

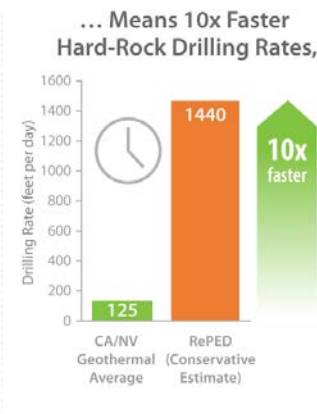
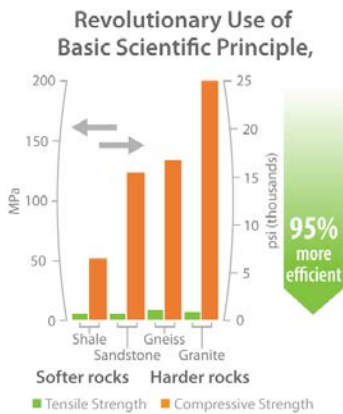
# RePED 250: A Revolutionary, High-Drilling Rate, High-T Geothermal Drilling System and Companion Power Electronics

The project employs a basic scientific principle—that rock is significantly weaker in tension than in compression—to revolutionize the speed and lower the cost of hard rock drilling.

Project partner Tetra has developed an electrocuting technology—a repetitive, pulsed electric drill (RePED), capable of crushing rock in tension and at high speeds. In this project, NREL, TPL Inc., and Tetra are upgrading the RePED drilling system for operation in 250°C environments, and demonstrating its effectiveness drilling hard rock. The RePED drilling system is being designed to function with most of the elements of a conventional drilling system (e.g., drill pipe, steering tools, measurement-while-drilling (MWD) systems, mud systems), so no specialized rigs or drill pipe are required.

## Objective: Faster, Lower Cost Geothermal Drilling

- Geothermal drilling rates in the U.S. average only 125 ft/day, much slower than oil and gas drilling which averages 750 ft/day.
- Geothermal wells have additional challenges: hard rock and high temperatures



Traditional drilling systems work to overcome compressive strength. But rocks are significantly weaker in tension than in compression. This RePED innovation overcomes tensile strength to crush rock.

Time is saved by crushing rock faster. Additionally, because RePED bits last the lifetime of the hole, non-productive time is saved by not requiring bit change trips.

RePED 250 Principles: using rock's comparative weakness in tension for faster drilling. *Illustration by NREL*

## RePED 250: Repetitive Pulsed Electric Drill (250°C)

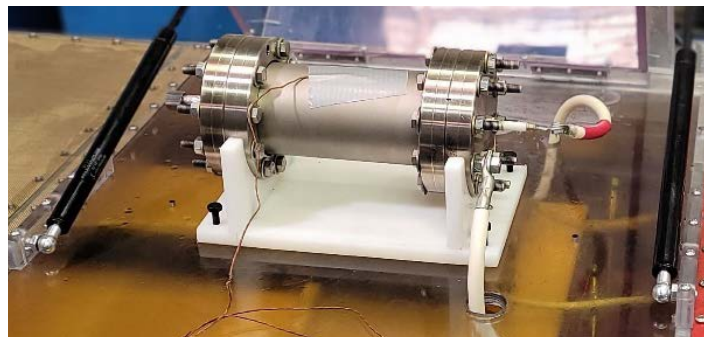
- Electro-crushing technology: Crushes rocks in tension using electric pulses.
- Granite's tensile strength is 5% of its compressive strength.
- Requires less energy, time, and cost to drill than conventional rotary systems.

## RePED 250 Innovations: Electronics for 250°C Environments

- High power switches
- High power capacitors
- Efficient electric generators

## Task 1: High-T Capacitor

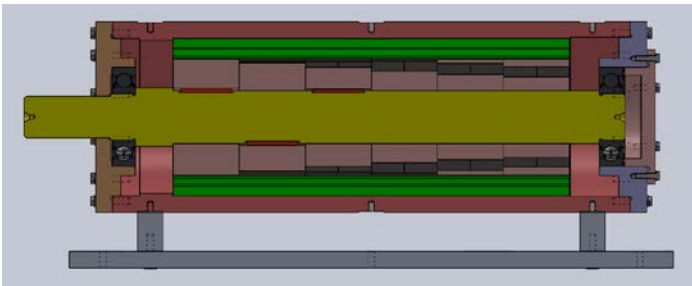
<b>State of the Art</b>	Low-temperature, polypropylene film, pulsed-power capacitors are readily available, but only capable of operating to 100°C. Ceramic capacitors do not have adequate energy density for this application.
<b>Target</b>	Design and fabricate full scale high-T polymer capacitor banks with pulsed power capabilities at 250°C, testing pulse life versus voltage stress, discharge current, and temperature.



Full scale high-temperature pulsed power capacitor undergoing tests. *Photo from TPL Inc.*

## Task 2: High-T Alternator

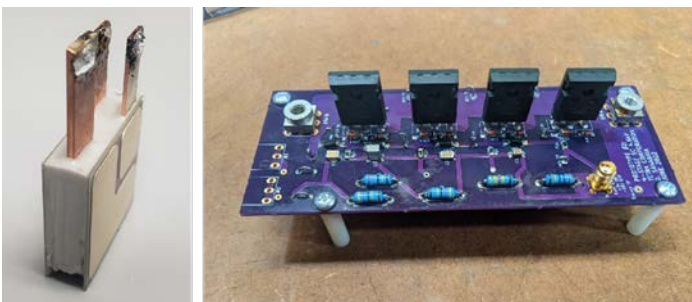
<b>State of the Art</b>	Low-temperature alternator technology is well-developed, utilizing conventional, low-temperature permanent magnets and seals.
<b>Target</b>	Design an alternator that is capable of 250°C operation, power rating of 35 kW, operating speed of 1000 RPM, and provide 600V at 60% efficiency.



High-temperature alternator was designed, and a prototype built. It is currently undergoing testing. *Photo by Ben McGilton, NREL*

## Task 3: High-T Switch

<b>State of the Art</b>	Silicon switches are capable of pulsed power applications but are only capable of operation to 80-100°C. Silicon-carbide switches are intrinsically capable of 300°C but are not available for pulsed-power applications.
<b>Target</b>	Switch that is capable of pulsed-power performance specifications, capable of operating at an ambient temperature of 250°C. Test switches in Cascode switch array.



High temperature encapsulated switch. Switches are combined into cascode switch arrays. *Photo from Tetra*

## Task 4: Tech to Market Impact

Though the proposed ARPA-E research and commercialization plan focuses on geothermal applications, other industries would have immediate benefits from these technologies and materials. An increasing number of systems are operating at higher temperatures, necessitating new high-T packaging, electronics, and dielectrics that can withstand mechanical and thermal stresses.

- **Geothermal:** In addition to increased geothermal power deployment, the RePED 250 Geothermal Drill will improve economics and deployment of geothermal direct-use (e.g., for greenhouses, recreation, industrial, and district heating uses).
- **Petroleum Industry:** Some oil and gas reservoirs require high-T drilling systems.
- **Fuel Cells:** High-T insulation has immediate applicability in packaging and dielectrics for solid oxide fuel cells (SOFCs).
- **Vehicles:** High-T switches and insulators are useful in vehicle applications, including exhaust systems, electric vehicle motors, and battery components.
- **Aerospace:** High-T capacitors and switches and generators/motors are needed for upgrading legacy aircraft and providing electrical in high-T environments.
- **Smart Grid:** High-T switches are applicable in Smart Grid applications in the distribution and sub-transmission systems.

## Contact

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