Superhot Rock Geothermal in the Philippines

A Potential Renewable Energy Gamechanger

CLEAN AIR TASK FORCE

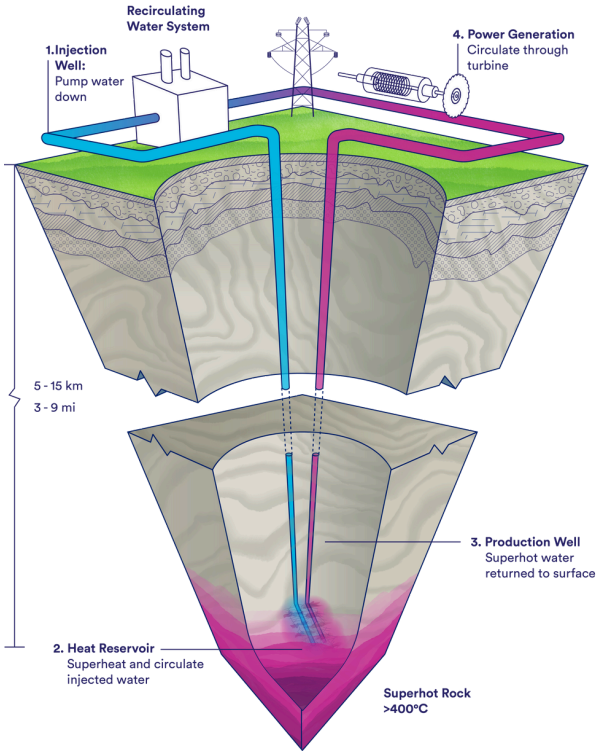
What if there were an always-on renewable energy source with the potential to replace fossil fuel power generation and meet much of the world's future energy needs? What if that energy source could provide firm power without variability issues? What if it had a low land footprint and was available around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

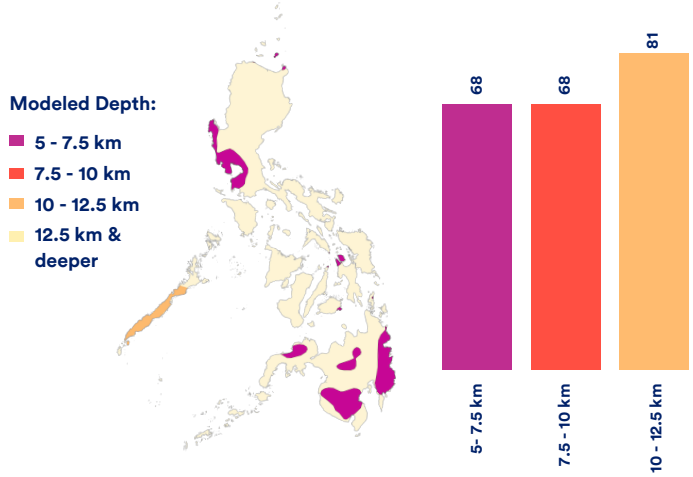


Figure 1: The potential of 1% of the Philippines's superhot rock geothermal resource (GW)

The Philippines consumed 106,110 GWh of electricity in 2021,[6] and its electricity demand is likely to rise in the coming decades due to a growing population, higher per-capita energy consumption, and increasing electrification. Just 1% of the Philippines's superhot rock potential could produce enough electricity to meet its 2021 electricity demand with over 1,695,092 GWh to spare for other end uses such as energy exports 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 the Philippines has significant superhot rock resources.[3] **Just 1% of the Philippines's superhot rock resource has the potential to provide 216 GW of energy capacity, which could generate over 1,801,202 GWh of electricity.** Put another way, just 1% of the Philippines's superhot rock geothermal endowment is equivalent to 1.1 billion barrels of oil[4] or 17 times the country's 2021 electricity consumption.[5]

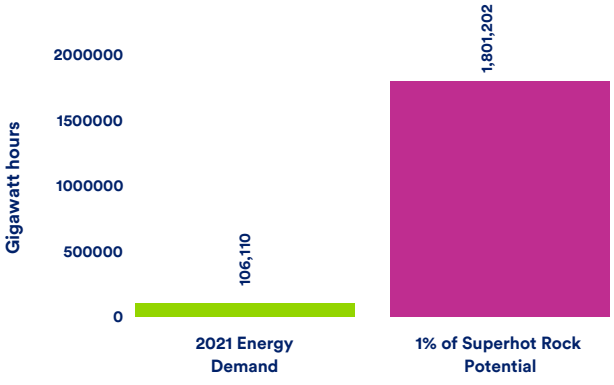


Figure 2: Historic electricity consumption compared to 1% of estimated superhot rock geothermal resource potential in the Philippines

Socio-economic development

The immense capacity of superhot rock geothermal could play a crucial role in reducing energy poverty and fostering sustainable development in the Philippines. Superhot rock geothermal projects can increase the overall capacity of the electrical grid, providing more reliable and consistent power to homes, businesses, and industries. Improved access to electricity is crucial for economic development.

