ZAWYA INDUSTRY REPORT

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GEOTHERMAL ENERGY

The stars are aligning

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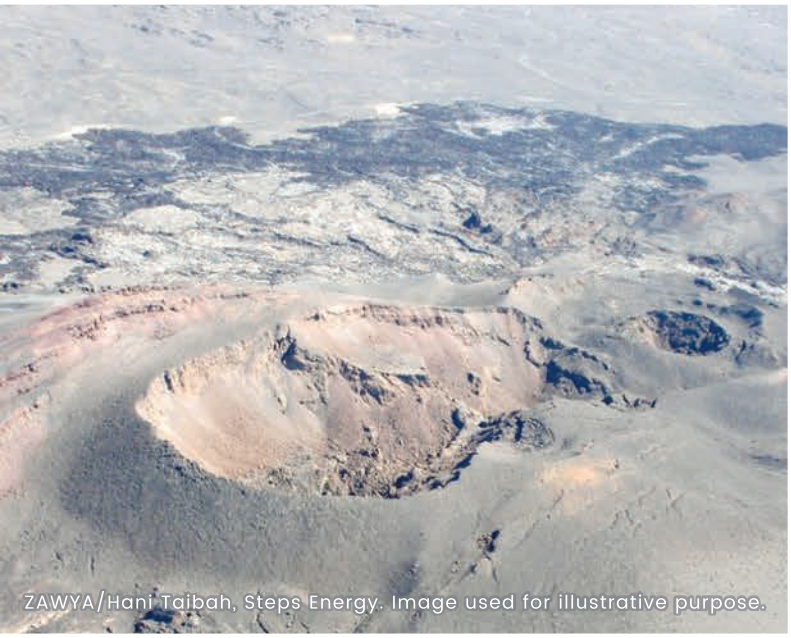
‘STARS ARE ALIGNING’ IN GULF GEOTHERMAL ENERGY BETS



ZAWYA/Hani Taibah, Steps Energy. Image used for illustrative purpose.

Government backed exploration projects could pave the way to energy security

A 400-metre-deep hole in the earth, dug by scientists on Saudi Arabia’s western coast, will help answer key questions around energy security and reducing carbon footprints – via geothermal energy.

The well, at 1,312ft deep, or almost half a kilometre, could lay the foundations for geothermal’s entry into the energy transition toolkit, especially in the Gulf region.

Bored down from the campus ground at King Abdullah University of Science and Technology (KAUST), on the Red Sea coastline, it is an ambitious project funded by the Saudi government and represents one of many investments across the Gulf and the globe to harness this technology.

Geothermal energy derives its name from the fact that it is produced by the heat emanating from the Earth's core, generated by the continuous decay of radioactive elements. This heat can be harnessed through geothermal power plants to generate electricity. Alternatively, it can be directly utilised for heating and cooling buildings and other structures via geothermal heat pumps.

Gulf countries are spending on geothermal energy in the hope they can hit their net zero targets but also to guarantee energy security.

And the region is certainly warming up to the idea of tapping yet another energy source from what lies beneath, with the added benefit of its ‘cleaner’ credentials.

The Saudi Geological Survey (SGS) and the Saudi Ministry of Energy’s recent pact to explore geothermal energy resources in the country set the ball rolling.

“This is the first step towards developing geothermal resources, and the move has energised the entire industry,” said Hani Taibah, founder of Steps Energy, a consulting firm conducting a study to prove the potential for geothermal energy in Saudi Arabia.

Saudi oilfield services company Taqa and Iceland’s Reykjavik Geothermal have partnered to develop large-scale direct use of geothermal cooling and desalination projects in the Kingdom.

