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GEOTHERMAL ENERGY

SPECIAL REPORT | SEPT - OCT 2021

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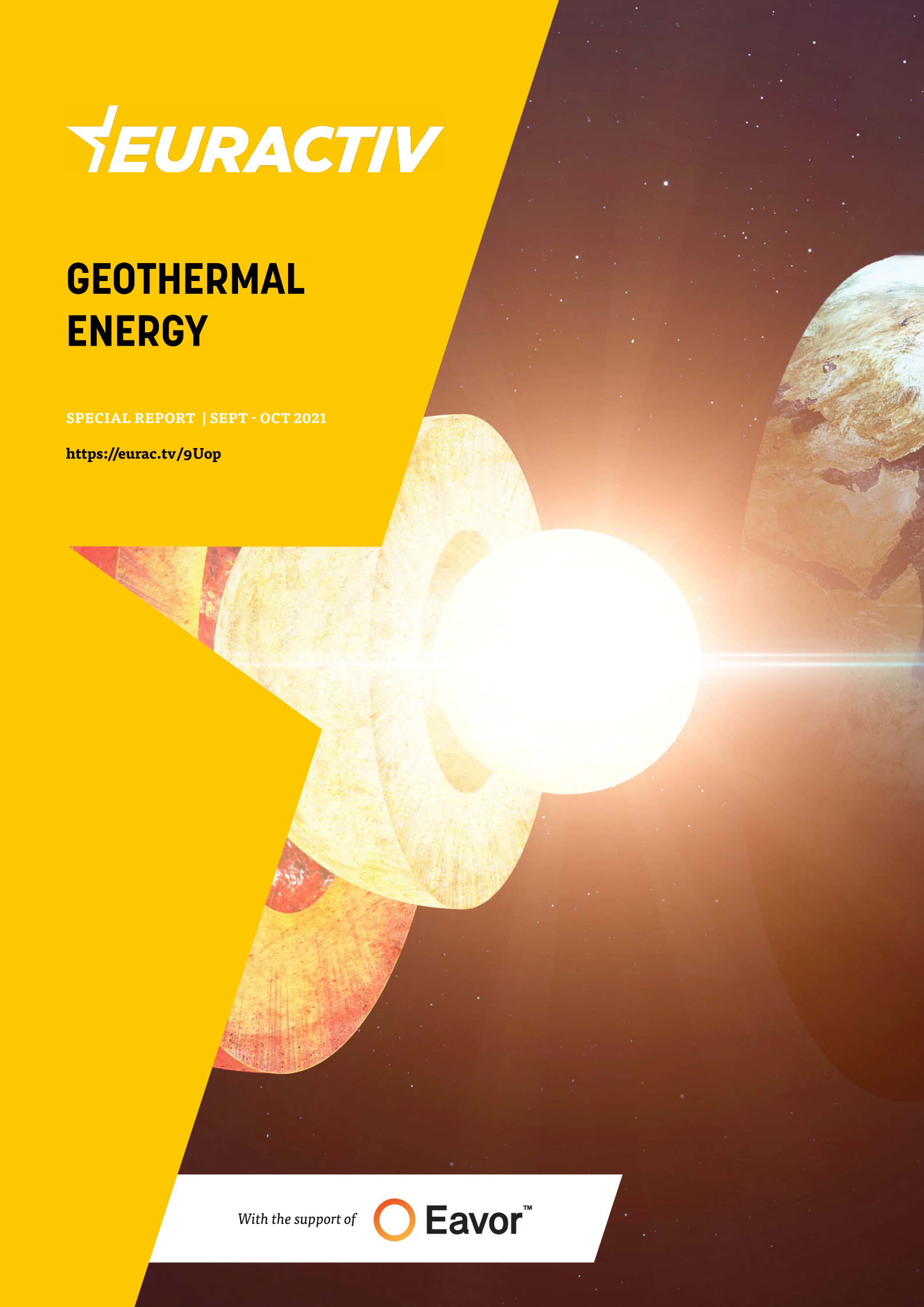

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Large-scale geothermal energy has long been constrained to volcanic areas where heat can easily be captured and turned into electricity. Today, breakthroughs in drilling techniques are opening new horizons, offering the prospect of "geothermal anywhere".

In this special report, EURACTIV looks at the latest developments in geothermal technology and the remaining challenges that need to be addressed before it can become a cheap and reliable source of renewable energy.

