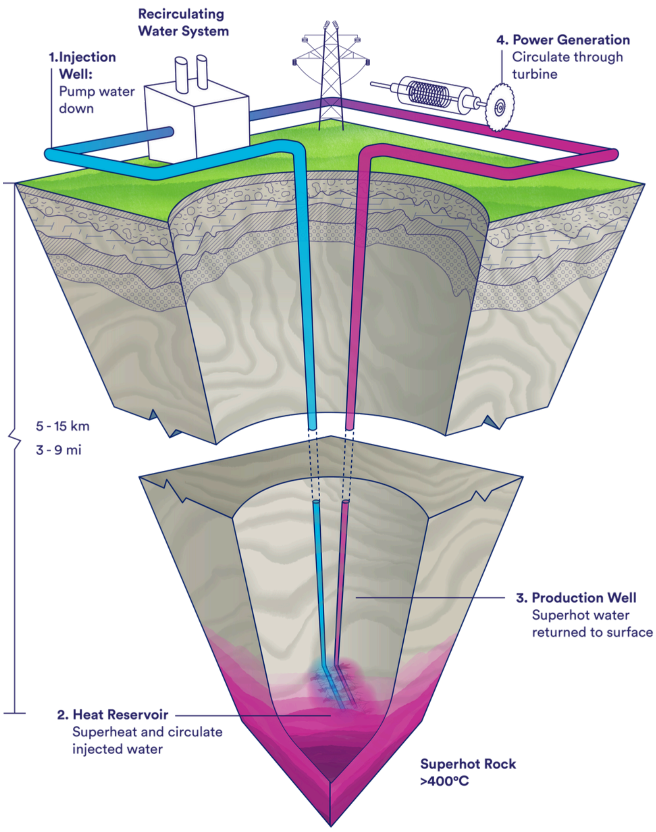
Superhot Rock Geothermal in Türkiye

A Potential Renewable Energy Gamechanger

CLEAN AIR TASK FORCE

What if there were an always-on renewable energy source with the potential to replace fossil fuel power generation and meet much of the world's future energy needs? What if that energy source could provide firm power without variability issues? What if it had a low land footprint and was available around the world, reducing the need to import energy?

This energy source is possible. It's called superhot rock geothermal.



The power of superhot rock geothermal

Superhot rock geothermal is an emerging energy source that could harness massive stores of renewable energy by pumping water deep into hot underground rocks, where it naturally heats up and then returns to the surface as steam. That steam could be used to produce carbon-free electricity, clean hydrogen, and other high-energy-intensity products.

Traditional geothermal systems in operation today only work in regions where hot water naturally exists near the earth's surface. By contrast, superhot rock geothermal systems would reach kilometers deeper into the earth and wouldn't require underground sources of water, making them viable across the globe.[1] With appropriate investment to overcome technological hurdles, superhot rock geothermal could reach commercial scale and potentially market prices.[2] If this is achieved, superhot rock geothermal could provide clean firm power at scale without the import risk and land-use footprint of other energy sources.

Superhot rock's enormous potential in Türkiye

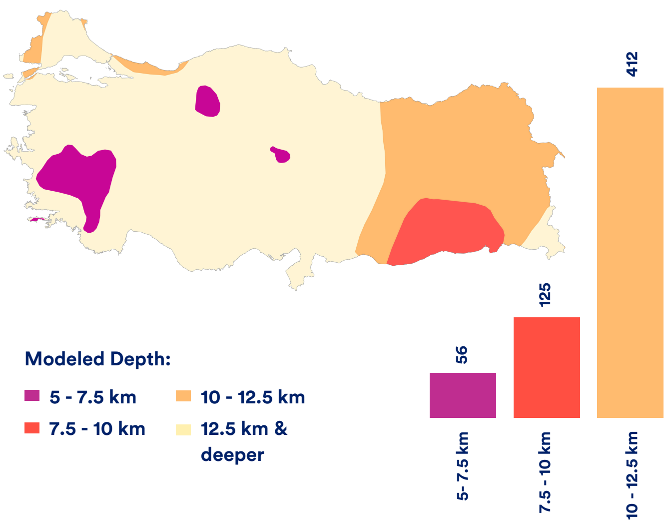


Figure 1: The potential of 1% of Türkiye's superhot rock geothermal resource (GW)

Türkiye consumed 334,718 GWh of electricity in 2021,[7] and its electricity demand is projected to rise to 609,503 GWh by 2050.[8] Just 1% of Türkiye's superhot rock potential could produce enough electricity to meet its projected 2050 electricity demand with over 4,331,282 GWh to spare for other end uses such as energy exports, desalination, and hydrogen production.

