U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Geothermal Technologies Office

Quarterly Update: May 28, 2020

Dr. Susan Hamm, Director

Image: Calpine

Q2 2020 Agenda

Webinar topics or suggestions? Contact us at: DOE.geothermal@ee.doe.gov

Topic	Speaker
Introduction	Susan Hamm, Director
Solicitations update	Susan Hamm
Geothermal Manufacturing Prize update	Sean Porse, DMA Lead Analyst
Utah FORGE update	Lauren Boyd, EGS Program Manager
2020 Geothermal Design Challenge winners	Elisabet Metcalfe, EGS Technology Manager
Q&A	Submit your question via WebEx chat

DOE COVID-19 Response

- We are working remotely…yet we remain resilient and responsive.

- We are active and connected on a daily basis.

DOE COVID-19 Response

Office of Science Laboratories

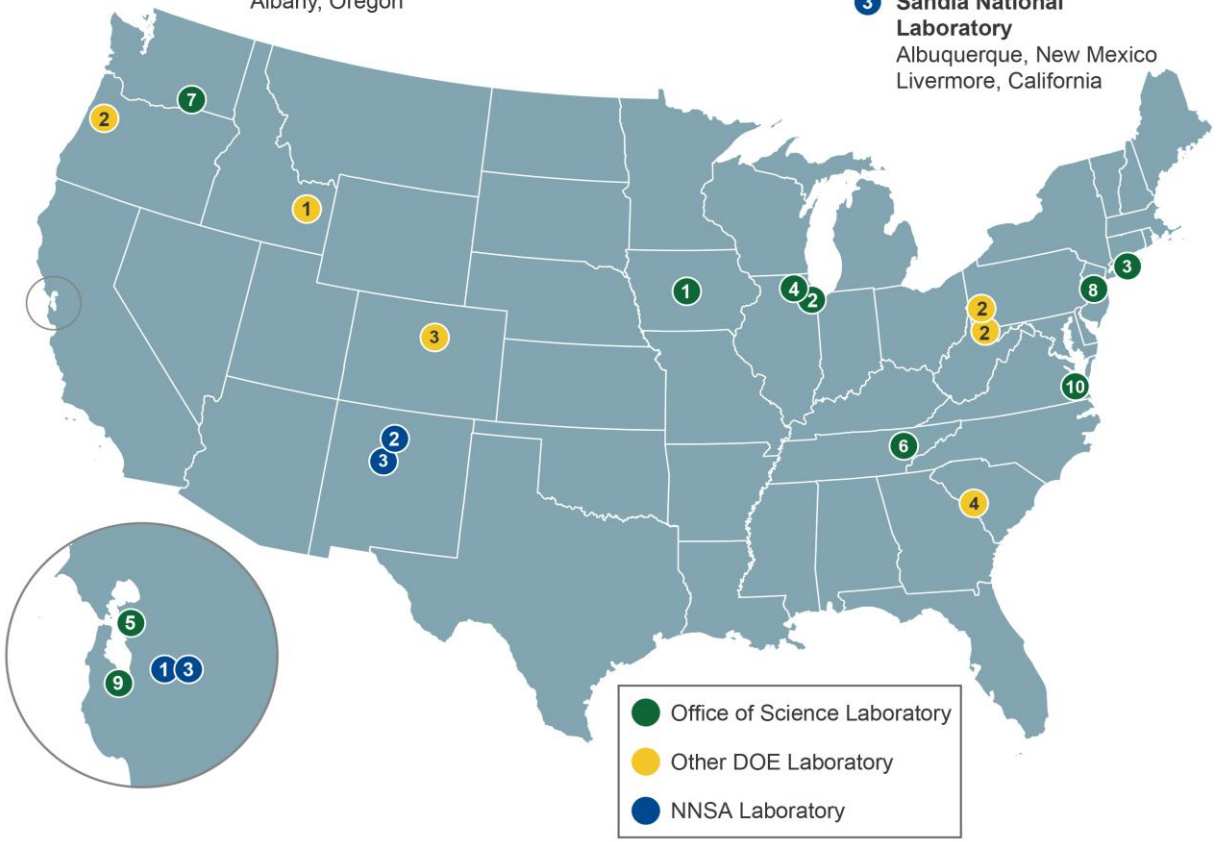
1. **Ames Laboratory**
   Ames, Iowa
2. **Argonne National Laboratory**
   Argonne, Illinois
3. **Brookhaven National Laboratory**
   Upton, New York
4. **Fermi National Accelerator Laboratory**
   Batavia, Illinois
5. **Lawrence Berkeley National Laboratory**
   Berkeley, California
6. **Oak Ridge National Laboratory**
   Oak Ridge, Tennessee
7. **Pacific Northwest National Laboratory**
   Richland, Washington
8. **Princeton Plasma Physics Laboratory**
   Princeton, New Jersey
9. **SLAC National Accelerator Laboratory**
   Menlo Park, California
10. **Thomas Jefferson National Accelerator Facility**
    Newport News, Virginia

Other DOE Laboratories

1. **Idaho National Laboratory**
   Idaho Falls, Idaho
2. **National Energy Technology Laboratory**
   Morgantown, West Virginia
   Pittsburgh, Pennsylvania
   Albany, Oregon
3. **National Renewable Energy Laboratory**
   Golden, Colorado
4. **Savannah River National Laboratory**
   Aiken, South Carolina

NNSA Laboratories

1. **Lawrence Livermore National Laboratory**
   Livermore, California
2. **Los Alamos National Laboratory**
   Los Alamos, New Mexico
3. **Sandia National Laboratory**
   Albuquerque, New Mexico
   Livermore, California