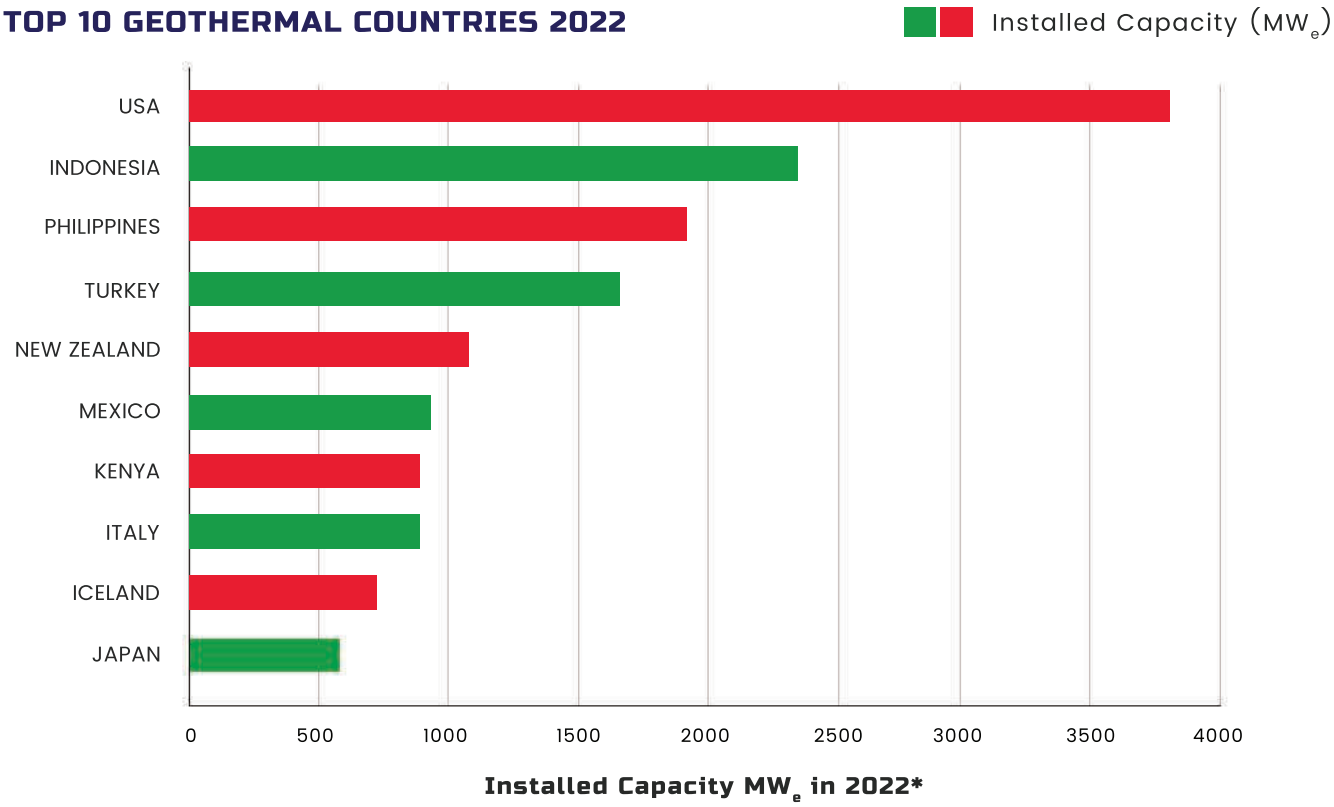
Oman has also tasked American firm SLB, a global energy tech firm, to frame a geothermal strategy, while UAE's Masdar and ADNOC Drilling have teamed up to develop geothermal projects in the UAE and other countries.

Its potential notwithstanding, geothermal energy has remained in the shadows of its renewable energy peers solar and wind – and that's mainly down to initial exploration costs.

According to the International Renewable Energy Agency (IRENA), electricity generation from geothermal energy has grown at a modest rate of around 3.5% annually, reaching a total installed capacity of approximately 15.96 gigawatts electric in 2021. It still accounts for a mere 0.5% of renewables-based installed capacity for electricity generation, heating and cooling globally.

However, geothermal deployment for heating and cooling clocked 9% annual growth between 2015 and 2020, to reach 107 gigawatts thermal in 2020.

TOP 10 GEOTHERMAL COUNTRIES 2022



*As of Jan 2022

Source: ThinkGeoEnergy Research (2023)

ZAWYA/Hani Taibah, Steps Energy. Image used for illustrative purpose.

ZAWYA/Hani Taibah, Steps Energy. Image used for illustrative purpose.

WHY GEOTHERMAL?

