Technology breakthroughs will enable scaling Geothermal from a niche solution to available everywhere, with the potential of becoming the cheapest clean baseload generation on the planet.

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The Geothermal energy segment **has provided commercial clean baseload electricity around the world for more than a century**. It is a **mature, commercially proven technology**, that offers a unique combination of energy security, reliability and resilience that makes it more valuable per MWh than intermittent renewables, which require large land areas and battery backup.

However, there are certain reasons why geothermal energy deployment has been limited: (i) it's **location specific,** where a trio of underground features are found together: **Heat, Water, and Permeability**. This combo is also known as Hydrothermal System, (ii) it has **high upfront costs**, (iii) it involves **high exploration and drilling risks** since the need of those 3 features implies significant uncertainty both from a geological and hydrogeological perspective, and (iv) some **technological challenges** are still to be solved **to increase the range** of suitable geological conditions and **to efficiently harness the heat** from the rocks. Today, geothermal power plants can be found in different parts of the world, **but always limited to sites** where those 3 features exist (e.g., near a volcano or a magna intrusion capped by a permeable rock fed by meteoric water), and **only represents a mere 0.5% of renewables based installed capacity**, with only 16GW installed globally. In short, **Geothermal today** is not only **niche** on where it can occur but is also **expensive** and has significant **exploration and development risks** (with the perception that this risk is not worth the reward).

To break this geographic dependence and make geothermal relevant in the energy transition, we need to learn to target heat, instead of specific hydrothermal anomalies; this means that we need to tackle three main challenges: **(i) drill deep enough to get an attractive rock temperature, (ii) harvest the heat, (iii) and efficiently convert it to electricity**. Some of these technical challenges are very similar to those that the O&G shale industry tackled in the early part of this century, some others are new and unique. One of the key reasons why we are excited about Geothermal **is the compounding effect that solving these challenges will bring to the sector**; each of these levers can double the efficiency of geothermal by themselves, **achieving all of them can put Geothermal in the center of this Energy Transition**.

At TechEnergy Ventures we focus our geothermal investment thesis on the three levers that we think will ultimately make geothermal energy competitive virtually anywhere:

1. **Drilling**: By drilling deeper into the Earth's crust, higher temperatures and therefore power outputs will be enabled. Engineering challenges need to be solved to minimize sensitivity of the drilling system to rock hardness and temperature, trying to keep drilling costs as constant as possible with depth (today, they grow exponentially).

2. **Enthalpy Harvesting Systems**: Implementation of new systems designs that target an improvement in heat recovery, with the following innovative approaches being the most developed:

a. **Enhanced Geothermal Systems (EGS)**: Stimulation techniques to increase permeability in the reservoir rock, targeting higher flow rates and avoiding short-circuiting.

b. **Advanced Geothermal Systems (AGS)**: Heat extracted only through conduction in a closed-loop system; it can be applied anywhere minimizing exploration risk.

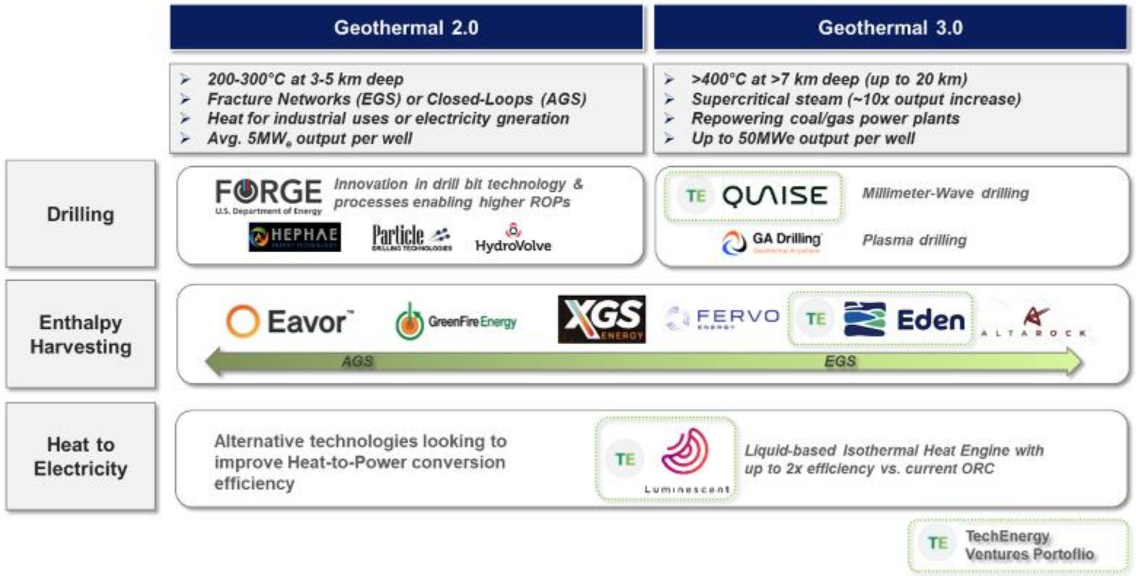
3. **Heat to Power:** New technologies that can improve the performance of currently used Organic Rankine Cycle (ORC) which is limited relative to Carnot Efficiency, enabling lower Capex/MW ratios.