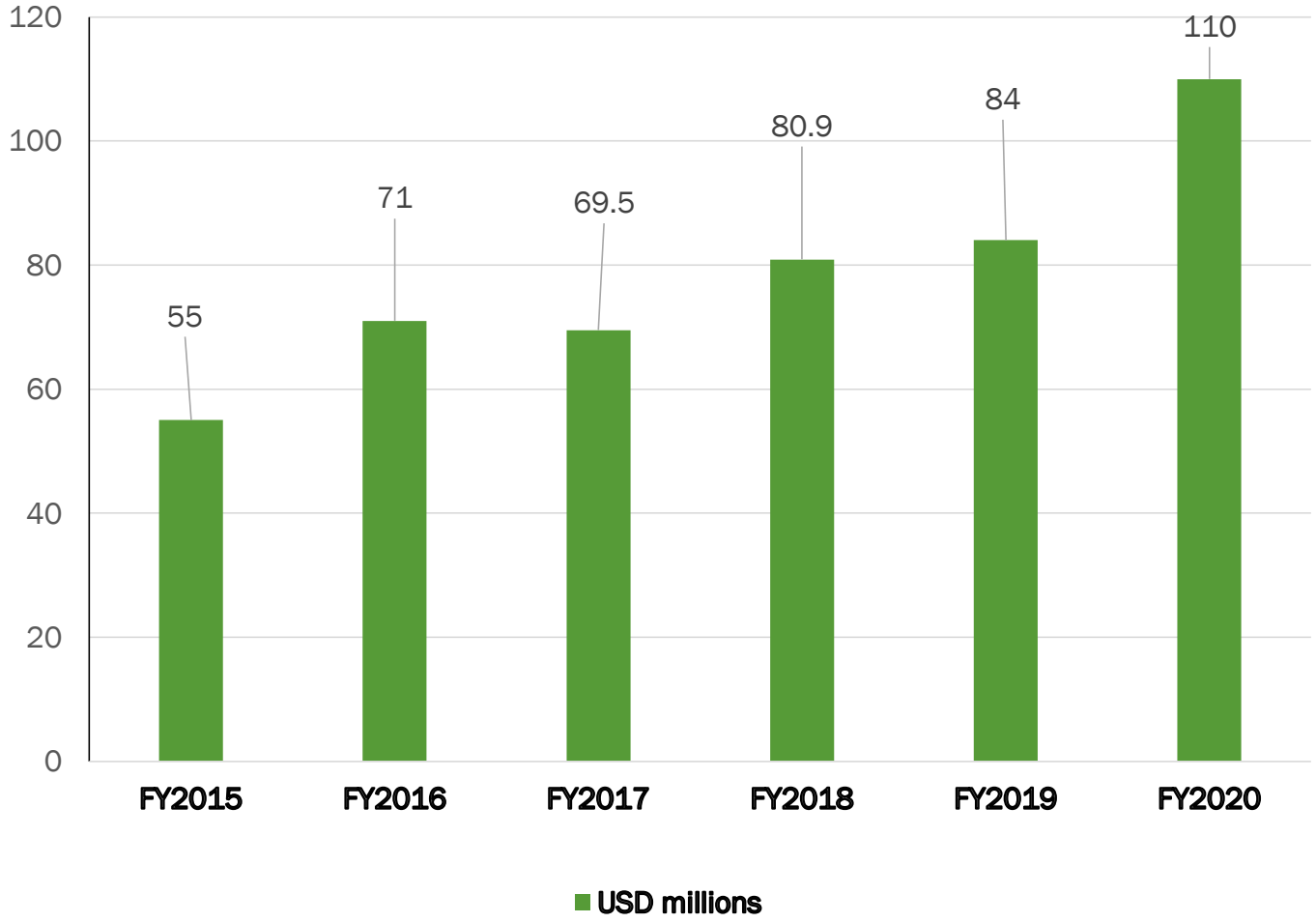


Welcome Our New Program Manager

Dr. Alexis McKittrick

- Will oversee GTO's hydrothermal resources and low-temperature and co-produced resources groups.
- Previously with IDA Science & Technology Policy Institute.
- Led development of the FORGE Roadmap in 2018.
- Previous Federal experience in the U.S. EPA's Climate Change Division.
- Holds a Ph.D. in Chemical Engineering from Georgia Tech.
- Mentor to young engineers and scientists; maintains an active role with SWE Board of Directors.

Budget Snapshot



Wells of Opportunity: Closed – Currently Reviewing

Up to $25 million in funding to advance EGS technologies and techniques.

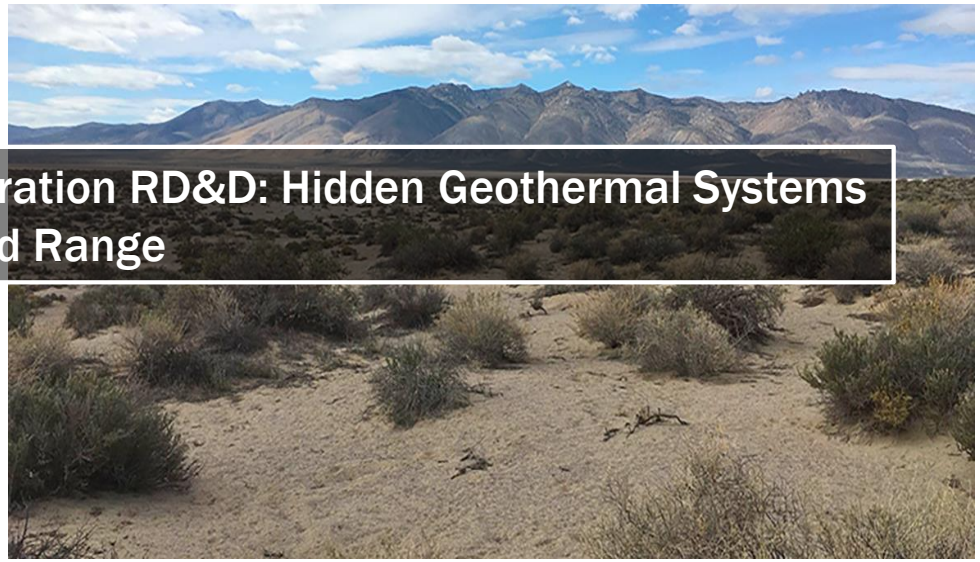
- **<u>Topic 1</u> – PILOT: Prepare and repair existing wells and test downhole tools and well stimulation technologies.**

