PROVEN DRILLING TECHNOLOGIES HELP UNLOCK THE NEXT GENERATION OF GEOTHERMAL ENERGY

Enhanced geothermal systems (EGSs) are rapidly emerging as one of the most promising sources of reliable, carbon-free baseload power. Unlike solar and wind, EGS resources can generate electricity continuously, providing a dependable complement to intermittent renewable energy sources.

But this promise comes with pitfalls, thanks to the extreme demands EGS plays place on drilling and completion tools. Most EGS projects target hard, abrasive formations several kilometers below the surface, where temperatures routinely exceed 150°C (302°F) and can approach or surpass 300°C (572°F). These environments accelerate equipment wear and increase mechanical loading on bits, bottomhole assemblies, and surface equipment. In many cases, naturally fractured intervals can also cause circulation losses, complicating fluid management and drilling efficiency.

To address these challenges, the geothermal industry is drawing on technologies and expertise developed over decades in oil and gas. NOV is adapting proven drilling systems, digital technologies, and well construction solutions to meet the demands of deeper, hotter geothermal environments and improve drilling performance while reducing risk and cost.

This approach was central to Fervo Energy's recent appraisal campaign at Project Blanford in Millard County, Utah. Working alongside Fervo, NOV supplied a suite of drilling technologies that helped execute one of the industry's most technically demanding geothermal drilling programs to date. The following sections review these technologies and how they supported Fervo's delivery of the hottest geothermal well in the company's history.

Project Blanford was the perfect proving grounds for adapting proven drilling technologies to help improve efficiency, reduce operational risks, and accelerate the commercialization of enhanced geothermal systems.

– Chuck Wright, NOV Corporate R&D Manager

Maintaining visibility in extreme drilling environments

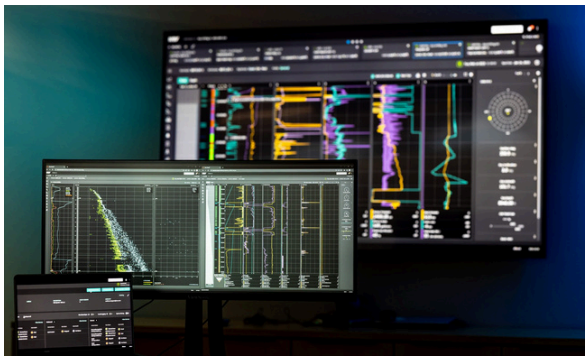
At Project Blanford, having continuous access to downhole conditions was essential as the drilling operation progressed into deeper, hotter, and more challenging formation conditions.

NOV's RigSense™ 4.0 electronic data recorder (EDR) served as the central platform for collecting and visualizing drilling data, continuously capturing key operational parameters including weight on bit, torque, rotary speed, rate of penetration, standpipe pressure, pump rates, and flow volumes.

Together, these measurements provided drilling personnel with a comprehensive picture of mechanical loading and hydraulic performance, allowing teams to identify changing formation responses, optimize drilling parameters, and manage equipment stress as conditions evolved.

The system also created a common operating picture across the rig while supporting collaboration between field and office-based personnel. Integrated with NOV's WellData™ 4.0 information system, drilling data was transmitted in real time to engineering and operations teams located away from the wellsite, enabling technical specialists to evaluate drilling performance using the same information available to rig crews.

This shared visibility allowed for faster decision-making as drilling conditions changed—a capability that becomes increasingly valuable as geothermal wells push into deeper, hotter reservoirs where operating margins can narrow rapidly.



Description: The WellData 4.0 information system gives remotely located technical specialists the same real-time access to drilling data as the rig crew, enabling more effective collaboration and improved decision-making.

Managing fluids for reliable drilling performance

Fluid management was equally important throughout the drilling campaign. Beyond transporting cuttings to the surface, drilling fluids were also essential to maintaining wellbore stability, supporting hydraulic efficiency, and assisting in cooling drilling components in the bottomhole assembly.

