INNOVATIVE WELL ARCHITECTURES TO MAXIMISE HEAT EXTRACTION IN AREAS WITH LOW TRANSMISSIVITY HOT SEDIMENTARY AQUIFERS: A REVIEW OF PARIS BASIN WELL DESIGN ACHIEVEMENTS

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The Recent French energy transition policies have strongly accelerated deep geothermal development, targeting an almost twofold increase in heat production from deep sedimentary reservoirs. In the Paris Basin, Dogger Middle Jurassic carbonates already support the world's largest geothermal district heating system, with about 50 doublets supplying roughly 1,500 GWhth/year. Planned new doublets are expected to substantially expand this capacity. Achieving these goals requires well designs that exploit multilayered reservoir structure to improve thermal longevity and productivity, while also making moderately to poorly productive areas economically viable.

The subhorizontal (SH) well concept was first applied at Cachan, south of Paris, to replace two ageing doublets with a design intended to intersect several productive layers through a stepwise, en echelon trajectory guided by production logs and drilling data. Both trajectories landed near the top of the reservoir at high angles, facilitating geosteering while limiting dogleg severity. Using RSS, MWD, LWD, PDC bits, and cuttings analysis, the first geothermal SH doublet achieved 450 m3/h with two 1 km drains and has operated reliably for several years. A second application in 2022 at a lower-productivity site delivered comparable performance using modified geosteering tools, suggesting that a pilot hole is not always essential. The multiradial (MR) concept was developed as a more compact alternative to SH wells. Its effectiveness depends on a three-legged inclined reservoir geometry and high landing angles that avoid sharp steering changes, navigation problems, and interlayer interference. Implemented in 2021 in a low-permeability sector southwest of Paris, the concept has been in operation since 2022 despite some design and operating compromises.

More broadly, multilateral architectures—well established in oil and gas—are becoming increasingly relevant in geothermal applications because they offer flexible access to laterally and vertically distributed reservoir layers. Advances in re-entry, coiled tubing, and high-angle conveyance technologies further improve their practicality in stratified media. The paper documents representative design workflows and reviews the main technological and economic issues associated with these architectures.