- **<u>Topic 2</u> – AMPLIFY: Test and validate targeted stimulation techniques for purposes of producing additional energy.**

WOO WELLS OF OPPORTUNITY U.S. DEPARTMENT OF ENERGY

Hidden Systems / AESI: Closed – Currently Reviewing

Up to $18.8 million in funding for up to six projects.



Topic 1 – Exploration RD&D: Hidden Geothermal Systems in the Basin and Range

Topic 2 – Advanced Energy Storage Initiative (AESI): Bi-directional Energy Storage Using Low-Temperature Geothermal Applications

Recent SBIR Awards (High Temperature Elastomer R&D)

Multiscale Systems, Inc. (Worcester, Mass.)

- *Development and Application of Mechanical Metamaterials to Address Needs in Geothermal Technologies*

Triton Systems, Inc. (Chelmsford, Mass.)

- *Novel High Temperature Nanocomposite Elastomer for Geothermal Applications*

Tetramer Technologies, LLC (Pendleton, SC)

- *High Temperature Elastomeric Materials*

Vuronyx Technologies (Arlington, Mass.)

- *Elastomeric Composite Materials*

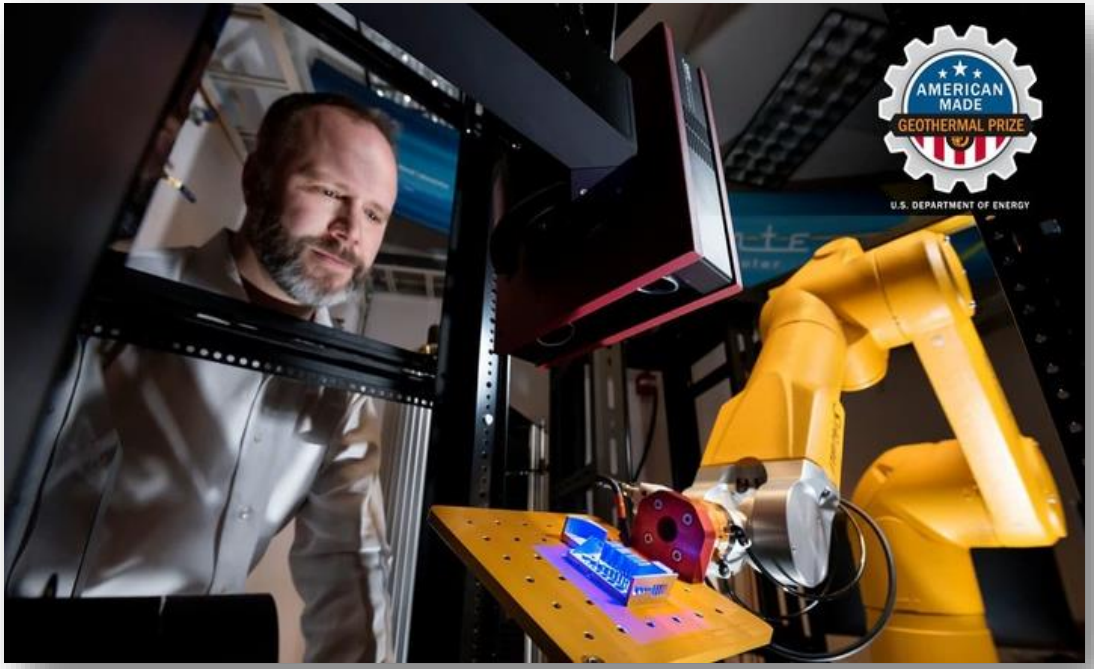
Image: IOM3

Geothermal Manufacturing Prize

Sean Porse, DMA Lead Analyst
Geothermal Technologies Office

Geothermal Manufacturing Prize – LIVE!

- **Launched on April 29, 2020**
- **$4.65 million in prizes** to spur geothermal manufacturing innovation by harnessing the potential of additive manufacturing.



