GeoTHERM
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Ortenauhalle Kongress 1
Tiefe Geothermie

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Ortenauhalle Congress 1
Deep geothermal energy

Harnessing Dry-Hot Rock Geothermal Resources in Hot-Spot Volcanic Islands Using Supercritical CO_2

Nutzung trockener heißer Gesteinsgeothermie auf vulkanischen Hotspot-Inseln mit überkritischem CO_2

Alejandro Schiuma, Nasikul Islam, Timothy Tarver
Exceed Geo Energy

Objective/ Scope

Volcanic islands such as Lanzarote combine high geothermal gradients with resource constraints — limited freshwater, land mass and reliance on imported fossil fuels. Harnessing dry-hot rock conditions through closed-loop sCO_2 systems provides a pathway for baseload clean electricity and multi-sector integration. sCO_2 geothermal plants provide baseload electricity, which can drive desalination, green hydrogen production, and agricultural heating. Waste heat cascades enhance water output and enable greenhouse agriculture, strengthening food security and reducing imports. Hydrogen production under stable geothermal power further positions islands as renewable fuel hubs.

Methodology Followed

Lanzarote, part of the Canary Island plume chain, remains thermally active. Crustal thickness of 6–10 km and geothermal gradients of 70–90 °C/km yield >200 °C at 2–3 km depth. The Timanfaya eruption (1730–1736) highlights ongoing magmatic activity. These factors lower drilling depth and cost while ensuring long-term resource sustainability. Hot-spot volcanic islands represent high-value geothermal settings due to shallow magmatic intrusions and thin oceanic crust. Lanzarote (Canary Islands) is an example where supercritical carbon dioxide (sCO_2) in a closed-loop configuration offers an efficient and sustainable alternative to conventional water-based systems. This paper presents the geological setting, thermal structure, and engineering advantages of sCO_2, and evaluates its integration with desalination, green hydrogen, and agriculture. The approach maximizes energy efficiency, reduces environmental impact, and aligns with EU funding priorities for energy transition.

Results/ Conclusions

sCO_2 geothermal plants provide baseload electricity, which can drive desalination, green hydrogen production, and agricultural heating. Waste heat cascades enhance water output and enable greenhouse agriculture, strengthening food security and reducing imports. Hydrogen production under stable geothermal power further positions islands as renewable fuel hubs. Shallower drilling reduces CAPEX by 25–35% compared to continental systems. Smaller turbines and reduced water handling lower plant costs and downtime. These advantages align with EU Green Deal, RE Power EU, and Horizon Europe priorities for innovative renewable systems. Closed-loop sCO_2 plants deliver zero-emission power, displace fossil imports, and support circular resource use. Benefits extend to job creation across drilling, O&M, desalination, agriculture, and hydrogen industries, fostering local resilience. The model demonstrated for Lanzarote applies to volcanic islands worldwide, including the Azores, Réunion, Hawaii, and Icelandic outer islands, where high heat flow, resource scarcity, and fossil fuel dependency create similar conditions.

Novel/ Additive Information

sCO_2 closed-loop systems in volcanic islands combine geological suitability with technical efficiency. They provide continuous clean power, freshwater, hydrogen, and agricultural support while minimizing environmental risks. This integrated strategy enhances both energy security and socio-economic resilience for island communities. To address the challenge of land, Exceed Energy Inc. has optimized the subsurface wells placement to generate between 200MW-300MW in 1400sq m (1.4 hectares) of surface land parcel capable of powering ~250,000 homes and large industries at >98% capacity factor on a 24/7 baseload making it the most competitive renewable power development operator to date using 10x less land mass as solar and 5x less than wind.