

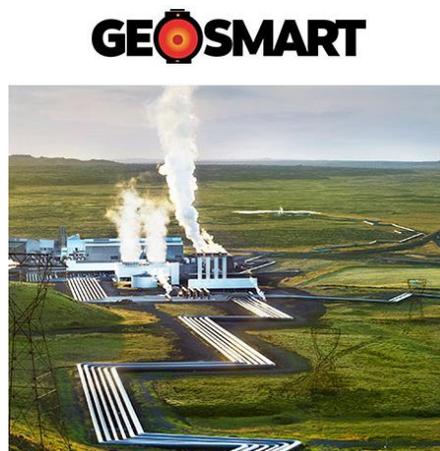
## GeoSmart Fact sheet - Gaps in standardization for the geothermal industry

Standardization typically begins when a technology or process is already in production or industrial use, i.e., has reached the upper Technology Readiness Levels (TRL). To be more specific, the technology or process should reach TRL 9. The pivotal aspect of a standard is that the current knowledge and best practice is made explicit and formal. A consensus on what constitutes best practice means that all stakeholders' views must be included.

International standardization of geothermal energy production activities is at an early stage; this is mainly due to the immaturity of geothermal relative to other low carbon energy technologies. This indicates that geothermal energy is still in the Research & Development (R&D) phase of its lifecycle, albeit at the upper TRL levels. Further development of technologies and processes around drilling and energy transfer technologies are key to advancement in geothermal standardization. The geothermal industry must overcome interrelated technical and commercial challenges such as high initial capex on drilling operations, inflexibility and inefficiency of power plant operation, and a lack of public funding for demonstrator plants.

As and when geothermal is widely adopted, these stakeholders will include expert R&D organizations, universities, plant operators and owners, supply chain companies, regulators etc. Less a formal group and more a self-forming knowledge network, these organizations will come together to form a consensus on the design, construction, and operation of geothermal plants. Clearly, this cannot be done if geothermal remains on the current TRL scale.

In this context, the European commission funded GeoSmart project (European Union's Horizon 2020 research and innovation programme- Grant agreement 818576) aims to identify the gaps in standardization for the geothermal industry. The project seeks to optimize and demonstrate innovations to improve the flexibility and efficiency of geothermal heat and power systems. At the core, it is dealing with technologies for geothermal to enhance competitiveness in smart and flexible operation.



The project combines thermal energy storages with flexible Organic Rankine cycle solutions to provide a highly flexible operational capability of a geothermal installation. Overall, GeoSmart technologies aim to reduce geothermal energy costs drastically, making it cost-competitive with fossil fuel-based counterparts.

The GeoSmart study revealed that international standards for geothermal energy production had been developed for a few specific aspects of the technology, such as thermal performance and chemical fluids analysis. For mechanical design and materials selection, manufacturing/welding, and drilling, codes and standards developed for other industries (especially oil and gas) are applicable. It is further noted that it is not possible to identify generic standards that would govern the use of the various energy transfer methods such as supercritical CO<sub>2</sub>, super-hot rock, thermo-siphoning, and supercritical H<sub>2</sub>O.

While developing comprehensive standards for the geothermal industry, it is advisable to categorize them by the stage of the product lifecycle they relate to, namely design, construction, operation/maintenance, and end of life/decommissioning. Additionally, in the case of geothermal, an extra stage is needed; the assessment and selection of the plant site, qualified as the exploration stage. Another aspect relates to taking on board the stakeholder's point of view regarding the standards. ISO's approach to standard development clearly mentions that stakeholders' commitment must be secured to develop new standards. Proposers of new standards must provide information on the project proposal and receive feedback from stakeholders. GeoSmart project is currently carrying out a stakeholders' survey covering standardization aspects in order to gauge the stakeholders' viewpoint on gaps in geothermal standardization. The observations from this survey, as well as a detailed understanding of the gaps in geothermal standardization will be incorporated into a manuscript currently under preparation.

Moving on to the big picture, it could be seen that common technical rules and standardization, among EU countries is one of the main legislation barriers for Geothermal Energy. Increase of awareness, need for standardization, improvement of the legal framework, and administration procedures and permitting are essential steps in moving forward and supporting the effectiveness of design, construction, maintenance, and operation of geothermal energy systems.

For oil and gas industry standardization in the previous decades, the presence of state-owned entities in the process compelled full and open participation by all stakeholders, ensuring standards were fully representative of the consensus view. While developing new standards, it is essential to ensure that commercial interests are best served. While it is certainly possible for geothermal to standardize in a deliberate and orderly fashion, it is perhaps more challenging than oil and gas industry standardization, with commercial interests more strongly represented than before.



**This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 818576.** This article reflects only the consortium view and that the Commission is not responsible for any use that may be made of the information it contains.