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Smernice za celostni pristop k projektom prenove stavb na podlagi izboljšanih plitvih geotermalnih tehnologij

Guidelines for an integrated approach of building retrofitting projects based on enhanced shallow geothermal technologies

Planungs- und Installationsrichtlinien für ein Gebäudesanierungskonzept auf Basis von EGS (Enhanced Geothermal Systems)

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CEN WORKSHOP AGREEMENT

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English version

Guidelines for an integrated approach of building retrofitting projects based on enhanced shallow geothermal technologies

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Foreword

This CEN Workshop Agreement (CWA 17941:2022) has been developed in accordance with the CEN-CENELEC Guide 29 “CEN/CENELEC Workshop Agreements – A rapid way to standardization” and with the relevant provisions of CEN/CENELEC Internal Regulations - Part 2. It was approved by a Workshop of representatives of interested parties on 2022-09-30, the constitution of which was supported by CEN following the public call for participation made on 2022-02-25. However, this CEN Workshop Agreement does not necessarily include all relevant stakeholders.

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Introduction

In Europe, the building sector is responsible for 40% of the total energy consumption and represents about a third of Europe's CO_2 emissions. Heating and cooling accounts for 50% of annual energy consumption in EU, making it the biggest energy end-use sector ahead of both transport and electricity[1]). This is a huge socioeconomic and environmental problem, considering that roughly 75% of EU buildings are not energy efficient[2]), and that approximately 75% of heating and cooling is still generated from fossil fuels[3]). On this basis, buildings represent a large energy-savings potential, once renovated and upgraded, if the heating and cooling sector sharply reduces its energy consumption and cuts its use of fossil fuels to fulfil the EU's climate and energy goals. However, today the annual renovation rate of the building stock varies from just 0.4 to 1.2% in the Member States. According to the European Green Deal, this rate will need to at least double to reach the EU's energy efficiency and climate objectives.

Given the labour-intensive nature of the construction sector, which is largely dominated by local businesses, building renovation plays a crucial role in European economic recovery especially following the COVID-19 pandemic. To kick-start the recovery, the Commission has launched several initiatives to further support the renovation of EU buildings[2]).

To pursue this dual ambition of energy savings and economic growth, in 2020 the Commission published a new strategy to boost energy-efficient building retrofitting called "A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives". Also, the EU has established a legislative framework (which includes the Energy Performance of Buildings Directive 2010/31/EU (EPBD) and the Energy Efficiency Directive 2012/27/EU), providing direction to the future sustainable built environment by supporting low carbon energy usage in buildings.

In this context, shallow geothermal energy (SGE) is a renewable energy source (RES) with large potential to facilitate energy savings and GHG emissions reduction in the building sector and therefore help to achieve all major objectives of the EU's energy policy. Moreover, the main reference organisations - such as ECTP[4]) and RHC-ETIP[5]) - have promoted and roadmapped the cost-effective integration of RES into building technical systems. The development of effective and affordable enhanced geothermal systems (EGSs) is crucial to exploit the EU geothermal potential as a major source of energy supply for heating and cooling purposes, by targeting bottlenecks that hinder the full deployment of geothermal systems as one of the key concepts in energy efficient building retrofitting.

This CWA is motivated by the main goals of the EU Horizon 2020 GEOFIT innovation project (funded under grant agreement number 792210). It is meant to provide general management guidelines for stakeholders involved in a building retrofit project based on SGE technologies.

The type of SGE building retrofit project which is addressed in this CWA focuses on the technologies described below. However, it is necessary to consider that SGE building retrofitting does not explicitly require the use of all these specific technologies.

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1) https://ec.europa.eu/energy/topics/energy-efficiency/heating-and-cooling

2) https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings

3) Eurostat 2019

4) ECTP European Construction, built environment and energy efficient building Technology Platform

5) RHC-ETIP European Technology and Innovation Platform on Renewable Heating and Cooling

- **Information and communication technologies (ICT) tools for ground research and worksite monitoring:** non-invasive and integrated techniques for ground research, worksite and building monitoring.

  The following innovative technologies can be considered:

  — Monitoring tools capable of assessing the stability of buildings involved in retrofitting operations, for example Ground Based Interferometric Synthetic Aperture Radar (GBInSAR).