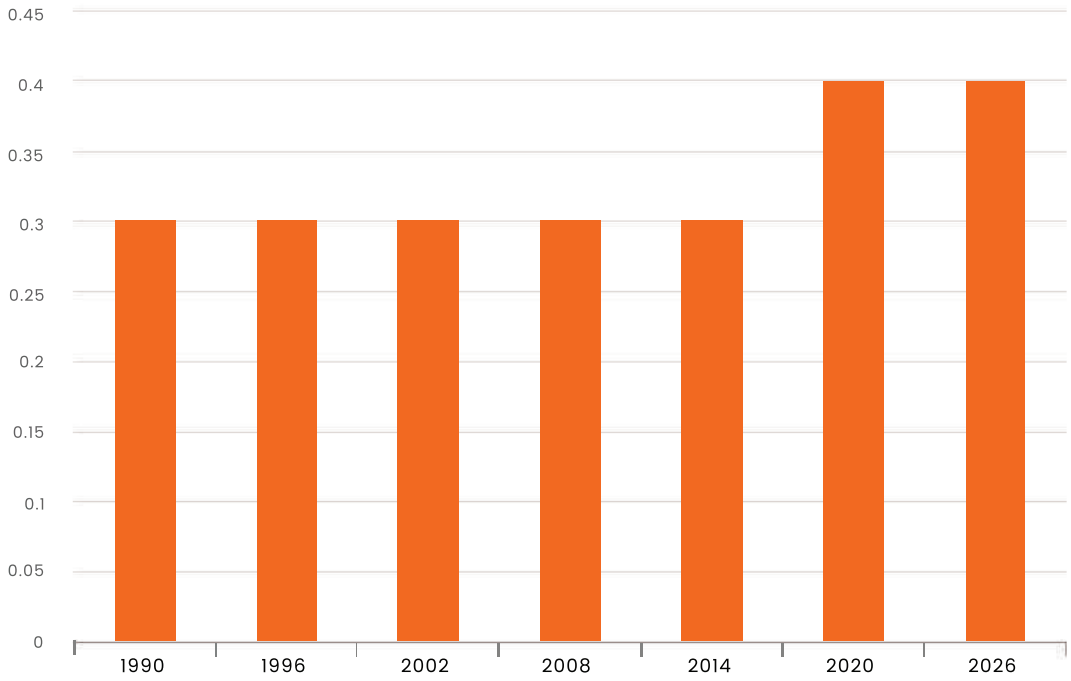
IRENA and the Global Geothermal Alliance (GGA) are now coordinating to promote wider geothermal energy development. IRENA believes geothermal energy is environmentally benign and that CO2 emissions are much lower than alternative forms.

Experts agree geothermal energy is critical for the global energy transition. It is classed as an infinite resource, as the primary energy source for geothermal power is heat generated from the earth's core. Another key advantage is that it does not have issues related to fluctuations of availability, storage, and transport. Its key advantage over wind and solar is that it is not impacted by weather conditions or seasons or 24-hour cycle.

Thomas Finkbeiner, Research Professor at the Ali I. Al-Naimi Petroleum Engineering Research Center, King Abdullah University of Science and Technology (KAUST), said: "Geothermal energy is critical for energy transition and will be required to provide baseload energy to support intermittent sources like wind and solar."

"Geothermal resources could reduce residential energy consumption by up to 70% if used directly for heating and cooling," noted Ammar Alali, President and Co-Founder of US-based climate tech firm Eden GeoPower, currently running several geothermal assessment projects in the Middle East.

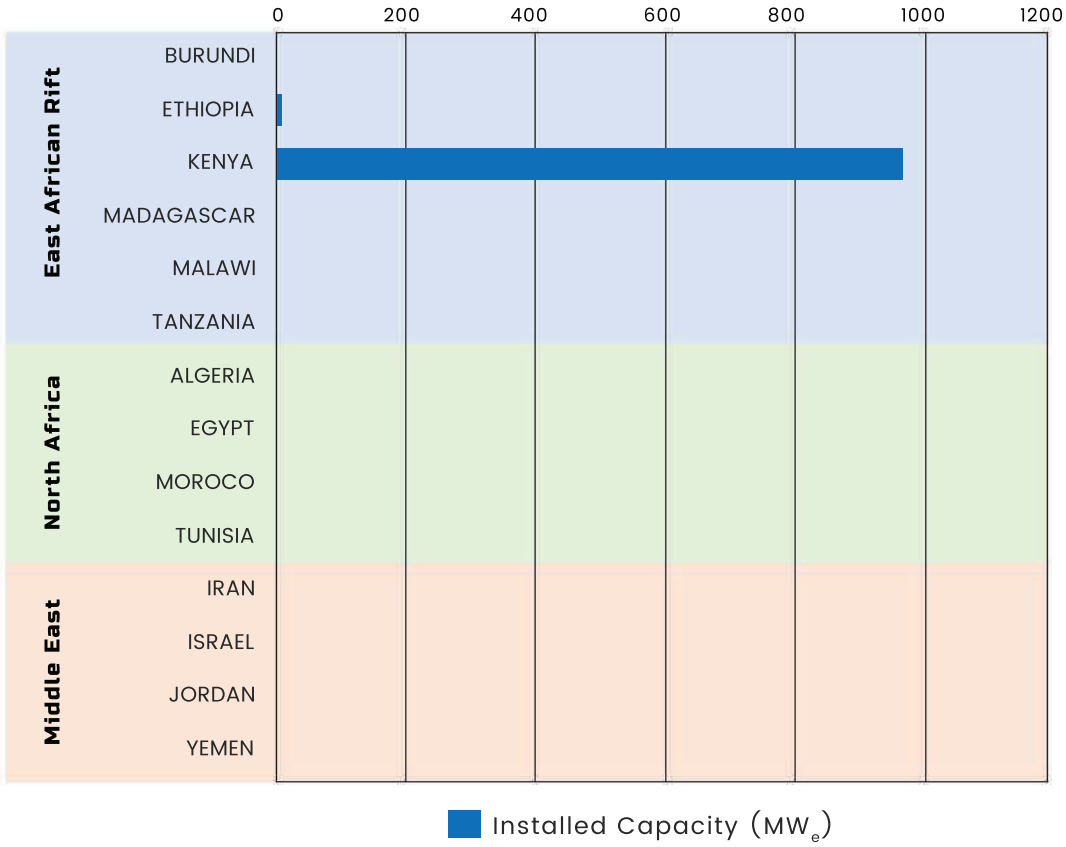
SHARE OF GEOTHERMAL IN GLOBAL ELECTRICITY GENERATION, 1990-2026



