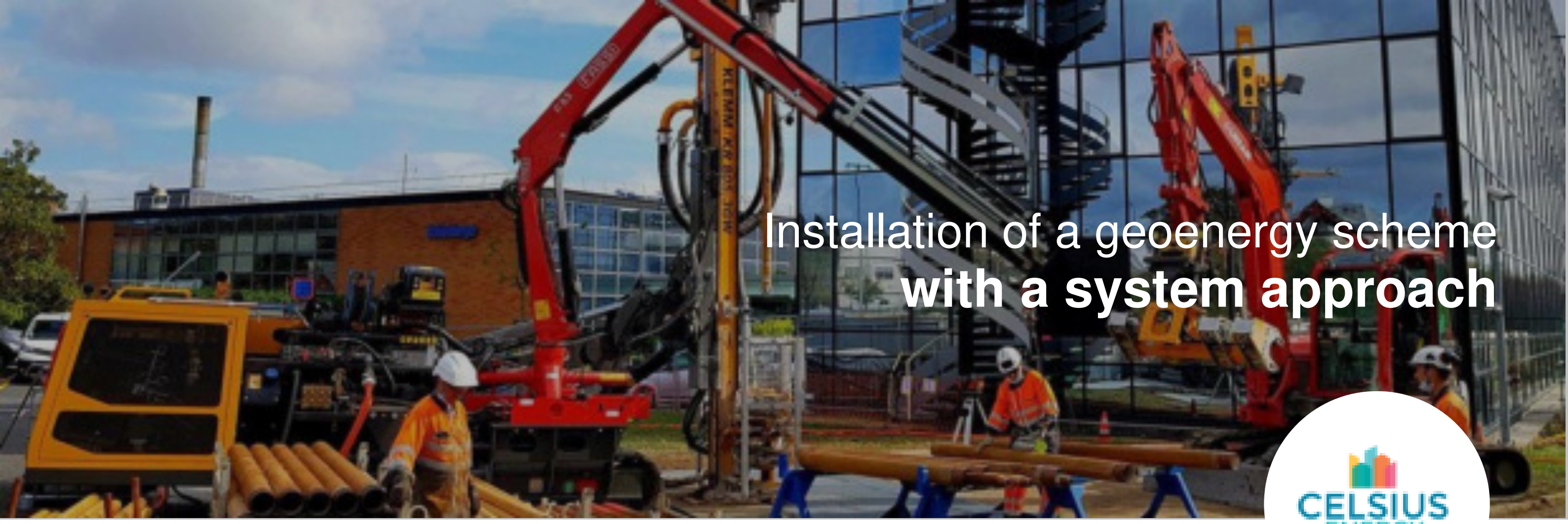
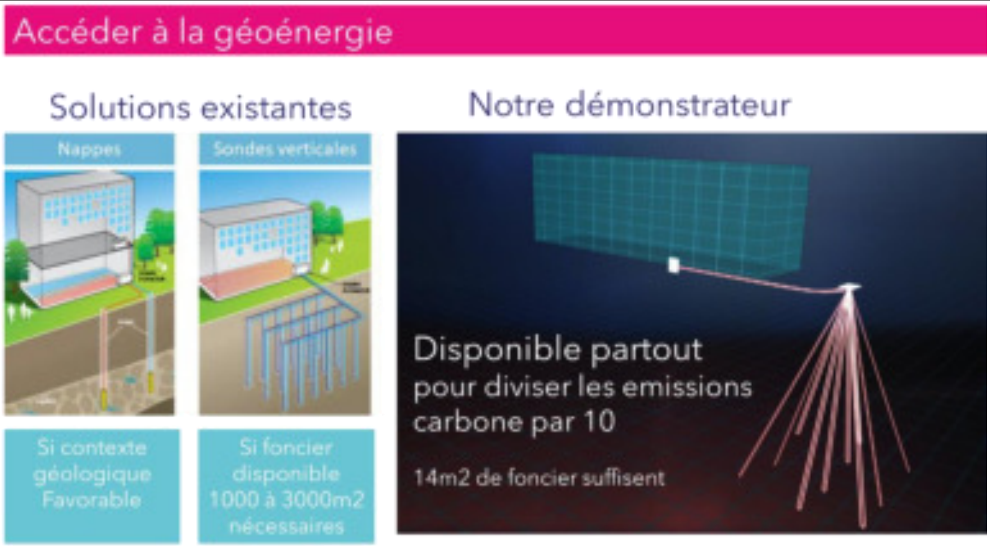


Installation of a geoenergy scheme **with a system approach**

Celsius Energy, a start-up of Schlumberger, has developed a geoenergy system for building heating and cooling which reduces its carbon footprint by up to 90%

