This writing task was in the responsibility of the Coordinating Authors decided by the project consortium since M18 management meeting and presented above.

Scientific verification of the content by the **PSC #1 – Project Specific Committee - RTD, Production & Innovation** lead by UNIPD – Antonio Galgaro. The members of PSC #1 were Antonio Galgaro – UNIPD, Burkhard Sanner – UbeG, Luc Pockele – RED, Michele De Carli – UNIPD, Ric Pasquali – GEOSERV, Javier Urchueguia – UPV, Dimitris Mendrinos – CRES and Robert Gavriliuc – RGS.

Each volume was verified by at least 2 members of PSC #1 members. The members of the PSC #1 decided the verification matrix for all 7 volumes so that a person doesn't verify a volume in which he was among the authors. The interface between the coordinating authors and the scientific verification team and the implementation of the suggested modifications / corrections / additions was in the coordinating authors' responsibility up to the finalization of scientific verification phase.
Linguistic verification of the scientifically verified volumes in English language was shared between the two partners from countries with English as an official language: GEOSERV (4 volumes) and DLH (3 volumes and the Technical Brochure).

After this laborious process, the resulted volumes, scientifically and linguistically verified were edited and represent the **FINAL ENGLISH VERSION OF THE TRAINING MANUAL (7 VOLUMES)** that is reported in this deliverable, **uploaded and accessible in the project's website.**

5. Editing of English version of the 7 volumes of the Training Manual and of the Technical Brochure

Before finalising the 7 volumes, in M54 - Athens management meeting, the RGS proposed to the partners some **graphic design options** for the TTP. The final version was unanimously chosen and the final details from cover content to layout were agreed. To ease the decision RGS brought in Athens some printed copies of the 2 volumes that were completed (written, verified and edited) at the time - Volume 1 and Volume 7.

The **EDITING** activity of the TTP included:

a. The CONTENT editing (organization of content, logical flow and presentation of content and ideas, structure of text / chapters / subchapters),

b. The LINE editing (fixing the mechanics of writing, titles, capitalization) and

c. The Proofreading (tables and figures formatting, consistency and aesthetic aspects).

A large number of the above aspects were previously function as rules set by the **PROCEDURE for the elaboration of the volumes** (referred above) and all the **coordinating authors**, the **scientific verifiers** and the **linguistic verifiers** knew and applied these rules which simplified the editing process.

The **editing** process of the English version as the FINAL step before translating, focused on the uniformity of the 7 volumes, in the correct pagination of each one, in the correct numbering and hierarchy of the figures, illustrations, tables, bibliographical references, in the picture quality (resolution), in the translatability (editable information in graphic representations and tables), in the unitary frame of tables, and, last but not least, in the aesthetic design and uniformity of all the TTP components. The process was realized by a specialized publisher according the detailed **editing** specification designed by RGS.

With few exceptions, the editing activity was realized only once for the final **scientifically and linguistically verified** products.

6. Translating in 6 national languages

After the editing of the final English version of TTP components, the final step of TTP elaboration was the **TRANSLATION** in 6 national languages.

According the GA provisions, the TTP components were translated by the project responsible partners for TTP translation in 6 national languages:

a. **ITALIAN** language – by UNIPD and SUPSI

b. **SPANISH** language – by TECNALIA

c. **GERMAN** language – by FAU

d. **ROMANIAN** language – by RGS and PIETRE EDIL

e. **GREEK** language – by CRES

f. **FRENCH** language – by GEOGREEN and GALLETTI

In the case of **double responsibility** (Italian, French and Romanian) the two responsible partners equally shared the responsibility both for the quality of the resulted product and for the activity deadline.

The translated volumes of the Training Manual (including the 2 User Manuals) and of the Technical Brochures have been immediately in the public area of GEO4CIVHIC website, whele the versions in the other 6 languages are in progress and will be uploaded shortly when ready but certainly before the ECoEs courses.

7. Conclusions and lessons learned

The main conclusions presented below have been drawn after 64 months of the project as well as based on the comparison of the approach in the GEO4CIVHIC project with previous projects, especially in Cheap-GSHPs project.

A significant improvement and streamlining of the project management was achieved by setting the decision level from the Manual level as a whole to the individual VOLUME level and also by structuring the Manual having as “bricks” the distinct scientific aspects instead of WP(s) as it was in previous projects (Cheap-GSHPs).

The management of the Manual elaboration was focused on efficiency and the previous experience of the consortium as a team allowed us to obtain good results not only in the research activity, but also in the way in which it was reflected in the TTP.

Although during the reporting period, the entire project activity was profoundly and dramatically marked by the coronavirus pandemic, all the partners struggled to adapt at the given conditions, to continuously improve the TTP and finally to create a complete, coherent and qualitative training instrument that will be used in the training events during the last months of the project up to M68, but, at the same time, in the activity of the network of the European Centres of Excellence for shallow geothermal application in civil and historic buildings during and after project completion. Therefore, this TTP will be useful not only on the training courses that will continue after the closure of the project, but also long after the GEO4CIVHIC finalization as far as it represents a valuable asset for the use of ECoE network.

All the partners actioned on the entire period of time M12 – M64 with the ambition to create a representative and useful training tool package.