- **Prize Goals**
  - **Reduce** design and manufacturing lead times
  - **Save** money and materials
  - **Improve** geothermal tool, equipment, or component performance

To learn more: **herox.com/geothermalmanufacturing**

Geothermal Manufacturing Prize Structure

Ready! Launch: April 29, 2020

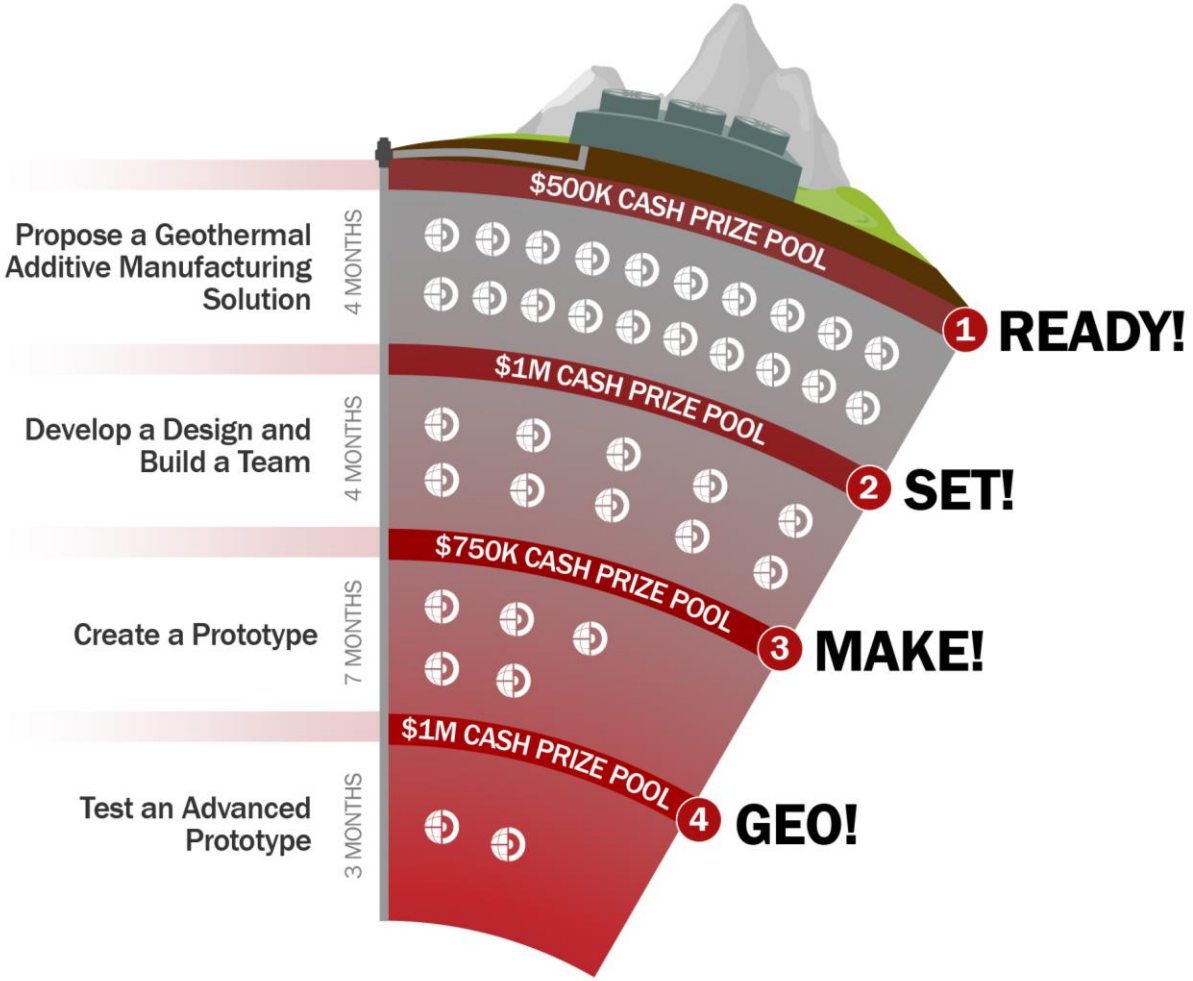
Apps Due: Aug. 26, 2020

Ready! Close: Nov. 4 2020

May 2021

January 2022

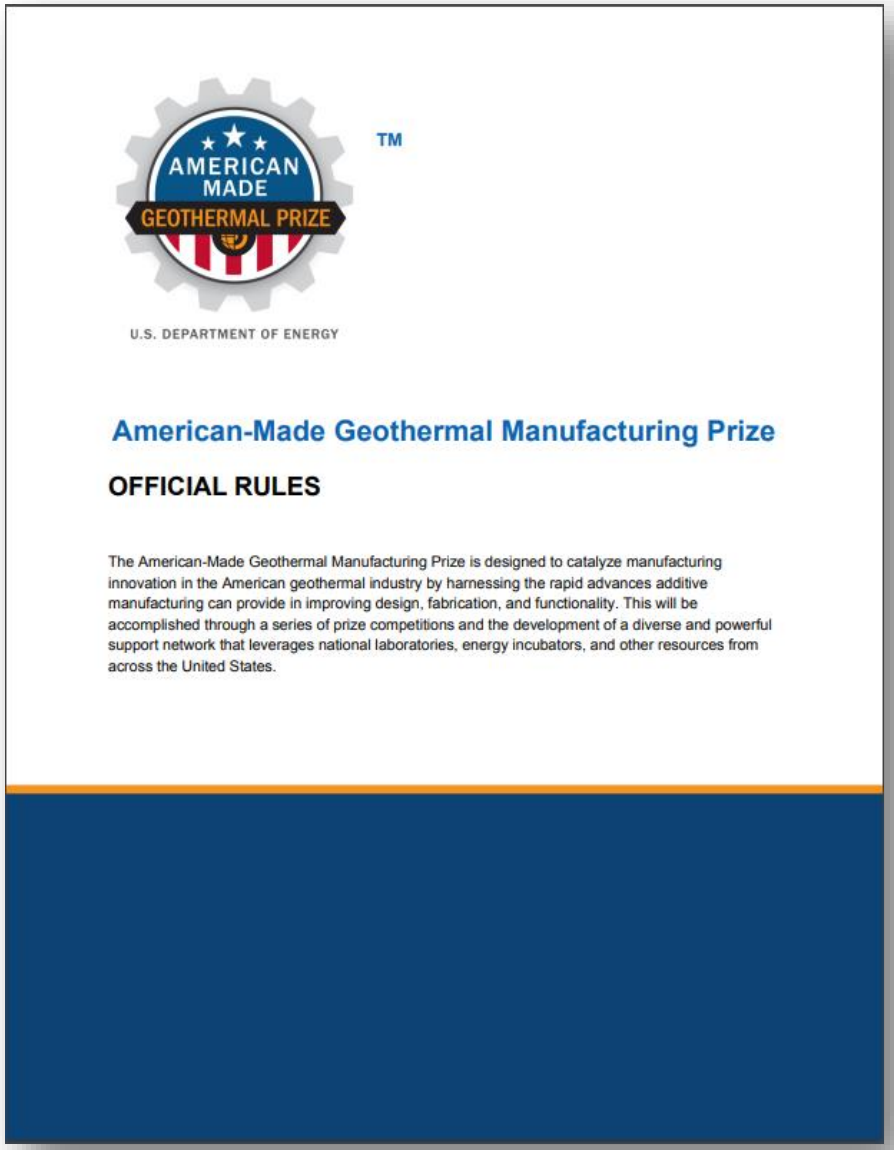
July 2022



To learn more: **herox.com/geothermalmanufacturing**

Geothermal Manufacturing Prize Rules

- Official Rules of the Prize are available online on the Geothermal HeroX Page.
- Located under the Guidelines as well as the Resources tabs.



Prize Outreach Activities

- Geothermal Prize 101 Webinar
  - May 27, 2020
  - **Webinar available on HeroX**

AMERICAN MADE GEOTHERMAL PRIZE

U.S. DEPARTMENT OF ENERGY

- Nation of Makers Conference
  - June 4, 2020 / 2-6 PM ET
  - Three Sessions on:
    - Geothermal energy
    - Additive manufacturing
    - Sparking collaboration

To learn more: **herox.com/geothermalmanufacturing**

Utah FORGE Update

Lauren Boyd, EGS Program Manager
Geothermal Technologies Office

The Milford FORGE Site

Frontier Observatory for Research in Geothermal Energy – Milford Site, Utah Solicitation 2020-1

Solicitation Issue Date:	April 30, 2020
Informational Webinar:	1:00 PM Mountain Time, May 6, 2020
Submission Deadline for Concept Papers:	2:00 PM Mountain Time, May 27, 2020
Encourage/Discourage Decision Notification:	June 15, 2020
Deadline for Solicitation Questions:	2:00 PM Mountain Time, August 3, 2020
Submission Deadline for Full Applications:	2:00 PM Mountain Time, August 10, 2020
Expected Date for Selection Notifications:	November, 2020