NOV's pit volume totalizer (PVT) system continuously monitored pit volumes, inflow and outflow rates, and overall fluid behavior during drilling. By providing early indications of fluid gains or losses, the system helped crews quickly identify changing downhole conditions and circulation losses commonly associated with natural formation fractures.

Maintaining continuous awareness of drilling hydraulics and fluid performance provided another layer of operational confidence as the appraisal well advanced toward its target depth.

Engineering drilling technologies for hard, high-temperature rock

While digital systems improved operational awareness, drilling performance ultimately relied on equipment capable of withstanding the demanding geothermal environment.

Before drilling began, NOV worked with Fervo's drilling team to evaluate anticipated formation characteristics and operational objectives for the well. Based on those discussions, NOV supplied drill bits equipped with its ION+™ Fortis™ polycrystalline diamond compact (PDC) cutter technology for the intermediate and production hole sections.

Description: The ION+ Fortis PDC cutter is designed for durability, improved tangential strength, enhanced thermal stability, and reduced flexing and cracking—resulting in higher ROPs in long-lateral, high-temperature intervals.

Originally designed for durability in the mechanically demanding, interbedded formations encountered in unconventional oil and gas wells, the ION+ Fortis's hybrid impact- and abrasion-resistant cutter design combines impact resistance with abrasion resistance—an advantage when drilling hard, heterogeneous geothermal formations.

Extending bit life is particularly valuable in geothermal drilling, where every trip out of the hole adds time, cost, and additional thermal cycling for drilling equipment. Maximizing footage drilled per bit directly contributes to improved project economics.

Field performance demonstrated the effectiveness of the optimized bit. The PDC bits delivered higher penetration rates, longer run lengths and bit life, and consistent drilling performance throughout much of the well. A single 12¼-in. bit drilled an entire 1,825-m (5,988-ft) intermediate interval in one run. In total, NOV PDC bits drilled approximately 78% of well footage.

Efficient solids control supports drilling efficiency

Hard-rock geothermal drilling also generates large volumes of abrasive cuttings that must be removed continuously to maintain drilling fluid properties, protect downstream equipment, and support consistent hydraulic performance.

NOV Alpha™ shakers served as the primary solids-control stage at Project Blanford. Their 7G+ linear-motion design and optimized fluid handling capability enabled efficient processing of high drilling fluid volumes to maximize cuttings dryness and preserve valuable drilling fluid.

Description: The Alpha shaker is designed for optimally enhanced linear motion to process more fluid at higher rates, deliver drier cuttings, and reduce operational drilling costs.

Alpha's design also incorporated an optimized vibration system that enabled the shaker to operate significantly quieter than conventional systems, fostering safer working conditions for rig personnel while maintaining solids-processing performance.

Demonstrating what's possible for next-generation geothermal

Together, NOV's real-time drilling intelligence, optimized drilling tools, and solids-control systems provided an integrated solution for maintaining drilling performance in one of the industry's most demanding environments.

Fervo drilled the vertical appraisal well to approximately 3.4 km (11,200 ft), where measured temperatures exceeded 290°C (555°F)—well above the threshold required for commercial geothermal development. According to the company, the well was drilled in fewer than 11 days and established the hottest geothermal well in Fervo's history while confirming an ultra-high-temperature resource capable of supporting planned multi-gigawatt development.

As enhanced geothermal systems continue moving from demonstration projects toward commercial deployment, the combination of proven drilling expertise and purpose-built innovation will become increasingly important. Project Blanford provides a compelling example of how transferring knowledge and technology across energy sectors can help unlock deeper, hotter geothermal resources and accelerate the delivery of reliable, carbon-free power at scale.

For NOV, Project Blanford reflects our strategy of applying decades of well construction experience to geothermal applications. Rather than developing new drilling systems from the ground up, we're focused on adapting proven technologies for the unique thermal and mechanical demands of geothermal wells.

– Alexis Garcia, Director, NOV Geothermal