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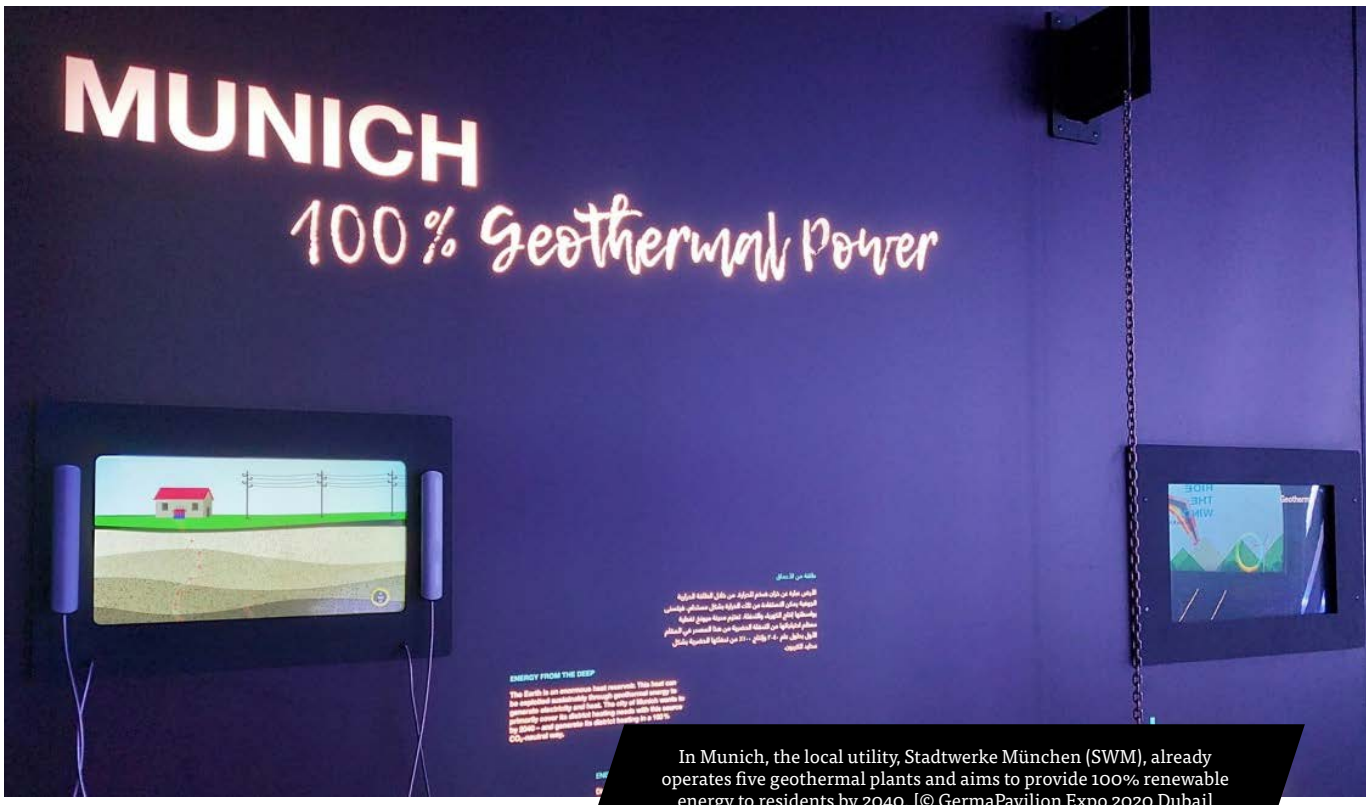
'Sun beneath our feet': The European cities turning to geothermal

By Anna Gumbau | EURACTIV.com



In Munich, the local utility, Stadtwerke München (SWM), already operates five geothermal plants and aims to provide 100% renewable energy to residents by 2040. [© GermaPavilion Expo 2020 Dubai]

A growing number of cities in Europe are betting on geothermal to provide households with clean heating, but the little-known renewable energy source will need more attention from Brussels in order to scale up.

Since 2003, Munich features among the European cities pioneering the deployment of geothermal energy.

The local utility, Stadtwerke München (SWM), already operates five geothermal plants. And in its 'Vision 2040' strategy, the city outlined plans to continue tapping into deep geothermal with a view to provide 100% renewable heating to residents by 2040.

About 560,000 households could be powered by geothermal energy alone in two decades, the utility told German newspaper SZ.

Buildings currently account for about 40% of the EU's energy consumption and are responsible for 36% of its greenhouse gas emissions. When industrial needs are added, heating even makes up around 90% of total energy consumption in a country like Germany, said Helge-Uve Braun, chief technology director at SWM.

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This is why heating and cooling decarbonisation features among the key objectives of the European Green Deal, which aims for net-zero emissions by 2050.