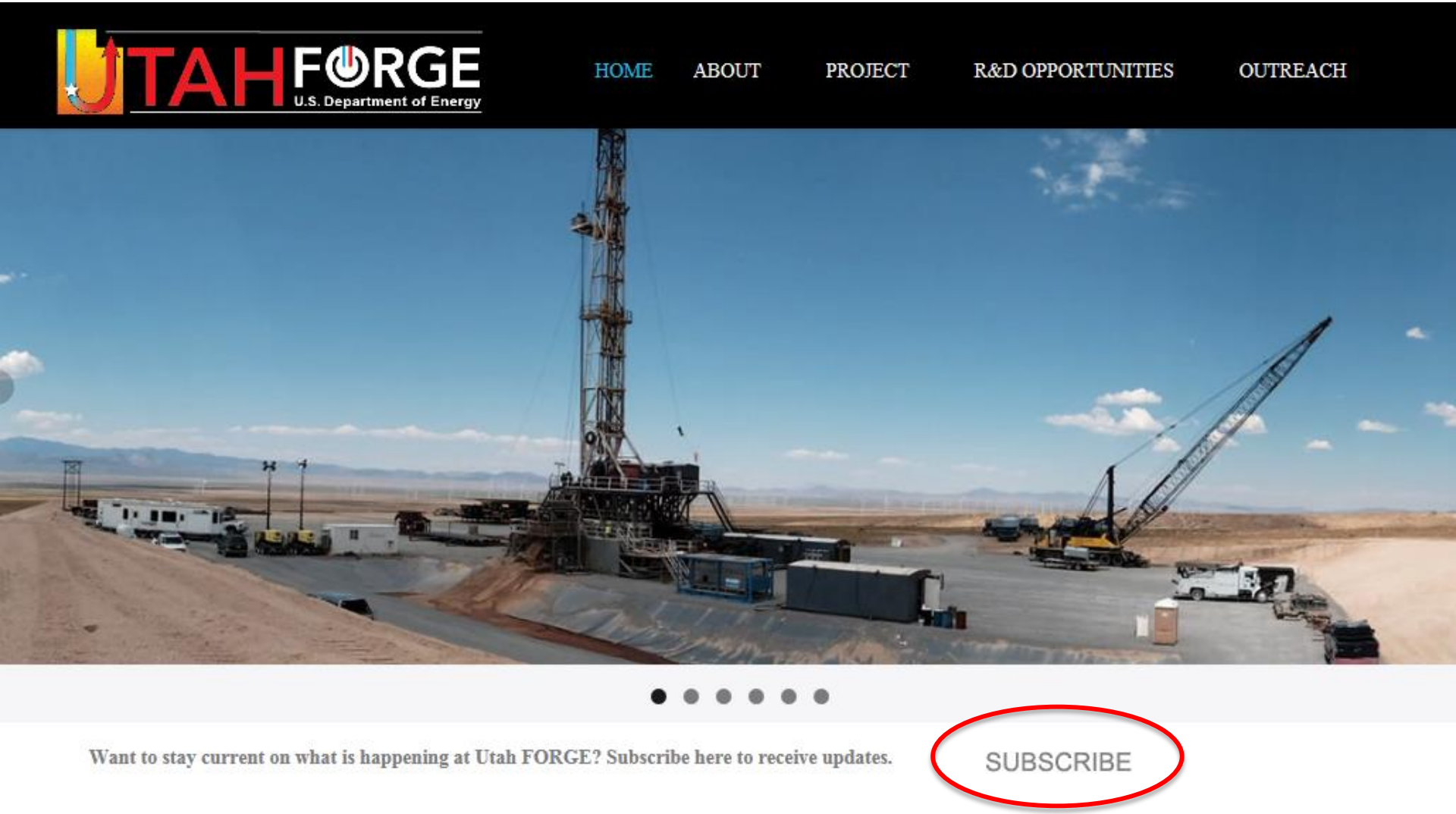
Solicitation 2020-1: Topic Areas

Topic	Title	Potential Funding	Potential Number of Awards
1	Devices suitable for sectional (zonal) isolation along both cased and open-hole wellbores under geothermal conditions	$12,000,000	1 to 3
2	Estimation of stress parameters	$3,000,000	1 to 3
3	Field-scale characterization of reservoir stimulation and evolution over time, including thermal, hydrological, mechanical, and chemical (THMC) effects	$8,000,000	1 to 4
4	Stimulation and configuration of the well(s) at Utah FORGE	$12,000,000	1 to 3
5	Integrated laboratory and modeling studies of the interactions among THMC processes	$11,000,000	1 to 6

Solicitation 2020-1: Award Information

Total Amount to be Awarded	Up to $46,000,000
Expected Number of Awards	Up to 18
Types of Funding Agreements	University of Utah Subaward Agreements
Period of Performance	Up to 36 months
Periodic Evaluation	Periodic Go/No-Go review Details finalized during award negotiation
Cost Share Requirement (Percentage of Total Allowable Costs)	0% Institutions of Higher Learning, Nat'l Labs, FFRDCs, Domestic Non-Profits 20% For profit institution

Web Access: utahforge.com



Other FORGE Events

Newsletter