  — Radar interferometry enabling 3-D spatial measurements.

  — Ground Penetrating Radar (GPR), with automatic detection process.

  — Interface between the GPR and Web Map Services (WMS) to download/upload the underground asset maps before/after the survey.

  — Building information modeling (BIM) integration of structural building monitoring tools during drilling works.

  — Drone monitoring.

- **Drilling technologies:** adapted to the context of SGE building retrofitting:

  — Vertical drilling.

  — Trenchless - horizontal directional drilling (HDD) techniques that enable the deployment of horizontal loops like geothermal heat exchangers in this context.

- **Geothermal/ground source heat exchangers (GHEX):** with corresponding suitable configurations for SGE building retrofitting and effective installation.

  — Vertical borehole type heat exchangers.

  — Earth basket and helical type heat exchangers.

  — Shallow horizontal or slinky type heat exchangers.

- **Ground Source Heat Pumps (GSHPs):** optimized for the use of geothermal heat and building retrofit applications. As existing buildings are less flexible compared to new buildings, this issue must be addressed explicitly.

  — Hybrid (thermally and electrically driven) heat pump (HP) system for high temperature lifts which integrates better with a smaller GHEX compared to conventional systems.

  — Electrically driven HP system for high temperature lifts which integrates better with a normal sized GHEX.

  — Integration of other RES (e.g., photovoltaic and solar thermal) to increase the total RES share.

- **Heating and cooling solutions** for energy-efficient building retrofitting.

  — Easy-to-install and efficient heating solutions, for example low-temperature heating (LTH) technology suitable for GSHPs.

— Easy-to-install and efficient cooling solutions, for example high-temperature cooling (HTC) technology enables a high coefficient of performance (COP) of GSHPs used in building retrofitting. The possibility to get cooling with direct use of the cold water in the bedrock can be also considered, as a very energy efficient method where the only energy required is that required to pump the liquid around.

- **ICT based control systems and building energy management systems (BEMS)** that enables the full utilization of the EGS in retrofitted buildings by unlocking energy flexibility services using demand side response techniques.

- **BIM** enabled tools for management of SGE building retrofitting.

Considering the interoperability of the aforementioned technologies, this document provides a general methodological management framework using an Integrated Design and Delivery Solutions (IDDS) approach for the SGE building retrofitting process, adaptable to project and site specificities.

IDDS was launched in 2009 and developed as a new priority theme of the board of the worldwide CIB organization (International Council for Research and Innovation in Building and Construction or "Conseil International du Bâtiment" in French). The CIB White Paper on IDDS[6)] defines it as "*the use of collaborative work processes and enhanced skills, with integrated data, information, and knowledge management to minimize structural and process inefficiencies and to enhance the value delivered during design, build, and operation, and across projects*".

This IDDS vision extends beyond new buildings to encompass modifications and upgrades, particularly those aimed at improving local and area sustainability goals. IDDS will therefore facilitate greater flexibility of design options, work packaging strategies and collaboration with suppliers and tradespeople, which will be essential to meet evolving sustainability targets.

The four key IDDS elements are: collaborative processes across all project phases, enhanced skills of the team, integrated information and automation systems, and knowledge management.

6) Owen, R., Palmer, M., Dickinson, J.K., Tatum, B., Kazi, A.S., Amor, R., & Prins, M.M. (2009). CIB White Paper on IDDS Integrated Design & Delivery Solutions [328].

1 Scope

This CEN Workshop Agreement (CWA) provides orientation for the management of building retrofitting projects based on enhanced shallow geothermal technologies.

This document provides guidelines for the classification of an integrated design team and the identification of the primary roles of actors among the whole project life-cycle. This document also provides a general workflow for building retrofitting projects based on enhanced shallow geothermal technologies, to be adapted or modified considering the specificities of each project requirements, and site characteristics, and stakeholder profiles involved in the process.

This CWA is not designed to support European legislative requirements or to address issues with significant health and safety implications. CEN and CENELEC are not accountable for its technical content or any possible conflict with national standards or legislation.

2 Normative references

There are no normative references in this document.