"The success of the energy transition is decisively dependent on the decarbonisation of heating, in which huge investment efforts, including more public funding, need to be made," Braun said.

LOCAL INTEREST

Often called the 'sun beneath our feet', geothermal energy is attracting renewed interest in Europe as local governments step up efforts to decarbonise their heating systems.

Geothermal delivers energy all year round, 24 hours a day, generating baseload electricity and heat while providing flexibility and dispatchability when other renewable energy sources like wind and solar are variable.

Italy continues to have the highest number of geothermal plants in Europe, all of them located in Tuscan cities like Pisa and Siena. But other major European cities, such as Paris and Vienna, are now also turning to geothermal energy to meet their decarbonisation targets.

At the EU level, however, regulators have so far paid little attention to geothermal.

Overall, renewable heating remains the 'orphan child' of Europe's energy transition, said Jörg Mühlenhoff, energy transition policy coordinator at CAN Europe, a green campaign group.

"The European Commission often focuses, unfortunately, on carbon capture and storage and other technologies, and more broadly, even hydrogen is discussed for heating our buildings," Mühlenhoff said.

"These technologies are not yet mature, besides the fact that their climate benefit would be more than questionable. Instead, we need to focus on sustainable renewable solutions that are readily available," he told EURACTIV.

'HIGH-LEVEL VISION' LACKING

The lack of political will is the main hurdle standing in the way of geothermal energy, Sanjeev Kumar, head of policy at European Geothermal Energy Council, told EURACTIV in an interview earlier this month.

The United States, Turkey, Indonesia, and China are among the countries pushing more strongly for geothermal energy, with political elites standing behind it. In China, for instance, the development of geothermal has featured in its last two Five-Year Plans.

A similar 'high-level' vision is required at the European level if geothermal is to contribute to the bloc's heating decarbonisation goals, said Marit Brommer, executive director at the International Geothermal Association, an industry group.

"At the moment, the high-level vision of the European Commission's plan, if you look at 'Fit for 55' and if you look at the Green Deal, is all about solar, wind and hydrogen," Brommer said.

"And if [geothermal technologies] are not mentioned in that high-level document setting our roadmap towards net zero, then it's going to be very difficult for member states, regions and city councils to actively seek the benefits and policy instruments to create a favourable regime or environment for geothermal," she told EURACTIV.

The revised Renewable Energy Directive is seen in the industry as a first step in the right direction to support geothermal. Yet the proposal currently stands falls short of boosting renewable heating and cooling, the 'orphan child' of Europe's energy transition, according to Jörg Mühlenhoff from CAN Europe.

Getting the green light from local authorities to drill and install a geothermal plant can also be a long and frustrating process, said Daniel Moelk, country manager for Germany at Eavor, a Canada-based geothermal start-up.

"If you look at municipalities, they want to decarbonise today. And permitting and land issues slowing us down come with a risk. We can only wait until a certain point of time, but if it takes too long, municipalities might have to choose a less favourable solution, like prolonging the offtake agreement with coal-fired power plants or building a gas turbine," he said.

'POLICY MIX' NEEDED TO SUPPORT GEOTHERMAL

Installing a geothermal plant is not cheap. Drilling costs amount to around €5 million per well, representing the lion's share of the total expenditure.

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But once the installation is in place, geothermal offers a cheap and reliable energy source compared with fossil gas while delivering much more energy per unit.

In addition to the revised Renewable Energy Directive, experts believe that several other policy measures included in the EU's 'Fit for 55' climate package could support the development of geothermal energy.

The revision of the Energy Taxation Directive should make heat pumps and renewable heating sources much more cost-competitive than fossil gas boilers, said CAN Europe's Mühlenhoff.

"Fossil gas boilers are so cheap because it's a mass technology, and they are even subsidised publicly and supported with low energy taxes compared to the energy content, which creates a distortion of the competition between the energy carriers," said Mühlenhoff.

But any reform will be hard to agree on as decisions on taxation are taken by unanimity at the EU level.

"There is still a long way to go. To decarbonise the heating sector with the help of deep geothermal energy, it is necessary to create a level playing field for district heating and individual heating systems," he told EURACTIV.

Yet, there are also favourable winds blowing for the industry. Helge-Uve Braun from SWM believes carbon pricing policies will be essential to support the scale-up of geothermal. This includes new initiatives such as plans to extend the EU's emissions trading system (EU ETS) to heating and road transport, he said.

INTERVIEW

Industry: Geothermal energy requires European policy solutions

By Kira Taylor | EURACTIV.com

Hellisheidi geothermal power plant in Iceland [Johann Helgason / Shutterstock]

Geothermal power is a reliable and renewable energy source that is local by its nature and offers baseload power generation. Alongside energy efficiency measures and other renewable heat sources, like heat pumps, it could be part of the solution to Europe's energy crisis, says Sanjeev Kumar.

