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Celsius Energy: an industrial, digital native geotherapy solution to accelerate the deployment of low-carbon heating and cooling

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Celsius Energy is a technology company with the mission to decarbonize the building HVAC industry by designing and developing shallow geothermal energy installations. A Celsius Energy system consists of three elements: a borehole heat exchanger (BHE), a heat pump for both heating and cooling, and a digital geotherapy management solution.

The first system was built in Clamart, France, in 2020 [1]. Dozens of other installations have been designed and built for different types of uses and operating requirements, from single buildings to district heating networks. Celsius Energy has already drilled more than 120 wells in several countries, including 6 completed borehole exchangers at customer sites.

One of the key features of Celsius Energy systems is the geometry of the BHE, including both vertical and inclined wellbores. Inclined wells, and in particular a star-shaped layout (pioneered by the GZB center in Bochum), allow reducing drastically the surface footprint of an installation, making it possible to implement a geothermal exchanger in contexts such as urban areas or existing buildings where vertical wells alone would not be feasible.

Celsius Energy takes advantage of the extensive industrial expertise of its parent company SLB to provide technical solutions and operating procedures to improve the reliability of its solution while reducing its implementation cost and time. For instance, controlling the trajectory of the wells is crucial to avoid wellbore collision, to remain within the boundaries of the property plot and to optimize the energy extracted by the inclined wells. The use of adequate drilling techniques and equipment ensures that well trajectories do not deviate from the well plan, and well placement algorithms developed by Celsius Energy guarantee that the most efficient BHE geometry is designed and can be updated in real time during the operations. The installation steps of a Celsius Energy system will be described during the talk.

On the other hand, Celsius Energy has developed tailor-made digital solutions to model, monitor and manage the system. The geotherapy management solution is instrumented with sensors and controls for IoT operation, including fiber-optic DTS and building management sensors; it uses sensor input, external information and past records for digital performance management. Also, integrated modelling tools have been developed in-house to describe the different components of the system with the desired level of detail, compare their behavior to the observed data and refine the dimensioning of each installation [2].

The application of industrial experience to the development and operation of GSHP systems and the development of fully digital energy management and modelling tools allow Celsius Energy to build robust, reliable and efficient systems in contexts where traditional installations would not be feasible.

References:

[1] Thierry, S. et al., (2021), The "Celsius Energy System": a low surface footprint ground source heat pump system for collective buildings in urban environments, GRC Transaction, 1097-1121, 45

[2] Parry A., Varadarajan P.A., Demichel C., Simon M., Thierry S., Sosio G., (2022), : Modelling and benchmarking the behavior of closed-loop borehole heat exchangers with inclined wells: the Celsius

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