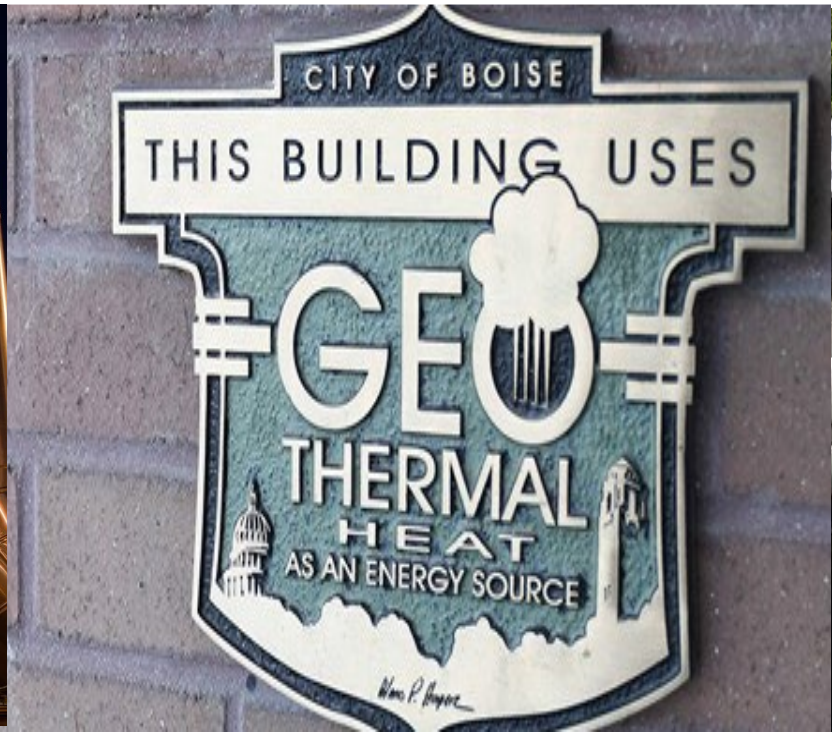
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Geothermal Technologies Office: An Overview

Lauren Boyd, EGS Program Manager

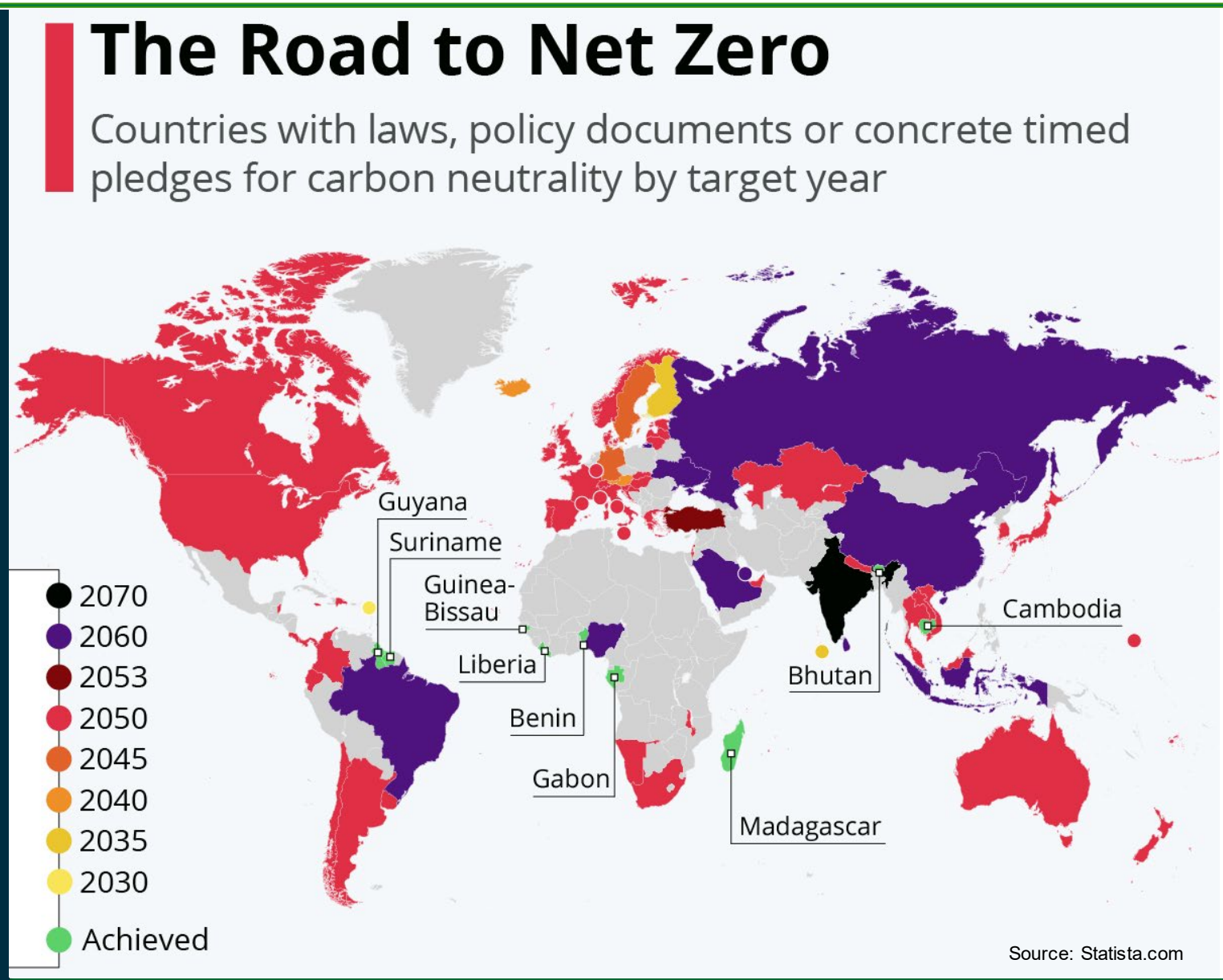
February 2022



Global Carbon Neutrality Pledges

Create a vibrant, clean energy economy that benefits <u>all</u> Americans.