Project start-up date	December 2020
Project location Places of implementation of the project at this stage and targeted geography if replicable.	Schlumberger Campus, Clamart, Hauts-de-Seine, France. 2 new projects are under development, one for an industrial building in Burgundy and another for an office building in the Paris region. In total, 40 projects are under examination in France, i.e. a total of 484,000 m2 of office space, healthcare buildings, schools and residential complexes. A large project is also being studied on the campus of a prestigious American university to establish its geoenergy potential in order to pool the energy needs of this multi-activity site and to reduce carbon emissions by a factor of 10.
Project objectives Type of climate innovation of the project with a description of the problem/issue addressed	1- Reduce CO_2 emissions from building heating and cooling by 90% through a geoenergy 2- Eliminate the contributions to urban heat islands due to air conditioning of buildings 3- Simplify the installation and use of geoenergy
Detailed project description	25% of GHG emissions worldwide come from building heating and cooling (Source: IAE). The Earth is a giant thermal battery able to supply heat in winter and to accumulate it throughout the summer to release it the following winter. By connecting buildings directly to the Earth's energy stockpile, Celsius Energy has developed a simplified geoenergy solution for heating and cooling new and existing buildings, even in a very urbanised environment. The geoenergy demonstrator developed by Celsius Energy and installed in Clamart, France allows the carbon footprint from heating and cooling to be reduced by a factor of 10. It is comprised of three main elements: ● A closed, star-shaped **heat exchanger**, equipped with double U probes, typically 200 metres in depth in which a heat exchange fluid circulates. This innovative structure allows the footprint on the ground to be drastically reduced: only 14m2 of land is enough to connect a building to the Earth's energy supply. The solution is very appropriate for a new or renovated urban building. ● A **Heat Pump** allows heat to be exchanged with the sub-soil to supply buildings in winter and to extract heat in the summer. The simultaneous provision of heat and cooling is also possible. ● **Digital control** minimises electricity consumption by optimising the sub-soil exchange in real time and the use of heat pumps coupled to the building. The digital control system also allows the performance of the system to be monitored and the maintenance of the connected heat pumps to be reduced.



A comparative analysis between the system developed by Celsius Energy and a conventional system [gas boiler + cooling unit] has been carried out focusing especially on the equivalent tonnes of CO_2 released. The analysis concluded that the emissions from the Celsius Energy system related to the works phase are compensated within 10 months when compared to the reference system, and has a global warming potential (GWP) 7.5 times lower at the end of 50 years of operation.

In use, geoenergy eliminates 90% of carbon emissions per kilowatt-hour generated, compared to the reference gas and cooling unit.

Main project's levers for reducing the greenhouse gas emissions

Reduction levers	Details on the aspects of the project
☐ Energy and resource efficiency (including behaviour)	
☒ Energy Decarbonisation	Use of geoenergy for building heating and cooling
☒ Energy efficiency improvements	Continuous improvement of energy performances by data learning of building usage modes combined with weather forecasts
☐ Improving efficiency in non-energy resources	
☐ Emissions absorption: creation of carbon sinks, negative emissions (BECCS, CCU/S, etc.)	
☐ Financing low-carbon producers or disinvestment from carbon assets	
☐ Reduction of other greenhouse gas emissions	

Emission scope(s) on which the project has a significant impact and quantification of GHG emission reductions per emission scope

	Aspects of the project contributing to the reduction of emissions by emission category	Quantification of associated GHG emissions by emission category *Please follow the quantification methodology used in the Afep guidelines.*
Reduction of the company's carbon dependency		
Scope 1 *Direct emissions generated by the company's activity.*		
Scope 2 *Indirect emissions associated with the company's electricity and heat consumption.*	Replacement of 100% of natural gas needs for heat generation with a mix: 82% renewable energy (geoenergy) + 18% electrical (heat pump power).	- 40T CO_2 per year: this building emitted 45 Teq CO_2 per year on average, i.e. 3250 $TeqCO_2$ over 50 years. It now emits no more than 5 per year (-92% CO_2)
Scope 3 *Emissions induced (upstream or downstream) by the company's activities, products and/or services in its value chain.*		
Increase of carbon sinks		