Sanjeev Kumar is Head of Policy at the European Geothermal Energy Council. He spoke to EURACTIV's Kira Taylor about the potential of geothermal to provide a reliable and renewable energy source in Europe.

Europe is in an energy crisis. Commission Vice-President Frans Timmermans has said that, if we had switched to renewables five years earlier, we wouldn't have the issues we're having with high energy prices. How do you approach the current issues from the geothermal perspective?

With geothermal, there are no supply issues. We are literally standing on an endless power source with billions of years' worth of heat that can be used for heating, cooling and electricity. So it makes perfect sense for regulators to invest time working out how to utilise geothermal energy.

We're not saying geothermal is the answer to everything, but if you balance geothermal with wind, PV, solar thermal, ground source heat pumps, air source heat pumps and better energy efficiency, then actually you can pretty much decarbonise the

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We're not saying geothermal is the answer to everything, but if you balance geothermal with wind, PV, solar thermal, ground source heat pumps, air source heat pumps and better energy efficiency, then actually you can pretty much decarbonise the largest energy consuming parts of the economy really quickly. Geothermal makes an 100% renewable energy system obtainable.

At the same time, if you electrify transport, you've got baseload power generation from geothermal. Regulators need to incorporate geothermal more in their pathways to decarbonising buildings, industry and transport. It needs to be part of the public conversation. If not a geothermal strategy, then certainly a geological strategy at the European level because a lot of these sectors require European policy solutions.

The best example is to look at the French Environment Agency. With geothermal, they found that the levelised cost of geothermal is €15 per megawatt hour (MWh) compared to €51/MWh for conventional fossil gas. So even with all of the massive subsidies for fossil infrastructure, gas is still infinitely more expensive than geothermal. If we can find a way to get more and more geothermal off the ground, then actually you would have solved a lot of issues.

The proof of the pudding is that, in EU countries' national energy and climate plans and in the last energy council conversation around the Fit for 55 package, there was a lot of resistance to the renewable heating and cooling subtarget in the renewable energy directive.

Member states don't want to do this. It constrains them. Yet this is the genesis of the political problem. If they're serious about this, they will address renewable heating and cooling. What I think they're looking for is a quick get out of jail card. We've had quick get out of jail cards for the last 40 years. And it just creates a crisis every couple of years and it puts Ukraine through the mill. It's just geopolitically not a smart thing to do.

Deep geothermal has a lot going for it: it's a renewable energy source, and it potentially provides baseload electricity supply without the variability of wind and solar. So why has it not picked up in a major way yet?

Geothermal up to now hasn't had the attraction that wind and solar has partly because you can't see it. Secondly, geothermal projects are much, much bigger projects to get off (under) the ground. Then the third issue is that there's just been very little policy focus around the specific needs of geothermal.

The main difference between wind and solar and geothermal is that they're both manufactured. You can go to a factory and start making the same standardised products on an assembly line. For geothermal, it's an engineered project, so each project fits into location and available resource. The challenge for the industry is to standardise as much of its licensing, permitting, project financing and risk mitigation. At the moment, these skill sets are wrapped up chasing oil and gas.

How have deep drilling techniques evolved over the years? What is the state of the art technology now?

The main advances in geothermal have all been around the depths at which you drill. So you have some technologies that are able to drill very, very deep. You then have issues in terms of the rocks or the geological formations you're drilling into. The harder the rock, the stronger the drill needs to be.

There are two main technological innovations that we've seen over the last couple of years – and we expect this to be transformative not just in terms of a new market, but also increasing the profitability of existing geothermal sites: horizontal drilling

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and multi-drain drilling.

The Engie & Athena multi-drain drilling project in Velizy-Villacoublay, France, won the Ruggero Bertani European Geothermal Innovation Award 2021 by nearly doubling the existing geothermal energy source by heating 12,000 houses with geothermal energy rather and saving 22,800 tons of CO_2 per year.

Significantly increasing energy flows from existing capacity is a both lucrative for the project developer and the environment.

Looking at the next 10 years, is that the main technology? How do you see geothermal growing?

Geothermal's challenge over the next decade is less about technology – the most sophisticated drilling already exists. Humanity has been able to drill very deep into quite hostile environments for a long time – they've just been searching for a resource that has caused considerable climate damage.

Shifting this to renewables means developing business models for large-scale geothermal energy utilisation. This requires regulators to create a market for renewable heat for the industry to move.

