VOUCHER CAPABILITIES MENU
Phase 2: Make!

VOUCHER OVERVIEW

If you win Phase 2: Make!, you will be awarded a $100,000 voucher to be redeemed at a national lab or a private facility. As a part of your submission package to Phase 2: Make!, you must include a Voucher Work Slide, which outlines where you would intend to redeem your voucher and what you would intend to do with it.

Further details about vouchers can be found on the Geophone Prize website.

The intention of this document is to introduce you to capabilities at the national labs that could be relevant to your voucher. This information can help you populate your Voucher Work Slide. For your Phase 2: Make! Voucher Work Slide, you must provide the name of the lab or facility you intend to work with and a brief outline of the work you would like done. You must submit a separate Voucher Work Slide for each lab (up to 2) or facility with which you intend to work.

If you go on to win Phase 2: Make!, the Prize Administrator will work with you to connect you to the relevant lab to further scope work.

If you have any general questions or would like to contact us, please reach out to the Geophone Prize Team at geophoneprize@nrel.gov.

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VOUCHER WORK SLIDE

Include a completed Voucher Slide in your Phase 2: Make! submission package. A template for this slide can be found on HeroX. If you are splitting your voucher between two different facilities, you must include a Voucher Slide for each facility and national lab. Do not fill in your technical needs, but rather, fill in anticipated work done on your team's behalf by a national lab or private facility in our Network.

American-Made Geothermal Geophone Prize, Phase 2: Make!

Prepared for {{Team Name}}, team POC: {{Name}}

{{National Lab/Private Facility}}, {{POC}}, {{POC email}}

Objective:

Anticipated scope of work:

Tasks: {{National Lab/Private Facility}} will perform the following tasks for {{team name}}:

-
-
-
-

Deliverables: {{National Lab/Private Facility}} will provide {{team name}} with the following:

-
-
-
-

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SELECT NATIONAL LAB GEOTHERMAL CAPABILITIES

While this is not an exhaustive list, it is intended to help you determine which lab you may want to work with and what their capabilities are related to geophones. You may elect to work with a lab that is not on this list or for capabilities not listed; this is intended to be a starting point. You may also elect to work with a facility in the American-Made Network.

Sandia National Laboratory (Sandia)

Voucher Representative: Giorgia Bettin

Sandia's Geothermal Research program has been at the forefront of innovation and R&D for the past four decades and has previously partnered with Geothermal Manufacturing Prize winners to support their projects via voucher funds.

High-Temperature Electronics: (Advice/Subject Matter Expert Input, Design, Evaluation)

Sandia has a decades-long history of developing high-temperature (HT) borehole electronic systems including development of a customizable HT borehole instrumentation system, interface electronics for novel HT electrochemical sensing elements, implementation of modern communication protocols on HT electronics, and evaluation of HT components in simulated HT and high-pressure downhole environments. Sandia also has a history of developing novel HT sensors, working with experimental HT sensing systems developed by collaborators, and working with off-the-shelf components and sensing systems to be incorporated into HT tools. Sandia has a state-of-the-art electronics laboratory equipped with a range of design, assembly, and evaluation tools for benchtop and HT electronics.

Prototype Testing at Geothermal-Type Conditions: (Evaluation/Testing)

Sandia maintains ovens and test chambers for evaluating prototype, components, circuit boards, mechanical systems, fixtures, tool prototypes, etc. in simulated geothermal conditions. Examples include (1) a 1L test chamber with maximum 300°C and 5000 PSI PTFE internal lining to enable testing in surrogate geothermal brines; (2) 5000-PSI long pressure chamber capable of testing up to parts ~2 ft long; (3) ported scientific ovens (300°C, 350°C, >450°C). Sandia also maintains the HOT Facility to evaluate performance of percussive drilling tools at temperatures characteristic of geothermal formations (~300°C).

System Integration, Analysis, and Subsurface Testing: (Design, Evaluation)

Sandia has extensive experience designing and integrating sensor packages into hardware systems. Prior to field testing, Sandia can test components for shock, vibration, and service loading. To complement these capabilities, Sandia maintains subsurface wellbores reserved for testing the performance of downhole tools,

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sensors, and actuators. Subsurface tests can be configured with additional actuators or sensors to create and observe the desired effect on a test article.

Additive Manufacturing Systems and Prototyping:

Sandia conducts research on the structure, processing, and properties of materials to improve their performance and support Sandia engineers to solve a broad range of materials selection, component design, component fabrication, coating and surface process development, and process problems. Specific technical areas include: (1) thin-film coatings deposited by both physical vapor deposition and atomic layer deposition and their characterization, including reactive and functional thin film science; (2) precision engineering at the meso-scale and using laser technology; (3) beam-assisted nano/micro-fabrication; (4) vacuum science, engineering, and gas analysis; (5) metal additive manufacturing using laser powder bed, directed energy deposition, and wire fed technologies; and (6) rapid prototyping/fabrication.

Lawrence Berkeley National Laboratory (LBNL)

Voucher Representative: [Yves Guglielmi]

LBNL has extensive experience in developing and deploying geophysical sensors that can withstand the elevated temperatures associated with geothermal systems. This experience extends to systems design, high-temperature electronics, component manufacturing, laboratory testing of sensor components at relevant PTX conditions, and field deployment. LBNL also has expertise in modeling seismic responses of different lithologies under a wide range of temperatures, pressures, and stress conditions—such modeling may help inform the desired design parameters for downhole geophones.