First-of-a-kind modeling from Clean Air Task Force and the University of Twente in the Netherlands estimated superhot rock geothermal potential around the world. While this modeling is preliminary, it suggests that Türkiye has significant superhot rock resources.[3] **Just 1% of Türkiye's superhot rock resource has the potential to provide 594 GW of energy capacity, which could generate over 4,940,785 GWh of electricity.** Put another way, just 1% of Türkiye's superhot rock geothermal endowment is equivalent to 2.9 billion barrels of oil,[4] 15 times the country's 2021 electricity consumption,[5] or enough energy to power Istanbul 124 times over.[6]

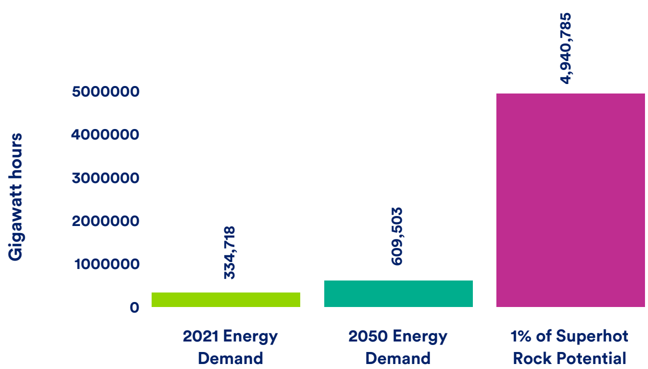


Figure 2: Historic electricity consumption compared to estimated 2050 electricity consumption and 1% of estimated superhot rock geothermal resource potential in Türkiye

Energy imports and independence

Türkiye imports 58% of its coal[9] and 98% of its natural gas,[10] with gas imports coming primarily from Azerbaijan, the United States, and Russia.[11] Superhot rock geothermal would be a clean firm energy source, providing dependable 24/7 power that could ultimately replace fossil fuels. Just 1% of Türkiye's superhot rock resource could replace all coal and gas imports used for electricity production, along with their associated methane emissions. These findings highlight the vast impact and energy security potential of this inexhaustible resource in diversifying Türkiye's energy portfolio and reducing import dependence.

Renewable, pollution-free energy

In 2021, Türkiye emitted 144 megatonnes of CO2eq from its electricity sector.[12] Türkiye's Nationally Determined Contribution under the Paris Agreement aims to reduce emissions by 481.8 megatonnes of CO2eq by 2030, and Türkiye also aims to reach net zero by 2053.[13] Just 1% of Türkiye's superhot rock geothermal potential could theoretically replace all of the coal and gas used for Türkiye's electricity production, reducing carbon emissions by approximately 144 megatonnes[14] – 30% of Türkiye's NDC goal. While superhot rock geothermal is unlikely to reach commercial scale in time to support Türkiye's 2030 climate goals, this finding illustrates its potential to enable Türkiye's low-carbon energy strategy over time. Superhot rock geothermal would also provide air quality and health benefits by reducing nitrogen oxides, sulfur dioxide, particulate matter, and other toxic pollutants associated with the combustion of fossil fuels. And excess superhot rock geothermal could play a role in producing low-carbon hydrogen for decarbonizing heavy industry.

Reliable and efficient grid

Superhot rock geothermal is available around the clock, rain or shine. An electricity system without this type of firm power requires building excess generation and transmission capacity to ensure there is always enough to meet demand. For example, a recent study of California found that an energy system that includes clean firm power would require one-third the new transmission compared to one without these resources.[15] Finally, the 24/7 production profile of superhot rock geothermal makes better use of existing grid infrastructure by operating reliably and consistently, reducing reliance on demand-side shifting and expensive backup generation.

Efficient land use

Superhot rock geothermal would be an extremely energy-dense resource, so its land requirements would be exceptionally low. Producing 1 GW of superhot rock geothermal is estimated to require roughly 12 km² of land, compared to approximately 160 km² of land for natural gas, 180 km² for solar, 520 km² for offshore wind, and 14,000 km² for biomass.[16]

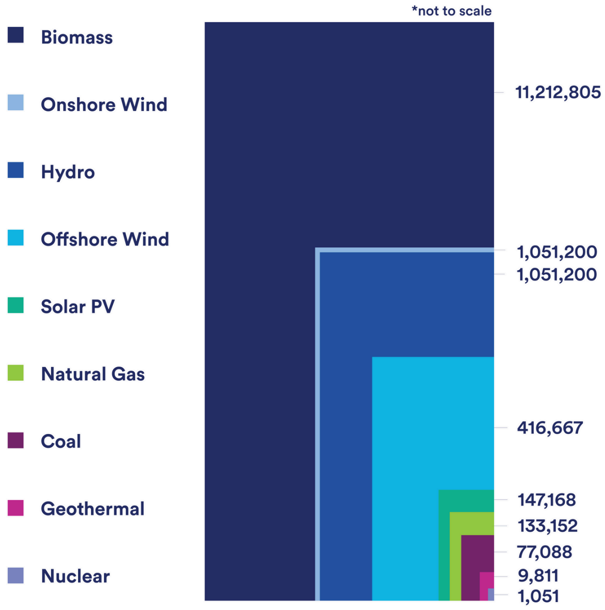


Figure 3: Estimated land use for superhot rock geothermal compared to other energy sources

Clean Air Task Force (CATF) is a global nonprofit organization working to safeguard against the worst impacts of climate change by catalyzing the rapid development and deployment of low-carbon energy and other climate-protecting technologies. CATF's Superhot Rock Geothermal team is dedicated to decarbonizing the energy sector through superhot rock geothermal. To learn more about the policy and technology innovations required to fulfil superhot rock geothermal's revolutionary potential, visit our website at www.cleanairtaskforce.org/superhot-rock. For inquiries, contact press@catf.us.

Footnotes

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