AT THE CORE *The Utah FORGE Newsletter*

Quarterly Newsletter to keep the community up-to-date on happenings at Utah FORGE.

Every issue will include updates from the Principal Investigator, technical discoveries, outreach news, announcements, data, events, etc.

https://utahforge.com/at-the-core/

Webinars

The Utah FORGE Team recently introduced a series of webinars; the first provides an overview of the geological setting of the Milford site and geoscience datasets acquired at Utah FORGE and available to the public.

https://utahforge.com/2020/05/13/geoscience-of-utah-forge/

Modeling Forum

An open forum to present modeling and simulation, both completed and planned, as well as activities conducted by the Utah FORGE Team.

These meetings are recorded and available for later viewing.

https://utahforge.com/2020/05/18/modeling-and-simulation-forum-2/

Geothermal Design Challenge 2020

Elisabet Metcalfe, EGS Technology Manager
Geothermal Technologies Office

Geothermal Design Challenge Winners

U.S. Department of Energy

GEOTHERMAL 2020 Design Challenge™

GIS Mapping

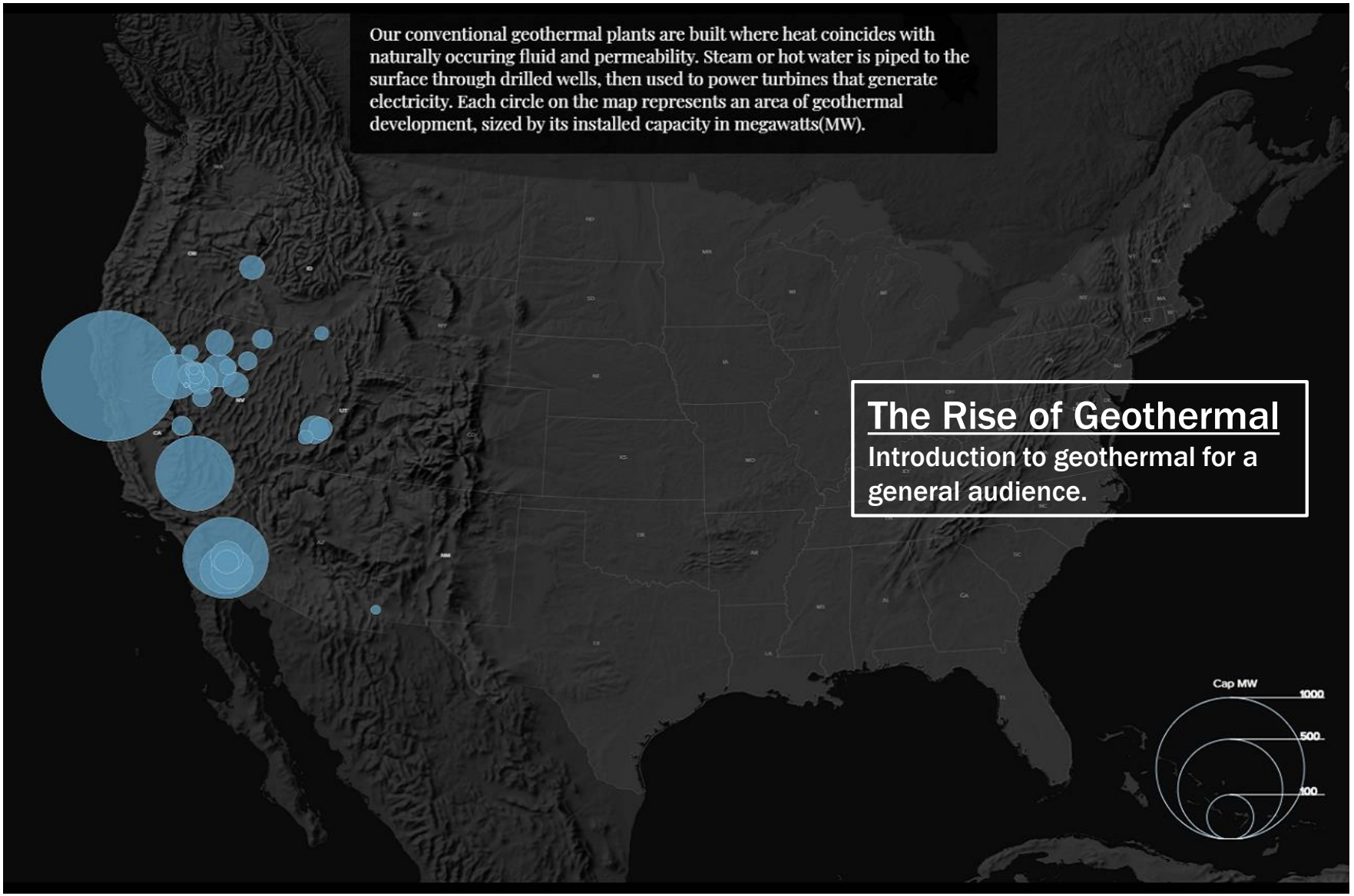
Challenge: How can GIS improve the way we visualize and communicate geothermal energy?