3 Terms, definitions, and abbreviations

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

BEMS	Building energy management systems
BIM	Building Information Modelling
BMS	Building Management Systems
BPE	Building performance evaluation
DHW	Domestic Hot Water
EGS	Enhanced Geothermal Systems
FEM	Finite Element Method
GBInSAR	Ground Based Interferometric Synthetic Aperture Radar
GHEX	Ground Source Heat Exchanger
GPR	Ground Penetrating Radar
GSHP	Ground-Source Heat Pump
HP	Heat Pump
HTC	High-Temperature Cooling
HVAC	Heating, Ventilation, and Air Conditioning
IDDS	Integrated Design and Delivery Solutions
LTH	Low-temperature Heating
RES	Renewable Energy Source
SGE	Shallow Geothermal Energy

4 Steps for an integrated approach

4.1 General

Building retrofitting is a complex and holistic process in which decisions should be taken by considering a large diversity of constraints, stakeholders, and specific objectives.

The integrated IDDS-based approach of a SGE building retrofitting project comprises three major aspects: people, processes, and technologies. For implementing the integrated approach of the project, three main steps should be followed (see Figure 1 for an explanatory scheme):

- **Building the project's integrated team:** The first step is to clearly identify the project team and to classify these actors according to their expertise and skills.
- **Defining project phases and identifying primary roles of the team members:** This step aims to define the main phases of the project and to identify the team responsibilities for each phase.
- **Developing a collaborative workflow schedule:** This phase aims to integrate all involved actors to develop the workflow and dataflow and to implement the BIM platform for the project site.

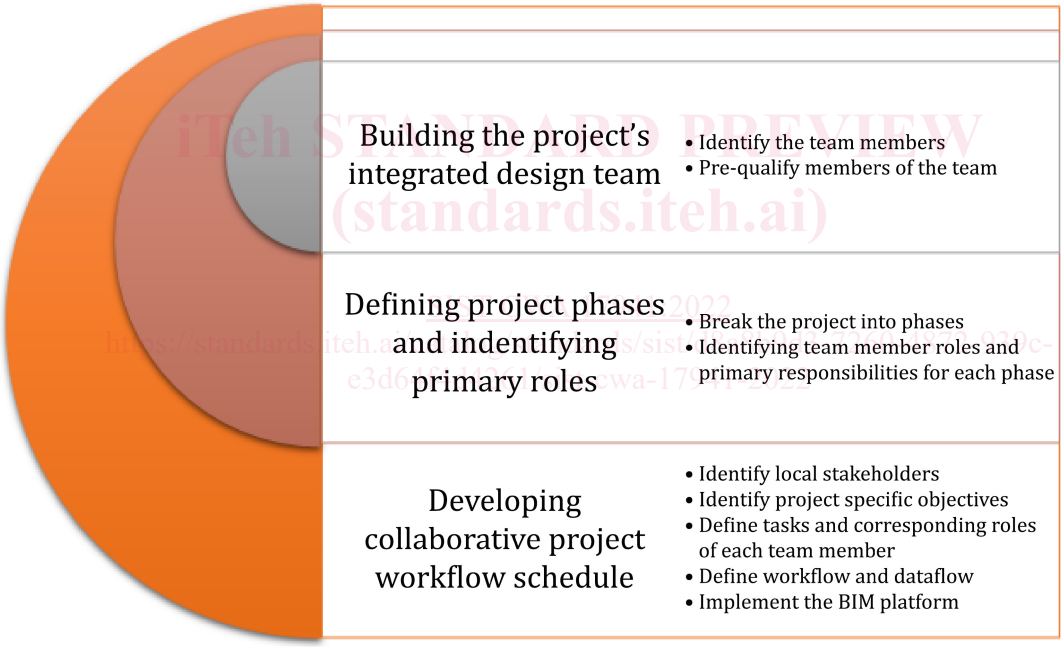

Figure 1 — Main steps for implementing the integrated approach of a SGE building retrofitting project

4.2 Building the integrated project design team

4.2.1 General

To support an integrated project approach, a building retrofit project should comply with systems associated with different kinds of users. The four main actor categories in an integrated project are (1) clients, (2) designers, (3) contractors, and (4) managers. Each of these categories encompass different types of actors. They should establish a high-level of collaboration with one another to pursue common objectives.