<table>
<tr><td></td><td>
<table>
<tr><td>Emissions Absorption
Carbon sinks creation, (BECCS, CCU/S, …)</td><td></td><td></td></tr>
<tr><td colspan="3">GHG emissions avoided by the company at third parties</td></tr>
<tr><td>Avoided Emissions
Emissions avoided by the activities, products and/or services in charge of the project, or by the financing of emission reduction projects.</td><td></td><td></td></tr>
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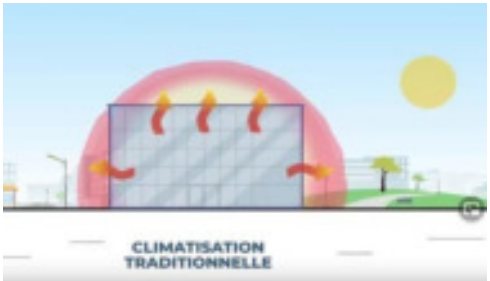
Clarification on the calculation or other remarks: click here to specify
The pilot building (3000m^2 surface-area) consumed 167 MWh/yr), 186 MWhLHV/yr of natural gas for heating and cooling. With an emissions factor of 253 $kgCO_2$/MWh, this represents 47 T CO_2/yr.
The geoenergy system developed by Celsius Energy allows the same needs to be met with 123MWH/yr of geoenergy with an emissions factor of 14.97 $kgCO_2$/MWh.
I.e. a reduction of 94.7% in CO_2 emissions per KWh of heat (or cold) consumed and an annual reduction of CO_2 emissions on the order of 44.5 tCO_2.
</td></tr>
<tr><td>Modality of verification of the quantification.</td><td>Calculation standard used (ADEME base, GHG protocol, etc.): ADEME Low Carbon, LCA methodology NF EN ISO 14044,
Verification of the calculation (internal or external): LCA performed by the independent firm EVEA.</td></tr>
<tr><td>Other environmental and social benefits of the project</td><td>From a surface area of 14m^2 of land, the demonstrator offers the possibility in a dense urban environment:
• Of providing renewable cooling;
• Of guaranteeing effective summer comfort even throughout extended heatwaves;
• Of providing quasi-passive natural cooling with an energy consumption up to 6 times better that traditional cooling units using energy from the Earth, geoenergy;
• Eliminating the contribution of urban heat islands from air conditioning, an increasing health problem for vulnerable persons.


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<tr><td>Project maturity level</td><td>☐ Prototype laboratory test (TRL 7)
☐ Real life testing (TRL 7-8)
☐ Pre-commercial prototype (TRL 9)
☐ Small-scale implementation
☒ Medium to large-scale implementation

Remarks: The project relies on
- optimisation of the existing technologies from different industries (low depth geothermal industries, petroleum industry technologies)
- innovations in holistic modelling of the system
- industrialisation of the installation process</td></tr>
<tr><td>Capacity and conditions of the project reproducibility, with associated climate impact mitigation potential</td><td>This installation was created in a systematic industrial approach in order to establish and optimise the process of design and production of the system. This process is reproducible. 500,000m^2 are currently under examination in France and throughout the world for future installations.</td></tr>
<tr><td>Amount of investment made (in €)</td><td>500,000€ - ADEME Heating Funds= 400,000 €</td></tr>
<tr><td>Economic profitability of the project (ROI)</td><td>☐ CT (0-3yrs)
☐ MT (4-10 yrs)
☐ LT (> 10 yrs)

Remarks: Click here to enter the information.</td></tr>
<tr><td>Engaged partnerships</td><td>The demonstrator project falls under the “Nous Sommes Prêts” [We are Ready] initiative. This initiative promotes the use of geoenergy nationally, bringing together more than 50 value chain players committed to sustainable buildings. Engie Solutions, Dalkia Smart Building, Vinci Construction, Rabot Dutilleul, Groupama Immobilier, l’Institut Français de la Performance Écologique du Bâtiment, Artelia, and geoenergy players.</td></tr>
</table>

	The structuration of this subsidiary is essential for achieving the goals of the SNBC (French National Low-Carbon Plan), the PPE (French multi-year energy plan) and the Sustainable Building Plan. 
Open comments from the project owner	Celsius Energy has developed an innovative solution for coupling buildings to the energy in their subsurface to achieve thermal comfort: ✓ **Sustainable: -90%** carbon impact compared to gas **heating**, **cooling** without contribution to urban heat islands; ✓ **Economical: -40%** of operating costs, **- 60%** of energy consumed, optimised investment; ✓ **Simpler**: turnkey, needing 100 times less land space than classic geoenergy installations, system equipped with **digital energy performance management.** The industrial vision combined with a building/subsurface system approach, drives the goal of moving to a national scale with strong territorial and international bases with projects already under way in other European countries and in a prestigious university in the North-Eastern United States. Here are several short videos that show a Celsius Energy installation, its operational phases and a virtual visit.
More about the project	
Contact the company carrying the project	Cindy Demichel, CEO Celsius Energy: cdemichel@celsiusenergy.com Olivier Peyret, chairman France Schlumberger: peyret@slb.com
Project URL links	https://www.celsiusenergy.com/ https://www.youtube.com/watch?v=e6rIvIiKJIA

Illustrations of the project	  

	

Celsius
Energy