1st Place Digital: "UW Cart Lab"
University of Wisconsin-Madison

1st Place Print: "Flying Squirrels"
Northern Virginia Community College

To learn more about the winning entries, visit: inl.gov/geothermalchallenge

University of Wisconsin-Madison



Northern Virginia Community College

Geothermal Locality Index

Where to Find "The Heat beneath Our Feet"

The Challenge

For the **2020 Geothermal Design Challenge on GIS Mapping,** we developed a **Geothermal Locality Index** to pinpoint potential geothermal resources near people who need heat and energy the most.

Geothermal energy often is overlooked as a renewable resource because it has greater financial and regulatory barriers than solar and wind power. Geothermal energy is often associated with western hydrothermal resources, where heated water is close to the surface. But low-temperature, geothermal reserves—those between 30˚C and 150˚C—also may be a viable option, even though they lack enough rock permeability, water flow, or both, to extract their steady heat.

Low-temperature, enhanced geothermal (LTEG) energy needs to be "enhanced" to make it accessible. Two recent developments have unlocked **LTEG** reserves. The first is fracking, which is used in the extraction of fossil fuels but can also be used for **LTEG.** Engineers inject water to increase rock porosity, absorb the heat, and carry it back upward. The second development is the advent of binary power plants. Once heat arrives at the surface, binary plants can harvest temperatures as low as 80˚C to heat a fluid that has a lower evaporation point than water, producing enough vapor to power turbines and generate electricity.

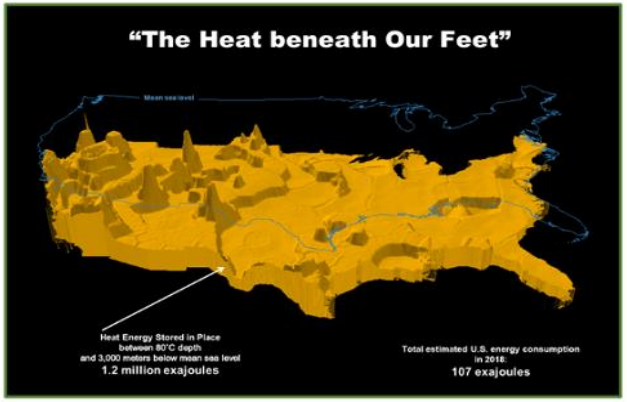
The energy potential of this "heat beneath our feet" far exceeds that of national demand.[1] Estimates of total **LTEG** resources between 30˚C and 150˚C have ranged up to 2.8 million exajoules.[2] Meanwhile, he estimated residential and commercial low-temperature heat demand in the United States is only 0.01 exajoules per year.[3]

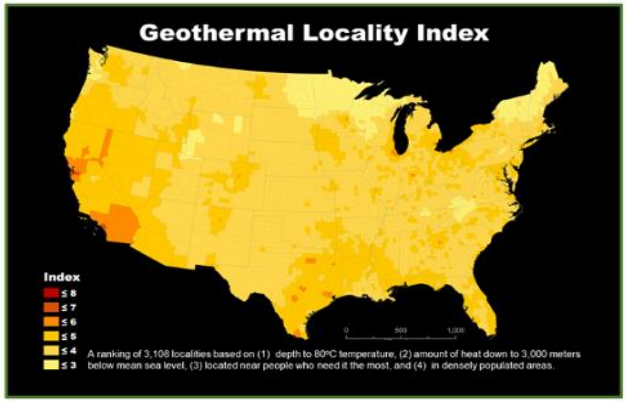
Geothermal energy can help communities diversify their energy portfolios to include more renewable resources. Its reliability makes it an ideal back-up for emergency situations and critical infrastructure like medical facilities, data centers, and government buildings.[4] Finally, it has a negligible footprint for carbon dioxide and other chemicals that contribute to global warming.[5]

Model

We developed a fuzzy membership GIS model with weighted components. The index ranked 3,108 localities based on the following criteria:

1. depth to 80˚C temperatures
2. amount of heat down to 3,000 meters below mean sea level (Accessible Resource Base or ARB)
3. located near people who need it the most
4. located near densely populated areas





Results

We calculated "the heat beneath our feet" or the total Accessible Resource Base (ARB) of **LTEG** with temperatures above 80˚C located down to 3,000 meters below mean sea to be 1.2 million exajoules. The total U.S. energy consumption for 2018 was estimated at only 107 exajoules.[10] This suggests that, if harvestable, geothermal heat alone could meet U.S. energy needs. Where should we focus efforts?