Now the main challenge for the industry is to focus on business model innovation. Part of this is looking at ways in which project developers can better utilise existing capacity, as well as experimenting on different ways to secure sufficient income to remain operational.

For example, geothermal lithium is a brand new and very lucrative business model. Extracting lithium chemical deposits, which have been processed by mother nature, adds a new revenue stream.

Corporate purchases are another model. In the US, Google partnered with Fervo to provide baseload carbon-free power.

Dandelion Energy is another example of business innovation in the US that could be replicated in European markets. Dandelion Energy was formed as a spin-off company from Alphabet, which owns Google, to scale-up geothermal Ground Source Heat Pumps (GSHPs) by creating an accessable consumer interface and amortising upfront installation costs into monthly bills. Then you also have a different business model in the sense of district heating. The issue there is how do you construct the business model at a local level?

One of the new markets that the industry is slowly starting to grapple with – policymakers are not in this space yet – is Heat Purchase Agreements (HPAs). Power purchase agreements have largely driven a lot of the growth that we're seeing today in wind and PV. Heat, however, has a different requirement because one has to build the infrastructure to connect the renewable energy resource and the customer. The ECOGI bio-refinery, located in France, is an example of a HPA. It uses geothermal heat from a local *Electricité de Strasbourg plant* to convert plant-based raw materials into pharmaceutical, nutritional and food products.

There's also an issue around building capacity for environmental impact assessors within member states and local regions as well because that kind of skill, while in some places has been maintained, requires support in others.

The final thing, again in the business model, is risk mitigation. Any technology will have a risk attached to it. With geothermal, you've got two risks. The first one is your project risk. Then, with geothermal as well, sometimes you have a resource risk. So you drill, but actually you need to drill a bit deeper in order to get the flow rate and resource that you originally modelled. Mature geothermal markets address these issues with private insurance products.

The issue is that there are only there are only a few mature markets for geothermal at the moment so support in the form of guarantees is needed to move enfant markets to mature ones.

You mentioned earlier the experience in drilling. Oil and gas companies have a lot of experience in this. They've conducted a lot of geological surveys, which are useful for geothermal. Why do you think more haven't come across into geothermal?

The profitability of drilling for oil or gas is infinitely more than geothermal. What you find historically is that, whenever there's been slack within the oil or gas market, the drilling service sector effectively just switches over to drilling for geothermal.

What we're now starting to see is many more companies moving into geothermal. Most of the big majors are now starting to talk about geothermal. It's the most logical space for them to move into.

The problem is that we lack the political conversation to accelerate this transition. At present, the political conversation centres on a just transition from coal industry, but there is no talk

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about the transition pathway for the oil and gas drilling industry.

Does something like closed loop systems offer oil and gas an out?

The underlying engineering basis of closed loop systems is geological understanding and horizontal drilling, which are the mainstay of the oil and gas industry. So clearly, you see that expertise coming over and developing new markets for geothermal.

The sector needs more of the way in which the oil and gas industry has standardised their products and regulations. All of this requires a regulatory pull from legislators, especially those focused on the revised 2030 targets.

Importantly, once geothermal does get those foundations in place, we expect significant volumes of growth for renewables at the expense of fossils. This is good for geothermal, jobs, sustainable growth, the environment and, of course, the climate.

There's this idea of geothermal anywhere – that, if you drill deep enough, you can pretty much provide geothermal energy to everyone. How likely is that? Are there still areas that would be missed?

There was a study that just looked at the existing district heating system and could you convert that over to geothermal. It found that, if you could do that, you could decarbonise 25% of Europe's population. This is just with the existing district heating infrastructure that is around 5, 6, 7 years ago.

In terms of whether geothermal is available everywhere, do you have the resources to meet demand? The answer is very simple: yes. Once we get the environmental impact assessment architecture correct, once we have better risk mitigation frameworks, then actually you can drill at completely different temperature ranges.

How bad is the risk of tremors for deep geothermal projects? Is the recent example in Strasburg a cautionary tale for companies looking to expand in Europe? Does it tell them they need to do more communication with communities or was that just a one off?

That's more a one off. This wasn't necessarily the company. They were asked to do additional testing by the regulator and that led to the incident. So part of the story there is that we need to have regulators who fully understand the geothermal technology.

We need to take this on board, learn whatever lessons need to be learned, and move forward. With every single thing that we do in life, whether you're building a renewable energy system, building a metro, house, school or hospital and it requires foundation work, then you're, by definition, moving into the territory where you will have an impact on the natural environment.

The question is all about how to manage these impacts. The industry is very keen to work with local stakeholders and communities to raise awareness and build engagement.

In terms of regulation, what are the main differences between Europe and the rest of the world? Are the restraints bigger in Europe than elsewhere?