The development of superhot rock geothermal projects also requires a workforce, creating job opportunities in various fields such as engineering, geology, and maintenance. This can contribute to reducing unemployment and poverty rates in the Philippines. Finally, the development of superhot rock geothermal projects may also attract foreign investment and expertise. Collaborating with international partners can bring in funding, technology, and knowledge, fostering a supportive environment for sustainable development.

Energy imports and independence

The Philippines imports 90% of its coal,[7] with almost all imports coming from Indonesia.[8] Superhot rock geothermal would be a clean firm energy source, providing dependable 24/7 power that could ultimately replace fossil fuels. Just 1% of the Philippines's superhot rock resource could replace all coal imports used for electricity production. These findings highlight the vast impact and energy security potential of this inexhaustible resource in diversifying the Philippines's energy portfolio and reducing import dependence.

Renewable, pollution-free energy

In 2021, the Philippines emitted 75 megatonnes of CO2eq from its electricity sector.[9] The Philippines's Nationally Determined Contribution under the Paris Agreement aims to reduce emissions by 2,505 megatonnes of CO2eq by 2030.[10] Just 1% of the Philippines's superhot rock geothermal potential could theoretically replace all of the coal and gas used for the Philippines's electricity production, reducing carbon emissions by approximately 75 megatonnes[11] – 3% of the Philippines's NDC goal. While superhot rock geothermal is unlikely to reach commercial scale in time to support the Philippines's 2030 climate goals, this finding illustrates its potential to enable the Philippines'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.

Efficient land use

Superhot rock geothermal will be an extremely energy-dense resource, so its land requirements will 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.[12]

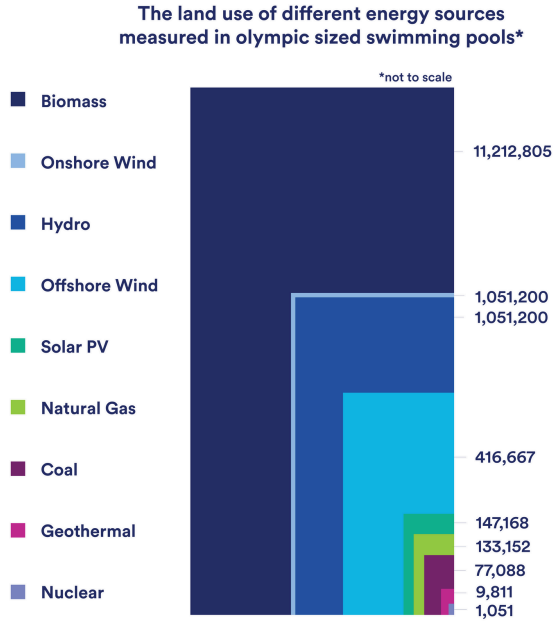


Figure 3: Estimated land use for superhot rock geothermal compared to other energy sources

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 fulfill superhot rock geothermal's revolutionary potential, visit our website at catf.us/superhot-rock. For inquiries, contact press@catf.us.

Footnotes

1. Hill, Bruce L. (2021). Superhot Rock Energy: A Vision for Firm, Global Zero-Carbon Energy. Clean Air Task Force. https://cdn.catf.us/wp-content/uploads/2022/10/21171446/superhot-rock-energy-report.pdf
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11. Assumes that all CO2 emissions from electricity production come from coal, oil, and/or gas, with no emissions coming from renewable energy sources.
12. Land use estimates for superhot rock geothermal from LucidCatalyst and Hotrock Research Organization. (2023). A Preliminary Techno-Economic Model of Superhot Rock Energy. https://www.catf.us/resource/preliminary-techno-economic-model-superhot-rock-energy. Land use estimates for all other energy sources from Lovering, Jessica, Swain, Marian, Blomqvist, Linus, & Hernandez, Rebecca R. (2022). “Land-use intensity of electricity production and tomorrow’s energy landscape.” PLoS ONE 17(7): e0270155. https://doi.org/10.1371/journal.pone.0270155