It is worth noting also that new subsurface characterization technologies will be necessary to enable identification of best resources and to reduce the risk of drilling a well where any one of the required elements (heat-water-permeability) is missing, which currently adds uncertainty and financial risks to the overall geothermal projects.

How Deep (hot) do we need to go? The first question is how deep we need to go to harvest sufficient heat and make wells economically. Given the Carnot Efficiency Curve, and the fact that a lot of the costs are fix and independent of the drilling target depth, the logic would tell us that we should go deep enough to get to 500°C at surface and unlock supercritical steam conditions; these could deliver 4-10x the enthalpy than say a 200°C steam. But while this is the case, the challenges of drilling deeper and hotter with today´s technology are also exponential…For this reason, we separate Geothermal in two categories:

1. **Geothermal 2.0:** Drill to 200-300°C (3-5 km), with existing/upgraded technologies, lever learning curves, and focus on improving drilling performances.

2. **Geothermal 3.0:** Drill to 500°C (7-10 km), with a completely new approach to drilling that can effectively reach these depths and capture enough heat to get or generate ca. 500°C supercritical steam at surface that can be used to feed existing carbon plants, leveraging existing steam turbines and interconnection capacity.



Geothermal energy2.0 vs 3.0

For Geothermal 2.0, innovations in Drilling are critical to begin developing geothermal beyond current frontiers. Drilling cost in geothermal projects may exceed 50% of the total Capex (especially for AGS approaches with long pipes design) and is mainly driven by ROP and bit life. Geothermal drilling involves higher temperature and harder and more abrasive rocks (e.g., granite) than O&G drilling. Therefore, some of its main challenges have been only partially addressed by the O&G industry. Focusing on drilling efficiency improvements and extending the operational limits of tools available nowadays, many startups and initiatives are working hard to develop enhanced mechanical drilling technologies that will hopefully help overcome current challenges. FORGE Initiative is a clear example of this, demonstrating the much better performance of PDC bits compared to tricone bits, combined with monitoring of critical parameters in real time, optimizing drilling efficiency and reducing well times by more than half. These optimized technologies are going to be commercially available in the shorter term when compared to more disruptive drilling techniques (such as lasers, plasma, or millimeter wave drilling), that will come later in time but will be critical to unlock the next Geothermal generation.

Geothermal 3.0, targeting the use of supercritical steam (500°C) as the working fluid, can extract up to ~10 times more useful electrical work from each drop of water when compared to non-supercritical conditions. Aiming for supercritical conditions is key to attain power densities consistent with fossil fuels and will allow to repower coal/gas power plants with supercritical geothermal steam, besides building new geothermal power plants instead of fossil-fired plants. These temperatures are available in 70% of the Earth at 10 km and everywhere at 20 km. The problem with going deeper resides on the basis of traditional drilling methods, which normally require using electronics, sensors, elastomers, that are currently limited to ~200-250°C. The lack of mechanical and temperature resistance of the BHA including drilling and monitoring tools results in frequent shut downs and exponential time spent in "Tripping", i.e. going in and out the well every time something breaks. To provide some context, tripping a drill bit at 5 km might take up to 30 hours (out and in), with an average drill bit duration being 400 m…That means that approximately 13 full trips or 200 hours of tripping would be required to drill a 5 km depth well, which for reference can be compared to a 330 hours on-bottom drilling time to reach that same depth (at an average ROP of 15 m/h), giving an idea of the huge impact tripping can have on the overall drilling process.