Within these four actor categories, those who should be considered at the earliest stage of a SGE building retrofitting project are shown in Figure 2. A variety of views, scientific or technical approaches, objectives, working methods, etc. are inherently present within a project. It is therefore necessary to define a management framework in order to deal with this diversity, to keep focus on the essentials and to ensure good communication between actors, to drive effective and collaborative work.

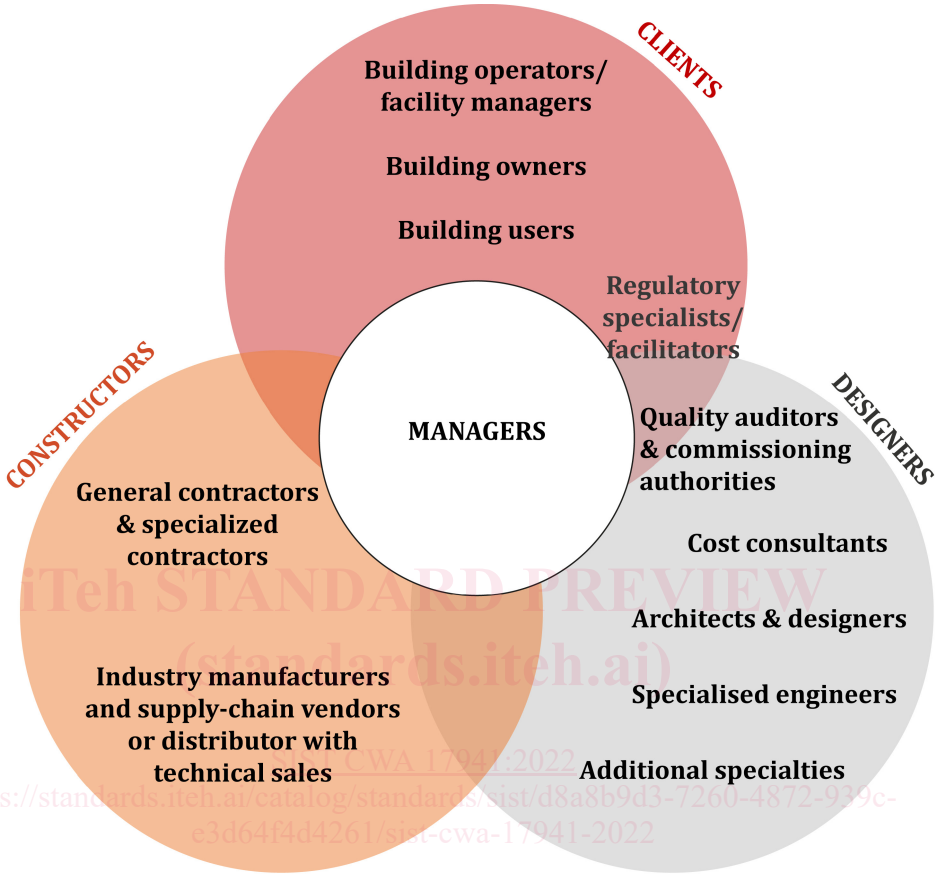

Figure 2 — Main categories and sub-categories of actors for a SGE building retrofitting project

4.2.2 Clients

In a SGE building retrofitting project, clients are broadly defined as the **local stakeholders** who are likely to be directly or indirectly affected by the intervention (building occupants) and any individual or group who may influence the management of the project. They can be for instance the building owners, the end users, the building operators, or the facility managers. All these actor profiles could interact with the building, its management and its systems after the project, and are therefore considered as clients using the systems or services provided by the project.

Building owners: According to the Integrated Project Delivery (IPD) Guide (Richard Cook 2007), building owners in particular take "*an active role in evaluating and influencing design options*". In addition, building owners may "*participate to establish project metrics at an earlier stage than in a traditional project*" and will also "*assist designers and constructors to solve issues*".

Building users: It is necessary to involve a representative of residents/building occupants/other consumer-users of a building (or proxy thereof) who would be directly impacted by the retrofitting works in terms of disturbance, comfort improvement, accessibility, aesthetics, etc. The local project partners can facilitate the involvement of users and communicate relevant information to the project team. The consultation should take into account both the likely lower technical knowledge of this group, and the need for inclusive and accessible consultation processes.