Despite its great resource potential, geothermal growth is limited to less than 5 GW over 2021-2026, representing only 0.2% of International Energy Agency's (IEA) forecasted renewable capacity expansion. Limited policy support to address the technology's pre-development risks hampers investment in large-scale geothermal projects.

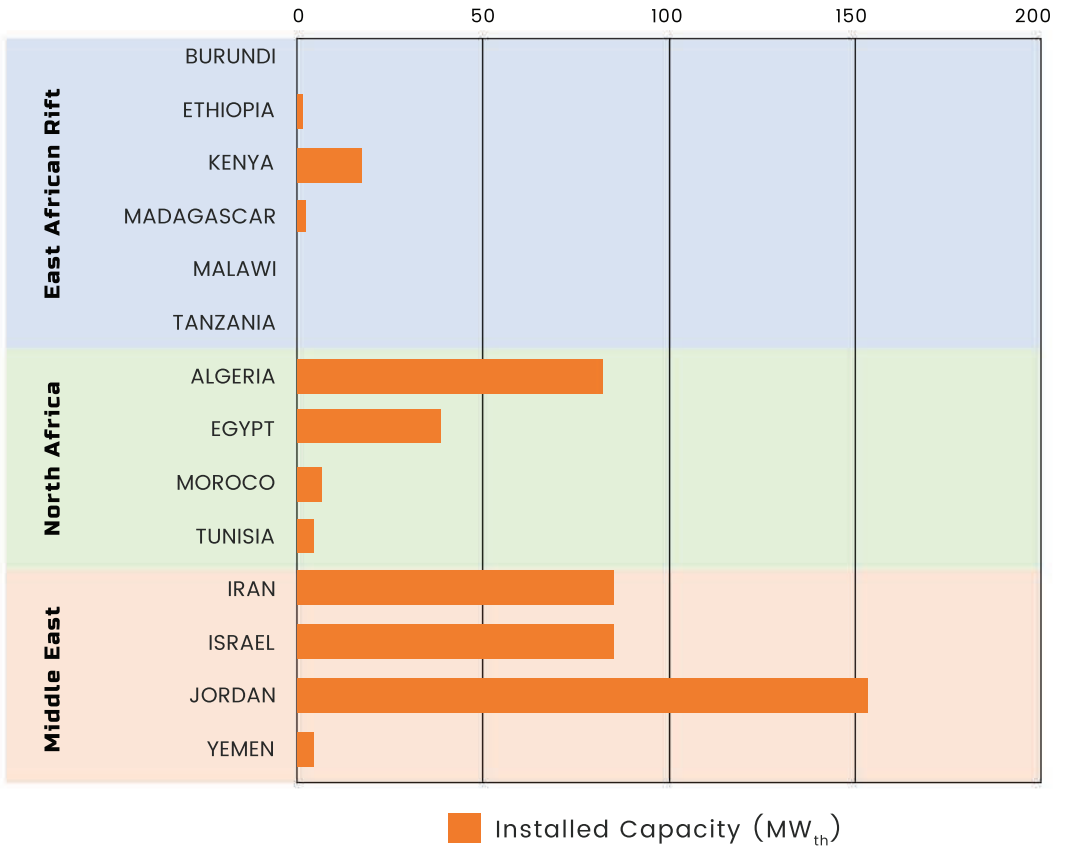
Source: IEA, Share of renewable electricity generation by technology, 1990-2026, IEA, Paris https://www.iea.org/data-and-statistics/charts/share-of-renewable-electricity-generation-by-technology-1990-2026 IEA. Licence: CC BY 4.0

INSTALLED GEOTHERMAL CAPACITY IN THE MEA REGION - ELECTRICITY



Source: Huttrer (2021); ThinkGeoEnergy (2022b); Lund and Toth (2021).