The main restraint is largely political will. Geothermal power was born in Italy in 1904. A great example of European innovation. The Laderello fields, in the Tuscany region, still produce geothermal power today.

But the US, Iceland, Turkey and, increasingly, China are the countries which have the political will to support geothermal power and/or heat plants. The US National Renewable Energy Laboratory (NREL) constantly produces estimates of capacity, guidance on technology, business models and policy.

In China, the 14th five-year plan is about geothermal. You can see that the Chinese government has clearly directed Sinopec, one of the largest oil and gas companies in the world, to focus on geothermal. That's a strong political direction.

We have nothing of the sort within Europe. In fact, the EU's commissioners for energy and climate spend all the time saying that the answer is more wind and solar rather than we need more renewables.

That is because, in Europe, there is an inbuilt strategic constraint called the internal market for gas. This provides a regulatory pull that locks the EU into gas consumption and locks out renewable heat.

‘Closed-loop’ technology brings promise of geothermal anywhere

By Anna Gumbau | EURACTIV.com

Eavor, a clean energy start-up founded in 2017, completed last year a first prototype of closed-loop geothermal power plant to deliver energy in Alberta, Canada.

Geothermal energy has until now been constrained to areas with special geological conditions where the earth’s heat is close to the surface. Today, closed-loop technologies make geothermal accessible almost anywhere in the world, opening up new prospects for mass-scale deployment.

Eavor, a clean energy start-up founded in 2017, completed last year the first prototype of a closed-loop geothermal power plant to deliver energy in Alberta, Canada.

Now, the Calgary-based company intends to deploy similar plants in Germany and gradually scale up its technology across Europe, thanks to backing from new investors.

The ‘Eavor Loop’, as the company calls its closed-loop technology, is a new generation of Advanced Geothermal Systems (AGS). It connects two vertical wells with many horizontal wellbores, which all together create a closed buried-pipe system.

These systems do not require the injection or extraction of any fluids from the earth. Contrary to deep geothermal techniques, it therefore does not require fracking – the controversial drilling process used in the extraction of shale gas.

“The system provides energy 24/7, independent from weather, season or if it’s day or night,” said Daniel Moelk, country manager for Germany at Eavor. “We can also dispatch the load and follow wind and solar by reducing the energy output when we have lots of wind and solar in the grid. And if these drop out, we can provide peak load,” he told EURACTIV.

“Therefore, we can work as a renewable battery without actually having to construct a battery or construct an energy storage facility,” he explained.

Geothermal energy has traditionally been developed in areas offering specific seismic and volcanic conditions, such as Iceland

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or Turkey, which have conventional hydrothermal sources.

But as Europe looks at measures to decarbonise its heating systems, some cities like Munich and Paris – which are sitting on deep aquifers – are now betting on geothermal energy to deliver heat and electricity in urban areas.

And closed-loop systems could offer them an option.

"I think there are places on earth where a closed loop might be the only technology that can offer a constant baseload," said Marit Brommer, executive director at the International Geothermal Association (IGA). "We need to demonstrate the technology at scale to understand how it serves this constant supply of electricity and heat," she said.

BORROWING FROM THE OIL AND GAS INDUSTRY

Closed-loop geothermal systems, as well as other deep-drilling technologies, could also bring an additional benefit: They enable the redeployment of both technologies and workers from the oil and gas industry who have prior experience in the field.

"The only other industry that goes down to those depths to try and visualise and understand what's going on down there is predominantly the oil and gas industry," said Robert Winsloe, vice-president for Business Development at Eavor.

"And in fact, the reason why the economics for the Eavor-Loop work is, ironically, because of the shale industry in North America," he said.

"This means that once we begin to scale quickly that volume, then we will be able to redeploy thousands of people from the oil and gas industry and redeploy a lot of that same technology as well," he told EURACTIV.

Oil and gas companies have accumulated decades of experience in drilling wells and exploring geological formations. Industry experts believe they could use the vast amounts of data collected over the years in the geothermal industry.

In fact, some of them have already started investing in geothermal. Earlier this year, oil majors including BP plc and Chevron invested $40 million in Eavor, hoping to build on the fossil fuel industry's drilling experience to expand the company's activities across the globe.

RISK AND REWARD

It will not be an easy ride, though. Deep geothermal technologies have so far used fracking, or high-pressure water, to fragment the rock and access heat sources deep underground.

This has caused public rejection in places like Strasbourg, France, where geothermal projects have caused tremors in the recent past.

"We need to communicate well our technology. Because we are not connecting to any hydrological aquifers, we have eliminated the risk of a seismic event during drilling," Eavor's Moelk said.

