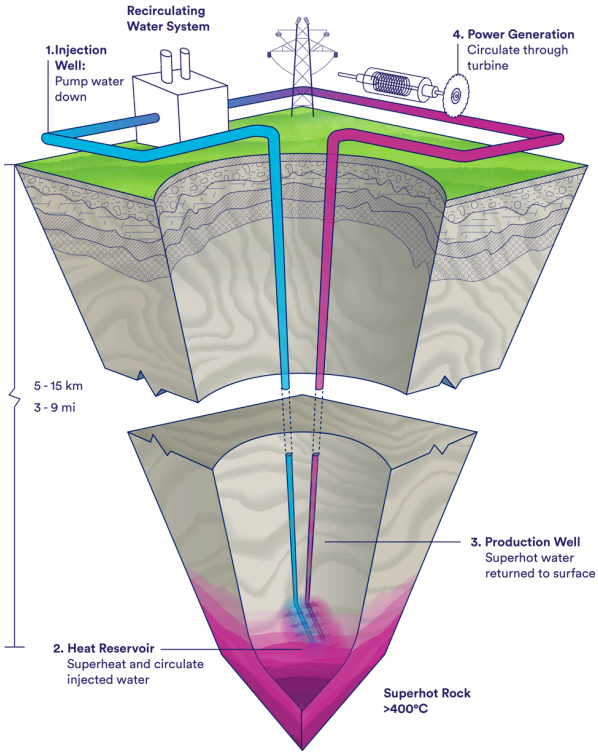
Superhot Rock Geothermal in Switzerland

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 kilometres 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 Switzerland

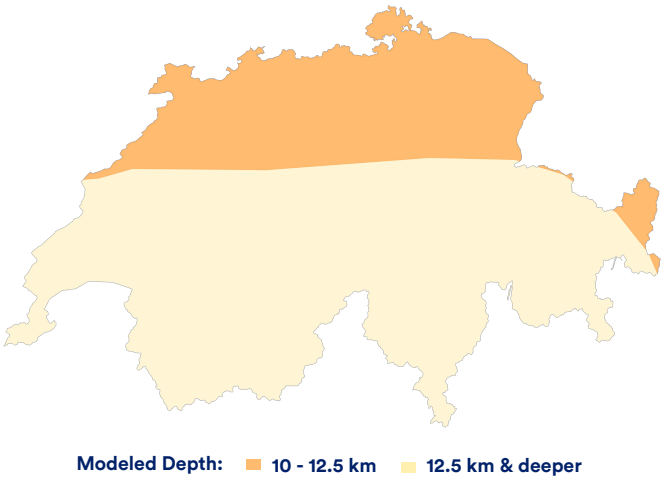


Figure 1: The potential of 1% of Switzerland's superhot rock geothermal resource (GW)

Switzerland consumed 66,039 GWh of electricity in 2021,[7] and its electricity demand is likely to rise in the coming decades. Just 1% of Switzerland's superhot rock potential could produce enough electricity to meet its 2021 electricity demand with over 101,797 GWh to spare for other end uses such as energy exports and hydrogen production.

First-of-a-kind modelling from Clean Air Task Force and the University of Twente in the Netherlands estimated superhot rock geothermal potential around the world. While this modelling is preliminary, it suggests that Switzerland has significant superhot rock resources.[3] Just 1% of Switzerland's superhot rock resource has the potential to provide 20 GW of energy capacity, which could generate over 167,836 GWh of electricity. Put another way, just 1% of Switzerland's superhot rock geothermal endowment is equivalent to 99 million barrels of oil,[4] 3 times the country's 2021 electricity consumption,[5] or enough energy to power Zurich 64 times over.[6]

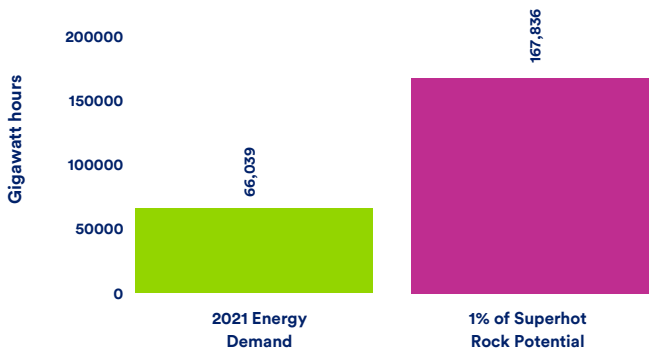


Figure 2: Historic electricity consumption compared to 1% of estimated superhot rock geothermal resource potential in Switzerland

Energy imports and independence

Switzerland imports all of its natural gas[8] and 48% of its electricity.[9] Superhot rock geothermal would be a clean firm energy source, providing dependable 24/7 power that could ultimately replace fossil fuels. Just 1% of Switzerland's superhot rock resource could replace all gas imports used for electricity production, along with their associated methane emissions, as well as all electricity imports. These findings highlight the vast impact and energy security potential of this inexhaustible resource in diversifying Switzerland's energy portfolio and reducing import dependence.

Renewable, pollution-free energy

In 2021, Switzerland emitted 3 megatonnes of CO2eq from its electricity sector.[10] Switzerland's Nationally Determined Contribution under the Paris Agreement aims to reduce emissions by 27.1 megatonnes of CO2eq by 2030, and Switzerland also aims to reach zero emissions by 2050.[11] Just 1% of Switzerland's superhot rock geothermal potential could theoretically replace all of the coal and gas used for Switzerland's electricity production, reducing carbon emissions by approximately 3 megatonnes[12] – 10% of Switzerland's NDC goal. While superhot rock geothermal is unlikely to reach commercial scale in time to support Switzerland's 2030 climate goals, this finding illustrates its potential to enable Switzerland's low-carbon energy strategy over time. Superhot rock geothermal would also provide air quality and health benefits by reducing nitrogen oxides, sulphur 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 decarbonising 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.[13] 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.[14]

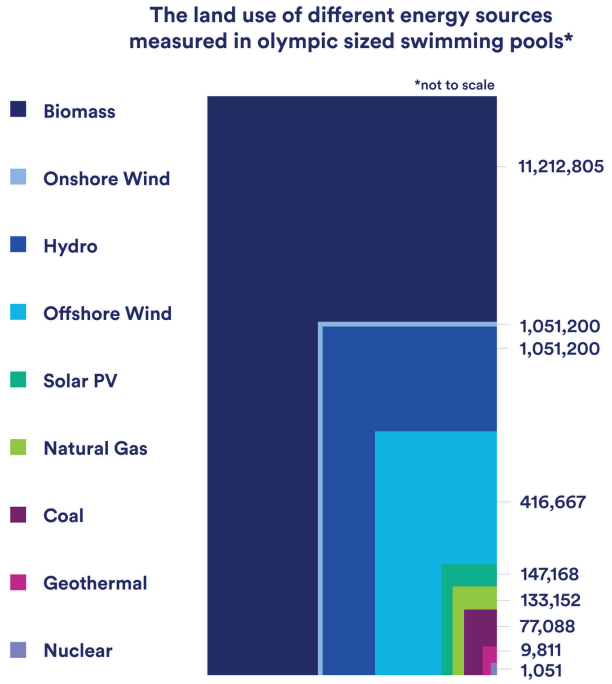


Figure 3: Estimated land use for superhot rock geothermal compared to other energy sources

Clean Air Task Force (CATF) is a global nonprofit organisation working to safeguard against the worst impacts of climate change by catalysing the rapid development and deployment of low-carbon energy and other climate-protecting technologies. CATF's Superhot Rock Geothermal team is dedicated to decarbonising 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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