INSTALLED GEOTHERMAL CAPACITY IN THE MEA REGION - HEATING & COOLING



Source: Huttrer (2021); ThinkGeoEnergy (2022b); Lund and Toth (2021).

RESEARCH PROJECTS UNDERWAY

The geothermal team at KAUST is currently working on two important projects – a geothermal exploration study within the KAUST campus and a project on whether sequestered carbon can be used in a geothermal system.

The geothermal pilot project within the KAUST campus involves drilling a 400-meter-deep well, initially for observation, experimental, and research purposes. "Findings and experiences from this well will be very valuable when planning and drilling a deep geothermal well," Finkbeiner said.

The geothermal team is also working on a research project on how to use carbon dioxide to extract geothermal heat.

"Instead of only sequestering captured carbon underground, you can use it in a geothermal system as a working fluid," said Martin Mai, Professor, Earth Science and Engineering at KAUST.

"A small pilot is ongoing in Europe but it is still immature technology. However, there's enormous potential to use state-of-the-art technology developed at KAUST to harness the power of geothermal energy in Saudi Arabia," said Volker C Vahrenkamp, Professor of Energy Resources and Petroleum Engineering at KAUST.

"Over the last few years, through our activities, we began to align the different stakeholders in the Kingdom. The ministries, the Saudi Geological Survey, NEOM and KAUST are getting more involved, and so the stars are slowly aligning," said Mai.

"If one successful well-funded, well managed and organised pilot project materialises, it serves as a role model for rapid implementation, and we might have a successful plant in five years," he added.

WHAT'S THE POTENTIAL?

Vahrenkamp noted that studies in the region have been predominantly academic in nature.

"So far, all studies in the region have been predominantly academic in nature and we do not have a comprehensive assessment of the region's geothermal potential yet," he said.

He continued: "The East and the West Coast of Saudi Arabia where the temperature is less than 200 degrees Celsius at depth and water is readily accessible are the most promising locations for geothermal energy sources, but inland areas also show some potential."

Vahrenkamp said the focus so far has been on medium enthalpy geothermal energy to explore its potential as a clean source of power for direct use such as water desalination and district cooling. "There is potential to use high temperature geothermal energy in the future, but that is much less understood and much more expensive to develop," he said.

"The temperature of subsurface fluids is 120-130 degrees Celsius at a depth of three kilometres, which is not enough to generate steam for electricity but is certainly enough for direct use applications," noted Finkbeiner.

"The region is promising. There could be good potential for geothermal energy generation and large-scale geothermal systems in some parts of Saudi Arabia due to the higher thermal gradient, but Oman will be more ideal for heating and cooling applications, due to lower sub-surface temperatures," claimed Alali.

Hani pointed out that heating and cooling applications are the easiest and fastest to implement as they don't need major government approvals, heavy investment and don't have long lead times.

He said the temperature of the subsurface can be tapped for heating and cooling applications using heat transfer technology.

"This can be done anywhere, even without exploration and it is four times more cost efficient than normal air conditioning," he added.

ZAWYA/Hani Taibah, Steps Energy. Image used for illustrative purpose.

WHAT DOES IT COST?

The levelised cost of electricity (LCOE) of a geothermal energy project depends on the depth, temperature and flow of steam or water, said Hani.

He said an average investment of $5 million is needed to build a 1-megawatt (MW) geothermal energy project, with a seven-year timescale to build a 50 MW project. In contrast, the investment needed to build a 1MW natural gas electricity generation project is an average of $1.2 million in Saudi Arabia, making geothermal energy four times more expensive to develop.

But a study done by Steps Energy found that after the sixth year, geothermal energy will be cheaper than natural gas power as there are no recurring input costs, and every MW of geothermal energy will save about 1.7 gallons of oil.

Vahrenkamp pointed out that mineral extraction from geothermal fluids can provide an additional revenue source.

The key challenge for developing geothermal energy projects is high exploration risk, Hani admitted.

“About 60% of the total project risk is in the exploration stage and this stage accounts for about 20% of the total project cost. This negatively affects bankability of geothermal projects."

He says all current geothermal projects in the world have only been able to start with the help of governments who funded the exploration risk or were financed by funds like the Climate Investment Fund of the World Bank.

“The MOU with Saudi Geological Survey itself shows the Saudi government’s intention to bear the cost of geothermal exploration risk. This would make these projects bankable and ready for local and international investors to play their role,” he added.

ABOUT ZAWYA

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