TechEnergy Ventures has invested in Quaise Energy, a start-up (MIT spinout) that is developing a drilling technology based on a concentrated electromagnetic beam also called Millimeter-Wave (MMW), aimed at enabling ultra deep geothermal and capable of reaching depths between 10-20 km and 500°C (supercritical conditions) at competitive costs. Quaise technology generates the MMW beam at the top of the well, and the beam then travels inside a tubular string called waveguide that delivers it to bottom hole. Drilling proceeds while the waveguide moves downwards. The beam causes an ablation to the rock (breakage, melting and vaporization) in theory without the need to replace components due to erosion and/or friction. Thus, reasons to trip in and out are minimized, dramatically improving the effective Rate of Penetration (ROP).

On the Enthalpy Harvesting technologies front, whether applied to Geothermal 2.0 or 3.0, novel enhanced strategies to efficiently extract the heat from the rocks must continue to be developed, to effectively eliminate the need to go to specific subsurface conditions (which has in the past limited the development of assets). Both AGS and EGS approaches will involve more complex challenges yet to be solved as depth and temperature increase. The former due to increasing drilling costs, and the latter due to difficulties in applying traditional stimulation methods from the O&G industry in typical EGS high-temperature, high-pressure environments. Increasing flow rate while preventing fluid short-circuiting (which leads to under-performing geothermal reservoirs) is still a technical barrier that limits EGS large-scale commercial adoption. Here again, FORGE initiative's efforts are aimed at developing, testing, and accelerating breakthroughs in EGS technologies.

TechEnergy Ventures has invested in Eden GeoPower, a Massachusetts-based reservoir stimulation technology company developing a groundbreaking electro-hydraulic fracturing technology that addresses many of the challenges involved in efficiently harvesting heat from the rock. The company combines both hardware and software solutions to identify underperforming fractures in geologic reservoirs and stimulates these fractures to increase fluid permeability. This allows for even fluid flow and maximal heat recovery, mitigating fluid "short-circuiting" issues that has challenged geothermal well productivity in the past.

Geothermal power generation involves heat extraction from the rocks, but efficient methods to convert this heat into power are also needed. Today this conversion is performed through various technologies (e.g., dry steam, flash steam power plants, binary power plants using Organic Rankine Cycle).

TechEnergy Ventures invested in Luminescent, an Israeli start-up developing a highly disruptive quasi-isothermal heat engine, which is able to convert heat into electricity at an unprecedent efficiency, significantly higher to that of traditional ORCs, making it a perfect fit for existing geothermal systems and with significant impact in the viability of new geothermal projects in the short and mid temperature range.

<u>Tecpetrol and TechEnergy Ventures' role in advancing the uptake of geothermal resources worldwide</u>

At Tecpetrol we have the ambition and we strongly believe that we can have a major role in the development of Geothermal globally, and especially in LATAM, where the Techint Group has its core operations.

Not only do we see an interesting VC opportunity in investing in startups in the geothermal segment (which is being done through TechEnergy Ventures, the CVC of Tecpetrol), but we also highly value the new business opportunities that can be developed around geothermal energy expansion, alongside providing alternatives to achieve Techint's decarbonization objectives (15 Mton/y steel production and 100 TWh/y energy consumption, in 2022). Equally important, we also believe that we can have a broad and positive impact on the companies we work with, by leveraging many of the capabilities that are at the core of the Techint Group and that are required to develop geothermal projects.

These are summarized in the next schematic:

We have already invested in Quaise Energy, Eden GeoPower and Luminescent, looking to support their efforts on each of the fronts they are working on, to ultimately achieve a larger adoption of geothermal energy in the world. In parallel, we continue to actively look for additional investments that would help us build a complete robust ecosystem of technologies, in the conviction that faster and cheaper drilling, better heat harvesting designs, enhanced surface equipment and better subsurface characterization will help unleash the potential of geothermal power.