"We cannot cause any earthquakes, and we cannot contaminate drinking water," he stressed.

Because of those setbacks, environmental and geological risk assessments related to geothermal have also become more stringent over the years.

"If there's one thing that oil and gas is good at is exactly that: it is the risk management and the de-risking of the subsurface where the oil and gas industry has so much more knowledge of because they have drilled millions of wells," said the IGA's Brommer.

"We need to be crystal clear on what we do, how we do that, how we manage everything in the subsurface, and take people with us in that journey. Because if we don't do that, I am very much concerned that the social acceptance that we worked so hard to gain will be lost," she added.

'Always on': The promise of new geothermal technologies

By Anna Gumbau | EURACTIV.com

The Nesjavellir geothermal power station in Iceland. Geothermal plants involve high upfront investment costs related to drilling and geological studies. But once up and running, they offer a cheap and reliable source of renewable energy. [javarman / Shutterstock]

The ability of geothermal energy to provide baseload electricity and flexibility to heating and power systems will be invaluable in order to move towards a 100% renewables-based system, experts say.

Geothermal energy, often dubbed 'the sun beneath our feet' for its capacity to provide an endless source of energy from the subsurface, currently has just about 16 gigawatt (GW) of capacity installed globally.

But new drilling techniques and the urgency to decarbonise heating systems are providing new momentum to the industry, which has plans to rapidly scale up.

In its 'Net Zero By 2050' report, the International Energy Agency (IEA) found that at least 52 GW of geothermal capacity will be needed by 2030 to be compatible with a climate neutrality scenario by mid-century.

"The beauty about geothermal is that it has this huge benefit of always being on," said Marit Brommer, executive director at the International Geothermal Association (IGA).

"We're not dependent on any weather conditions – we're dependent on good geology, and on good clients, meaning that we need to have a local relationship with our customers," she told EURACTIV.

A COMPLEMENT TO WIND AND SOLAR

Combined with variable sources like wind and solar, geothermal could provide a much-needed power baseload as part of a 100% renewable energy mix.

And the flexibility offered by closed-loop geothermal systems could also dispatch the load when output from wind and solar falls.

"We can work as a renewable battery without actually having to construct a battery or build an energy

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storage facility," said Daniel Moelk, country manager for Germany at Calgary-based geothermal start-up Eavor, which operates an advanced closed-loop system.

Similarly, Brussels-based NGOs CAN Europe and the European Environmental Bureau (EEB) published a report last year outlining a 100% renewables-based energy scenario for the EU aligned with the 1.5C goal of the Paris Agreement.

The report assumed that the share of geothermal energy in the bloc's total final energy demand could reach up to 10% by 2040, providing a substantial contribution to a fully renewable energy system.

"It is very valuable to have stable or dispatchable renewables," said Jörg Mühlenhoff a green campaigner at CAN Europe. "That's what makes geothermal energy quite attractive, and that's why we think it deserves much more interest and attention and support," he said.

PAIRING WITH HYDROGEN

Geothermal could also support the development of hydrogen, as the underground renewable source can be paired with solar power to make the production of renewable hydrogen more cost-effective.

"A hydrogen plant is often going to be justified based on a solar plant, and then you run that through the electrolysers" to produce renewable hydrogen, explained Robert Winsloe, vice-president for business development at Eavor.

"But you may only run them eight hours a day," he cautioned. "What you can do with geothermal is that you can keep the electrolysers busy for the other 16 hours of the day, and you get a much better return on investment with your electrolysers," he added.

Geothermal plants involve high upfront investment costs related to drilling and geological studies. But once up and running, they offer a cheap and energy-efficient source of energy. According to the French Environment Agency, the levelised cost of geothermal is €15 per megawatt hour (MWh) compared to €51/MWh for conventional fossil gas.

Yet geothermal industry associations and NGOs alike lament that the EU is doing too little to promote renewable alternatives to fossil fuels in heating.

"It goes without saying that we need to replace all the fossil fuels in the heating sector," said CAN Europe's Mühlenhoff.

"We need to deploy more renewable-based district heating networks in order to allow geothermal heat but also solar thermal heat to be integrated and distributed in an efficient way," he added.

According to Marit Brommer from the International Geothermal Association (IGA), regulators need to look at a mix of policy incentives.

"An enabling policy is everything to do with favouring renewables over fossil fuels. And that has to do with the carbon tax, it has to do with financial instruments, subsidies, tax breaks, it has to do with understanding what the benefits are of renewables. It needs to be incentivised by decision-makers," she said.