Geothermal Locality Index

Every locality in the United States except for three reached 80˚C levels within a depth of 3,000 meters. The Geothermal Locality Index scored them against each other, ranking them from 2.1 to 7.8. Marshall, Minnesota, was the lowest, and San Francisco was the highest. It is optimal for using **LTEG** resources because it has a dense population so heating and cooling services would lose minimal energy on the way to customers. It also would have lower drilling costs because the 80˚C reservoir is only 575 meters deep. Other western counties in the top 20 are similar. Localities along the Gulf of Mexico, Florida, and the Great Lakes also are strong candidates for **LTEG** resources. Only six eastern counties made the top 20, all because of their dense population and high heat demand. However, their 80˚C reservoirs are not close to the surface, meaning that extraction costs would be higher than for those of their western counterparts.

Top 20 Localities

Geothermal Locality Index	Locality	State	Depth to 80˚C meters	"The Heat beneath Our Feet" million EJs	Heat Demand million EJs	Population Density per square km
7.80	San Francisco	California	390	14,700	89	7,360
7.80	Oakland	California	390	14,700	89	7,360
6.80	Orange	California	1,470	840,400	20	2,109
6.80	San Mateo	California	970	606,700	16	906
6.80	Alameda	California	950	1,070,000	16	906
6.80	Washington	District of Columbia	2,490	15,620	90	3,969
6.80	Denver	Colorado	2,470	61,940	27	1,742
6.80	Bronx	New York	2,500	1,040	198	13,566
6.80	Kings	New York	2,500	1,760	145	12,061
6.80	Contra Costa	California	760	1,057,810	6	964
6.80	Broomfield	Colorado	2,450	1,400,000	0	574
6.80	Santa Clara	California	990	1,470,000	71	1,309
6.80	Los Angeles	California	2,490	3,288,000	16	2,403
6.80	San Diego	California	990	6,040,000	16	362
6.70	Carson City	Nevada	940	282,071	0	156
6.70	Santa Cruz	California	910	660,000	0	298
6.60	St. Louis City	Missouri	2,500	16,000	82	1,742
6.60	Los Angeles	California	1,910	3,288,000	16	952
6.60	Marin	California	910	307,400	4	184
6.60	San Bernardino	California	1,860	17,865,000	6	62

Conclusion

Most U.S. localities have an ARB that far exceeds heat demand. There is a constant supply of 18 million times more energy under our feet than we expended in 2018. The Geothermal Locality Index identifies 20 promising localities based on heat accessibility and population factors. It could be used to prioritize public education efforts as well as regulatory, policy, and financial incentives to consider use of an often-overlooked renewable resource: **low-temperature, enhanced geothermal** energy.

Geothermal energy is:

- **indefinite**: renewable
- **reliable:** always available
- **stable:** production rates are steady unless there is human error
- **independent:** does not fluctuate with political or economic changes

U.S. Department of Energy
2020 Geothermal Design Challenge™
GIS Mapping

References

[1] U.S. Department of Energy Geothermal Technologies Office (GTO) (2016). GeoVision: Harnessing the heat beneath our feet—analysis inputs and results. doi: 10.15121/1312361

[2] Mullane, M., M. Gleason, K. McCabe, M. Mooney, R. Young, and T. Reber (2016). An estimate of the resource potential within shallow, low-temperature geothermal resources of the United States for direct use applications. Golden, Colorado: National Renewable Energy Laboratory.

[3] McCabe, K., M. Gleason, T. Reber, K. R. Young, (2016). Characterizing U.S. heat demand for potential application of geothermal direct use. Geothermal Resources Council Transactions, v. 40.

[4] [illegible]

[5] International Finance Corporation, World Bank Group. (2007). Environmental, health, and safety guidelines for geothermal power generation. Retrieved from https://www.ifc.org/wps/wcm/connect/

[6] Finger, J. & D Blankenship. (2010). Handbook of best practices for geothermal drilling. Sandia National Laboratories, SAND2010-6048. Retrieved from https://www7.eere.energy.gov/sites/default/files/uploads/sand_pdf

[7] National Renewable Energy Laboratory. (2016). US Low-Temperature EGS Resource Potential Estimate [data set]. Retrieved from http://gis.openei.org/arcgis/rest/services/EGS

[8] Mullane, M. et al. (2016).

[9] McCabe, K. et al. (2016).

[10] Units and Calculators Explained. Energy Information Administration. Retrieved from https://www.eia.gov/energyexplained/index.cfm?page=about_btu_calculator

Questions?

We always welcome your feedback.
DOE.geothermal@ee.doe.gov

The **Geothermal Technologies Office (GTO)** works to reduce the cost and risk associated with geothermal development by supporting innovative technologies that address key exploration and operational challenges.

By advancing the value stream for grid (electricity) production and deep direct-use, GTO aims to make geothermal energy a cost-competitive, widely available, geographically diverse component of the national energy mix.

Visit us at: www.energy.gov/eere/geothermal