Examples of Current Projects That Involve High-Temperature Sensors:

- The Geothermica SPINE team at LBNL has been developing a high-temperature version of the Suggested Method for Step-Rate Injection Method for Fracture In-Situ Properties (SIMFIP) tool, which uses a fiber optic displacement sensor to measure real time fracture displacement in a borehole. Components of the SIMFIP tool have been upgraded to withstand geothermal temperatures, and the prototype high-temperature probe has been tested using the Solexperts high T&P testing facility in Germany.

- David Alumbaugh and his team have been working on a new research project entitled "Joint electromagnetic/seismic/InSAR imaging of spatial-temporal fracture growth and estimation of physical fracture properties during EGS resource development" at the Utah FORGE site. One key component of this project is to upgrade an existing high-TEM tool developed by GERD so that it can be deployed downhole during well stimulation with the goal of improved subsurface imaging.

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Other Types of Downhole Sensor Expertise:

- Distributed Acoustic Sensing (DAS)
- Distributed Strain Sensing (DSS)
- Distributed Temperature Sensing (DTS)
- Continuous Active Source Seismic Monitoring (CASSM).

Argonne National Lab (Argonne)

Voucher Representative: Oyelayo Ajayi

Well-Logging Technologies:

Argonne has developed a number of sensor and instrumentation techniques, including acoustic, ultrasonic, and electromagnetic, that can be used for in-situ and real-time monitoring of the condition and process of an enhanced geothermal system (EGS). The well-logging sensors and instrumentation include the following:

- Passive High-Temperature Acoustic Sensor: The sensor has been demonstrated to quantitatively measure the dependence of the flow-induced acoustic signal on flow rate, and potentially can be used to predict rock-fracture interaction/networks and reservoir permeability.

- Ultrasonic Flowmeter: The flowmeter uses the high-temperature ultrasonic transducers developed at Argonne to measure the flowrate either submerged in well or mounted on pipe.

- Ultrasonic Flow Characterization: Ultrasonic transducer-waveguide flowmeter has been developed to characterize multiple flow parameters including fluid density, pressure, volumetric flow rate, and void fraction of a gas-liquid two-phase flow in a harsh environment at high temperature, high pressure, and highly corrosive condition.

- Ultrasonic Time-Domain Reflection (TDR) Probe: The TDR technique can be applied to downhole temperature profile measurement in an EGS. The TDR technique was found to be unaffected by pressure and flow rate.

- 3D Fracture Imaging System: Modeling and preliminary tests of passive radio frequency radiometric techniques were conducted for more accurate identification of potential hydrothermal sites. The prototype uses directional polarimetric radar (joint multi-hole reflection Synthetic Aperture Radar and cross-hole tomography) to explore both subsurface and downhole fractures and medium properties such as permeability, permittivity, loss tangent, and wave propagation velocity.

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Embedded Motion and Vibration Sensor:

Argonne has a printed electronics lab and the capability to fabricate embedded motion or vibration sensors underneath the surface of glass or ceramic substrates for seismic sensing applications. These sensors can be designed passive and communicate with their readers through wireless radio frequency signal based on harmonic radar-transponder mechanism. Since the sensors are embedded and the sensors and readers are separated, these sensors can work under elevated temperatures and corrosive environment compatible with geothermal conditions. By using five-axis aerosol jet printing, we can also print sensors on a non-planner surface, which enables better adaptability to the drill pipe or drill well profiles. In collaboration with university collaborators, Argonne can design sensors using higher order harmonic frequencies to increase sensing data communication distance and dynamic range. Argonne also has the capability to design electrical circuits and rapid prototype reader electronics using the combined printed circuitries and surface mount microprocessors. In addition to harsh environment tolerance, the embedded sensors and printed electronics also have the advantages of low-cost and rapid prototyping.

Pacific Northwest National Laboratory (PNNL)

Voucher Representative: [TJ Heibel]

High-Temperature True Triaxial Frame with In-Situ Real-Time Imaging:

PNNL stewards a high-temperature true triaxial frame. The frame can independently control all three principal stresses up to 2000 psi on a 6” cubic sample at temperatures up to 200 C. The system is designed to inject various types of liquid, gas, and supercritical fluids into the sample. Acoustic emission monitoring and electrical resistivity tomography monitoring can be used to image changes in stress and fracture growth in the sample during a test.

High-Temperature Instrumentation and Electronics Design, Fabrication, and Testing:

PNNL has extensive experience with analog and digital electronics with the ability to design, fabricate, and test high-temperature systems. PNNL has experience with high-temperature piezoelectric materials such as bismuth tantalate, high-temperature silicon carbide electronics, and Peltier cooling elements. PNNL also has interrogators for distributed acoustic sensing (DAS), distributed temperature sensing (DTS) with extensive experience deploying and interpreting data from these sensing modalities. PNNL has also recently developed a high-temperature borehole air gun seismic source.

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High Temperature Environmental Materials Testing:

PNNL has a number of high-temperature, high pressure environmental testing chambers for both short-term and long-term environmental exposure. These are often paired with mechanical testing and microscopic evaluation to evaluate stress corrosion and other material degradation processes.

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Sample Voucher Slide

An example (mocked up version) of a completed voucher slide.

Prepared for Team XX, Team POC, Email
XX National Lab, POC, Email

Geothermal Geophone Prize, Phase 2: Make!

Objective: Characterize the performance of system components at temperatures of 225°C and above.

Anticipated Scope of Work:

Tasks:

- Performance characterization of X component
- Perform long-term tests at 225°C+ and high pressure to determine useful working time
- Consult on sensor design/components

Deliverables:

- Report on lab tests summarizing testing results
- Report on high-temperature sensor components/design options
- Technical feedback on component/design improvements

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