PROMOTED CONTENT

DISCLAIMER: All opinions in this column reflect the views of the author(s), not of EURACTIV Media network.

The Next Revolution in Green Energy is Coming from Right Beneath our Feet

By John Redfern | Eavor

John Redfern. [Eavor]

The energy industry is at a moment of reckoning. As the global energy demand continues to double and triple, climate change will not wait for us to solve the green energy conundrum on our own schedule.

John Redfern is the President and CEO of Eavor.

We need a bold transformation today. The good news is that we have a lot of tools available to us and, to our credit, we are beginning to use them. But our biggest clean energy resource remains largely untapped, the Earth itself.

Countries around the world are embracing wind and solar power, in one of the most dramatic technological revolutions in history. But the intermittency of these energy sources presents an intractable problem. Modern civilization simply can't power itself down on calm and cloudy days, and billions of dollars of research performed by some of the world's top minds has failed to produce the magical battery that will smooth out that curve.

The situation has become so bad that even the most committed environmentalists are turning their eyes back to problematic stopgaps like nuclear, natural gas and even biomass for baseload supply. But

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The situation has become so bad that even the most committed environmentalists are turning their eyes back to problematic stopgaps like nuclear, natural gas and even biomass for baseload supply. But there is a better way. The real magic battery is right beneath our feet.

UNLIMITED CLEAN POWER, IF WE HAVE THE SKILLS AND THE WILL TO TAP IT

The core of the Earth burns at thousands of degrees Celsius. That heat radiates continually outwards to our planet's surface, and will keep doing so for tens of billions of years. In other words, the Earth can be thought of as a colossal battery, with more clean power than we could hope to use. A Canadian government survey estimated that the geothermal energy potential in Canada alone was more than a million times greater than the country's total energy demand. And this is energy that's available every minute of every day. So why is everyone still talking about wind and solar?

If you bring up geothermal energy in a conversation about the clean energy transition, you will hear the same misgivings time and again. People will tell you that geothermal works fine in Iceland, but we don't all live on volcanic islands. They'll tell you it may require fracking to build and can contaminate the water and soil. They'll say it's simply not practical to scale it up to meet a meaningful demand. Every single one of those complaints is now obsolete. They may have applied to the geothermal plants of decades past, but the technology has fundamentally changed.

Yes, in traditional geothermal applications, water is freely cycled through fractured volcanic rock formations. And, yes, this means it is only viable in places where the geological stars align. But the new Eavor-Loop technology is as different from traditional geothermal as traditional geothermal is from oil & gas.

Built with advanced drilling techniques and expertise developed in the oil and gas industry, the Eavor-Loop is a self-contained system that circulates a proprietary fluid through a precision well system running kilometers deep. An Eavor-Loop can be placed almost anywhere, at any scale. With low-footprint installations, you can produce as much energy as you need, anywhere in the world, with zero emissions and perfect dispatchability. When the wind's not blowing and the Sun's not shining, Eavor-Loop can dispatch its energy when needed to fill that power gap, or provide baseload 24/7 when other clean energy solutions are unavailable.

PUT YOUR EAR TO THE GROUND. CHANGE IS COMING.

In one fell swoop, this technology answers every criticism levelled against renewable energy. Rather than cluttering up the natural vista and soundscape as wind turbines do, the Eavor-Loop is almost entirely subterranean and practically invisible. And, while solar panels require vast tracts of flat unused space, difficult or impossible to find in many parts of the world, the surface footprint of an Eavor-Loop is so small it can be embedded into existing communities without disruption, providing power right where it's needed.

As for concerns about scalability, the maximum output of the Earth's geothermal reservoir is virtually limitless. An Eavor-Loop can be layered and extended underground to any size required.

Perhaps the biggest complaints about the green transition, however, come from those whose livelihoods depend on the fossil fuel industry. It's easy to vilify the oil industry, but the reality is much more human. We can't blame a rig operator or a geoscientist for wanting to keep putting food on the table. And, as much as we talk about

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skills retraining, most of the workers who've spent decades on the oil patch are unlikely to be landing high-paying jobs in wind and solar.

But the high-precision equipment that must be expertly operated to build an Eavor-Loop are the exact equipment those oil and gas workers already use every day. Deploying closed-loop geothermal at scale would make oil patch skills and experience the hottest commodity in the clean energy industry.

Eavor-Loop really is the silver bullet, and it couldn't have come at a more crucial time. This can be the page in the history textbook where human ingenuity saves us from the brink and things finally start getting better. I'm not asking you to take my word for it, though. I'm just asking you to make it part of the conversation. The best solution will win out, but how long it takes to rise to the top depends on the quality of our dialogue. And we don't have an excess of time.

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