- ✓ **100% clean energy electricity by 2035.**
- ✓ **Cut CO_2 emissions in half by 2030.**
- ✓ Support transition of fossil fuels workforce to renewable energy.
- ✓ Create millions of new clean energy jobs.
- ✓ Deliver 40% of the benefits of clean energy to disadvantaged communities.



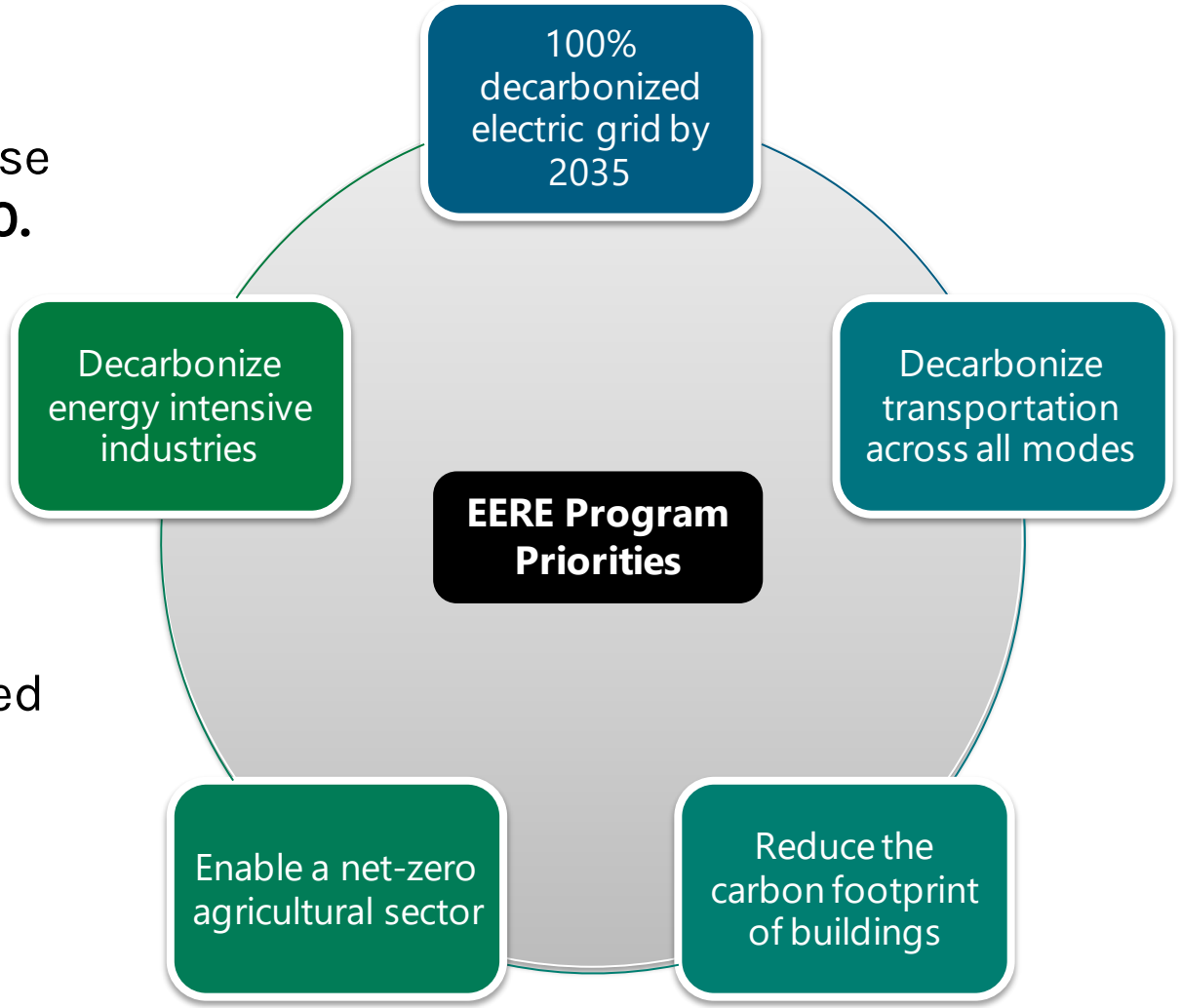
Renewed EERE Mission, Renewed Purpose

EERE Mission

Equitably transition America to net-zero greenhouse gas emissions economy-wide by **no later than 2050.**

Ensure the clean energy economy **benefits all Americans,** creating **good paying jobs** for the American people…

…especially workers and communities impacted by the energy transition and **those historically underserved** by the energy system and overburdened by pollution.



Keys to Ensure the Greatest Impact

Environmental Justice & Equity | **Diversity in STEM** | **Workforce Development** | **State & Local Partnerships**

GTO Mission & Program Areas

GTO's Strategic Goals:

- Drive toward a clean, carbon-free electricity grid by supplying ***8.5% of total U.S. generation through 60 GW of EGS and hydrothermal resource deployment.***
- Decarbonize building heating and cooling loads by capturing the economic potential ***for 17,500 geothermal district heating (GDH) installations and by installing geothermal heat pumps (GHPs) in 28 million households*** nationwide.
- Deliver **economic, environmental, and social justice advancements** through increased geothermal technology deployment.

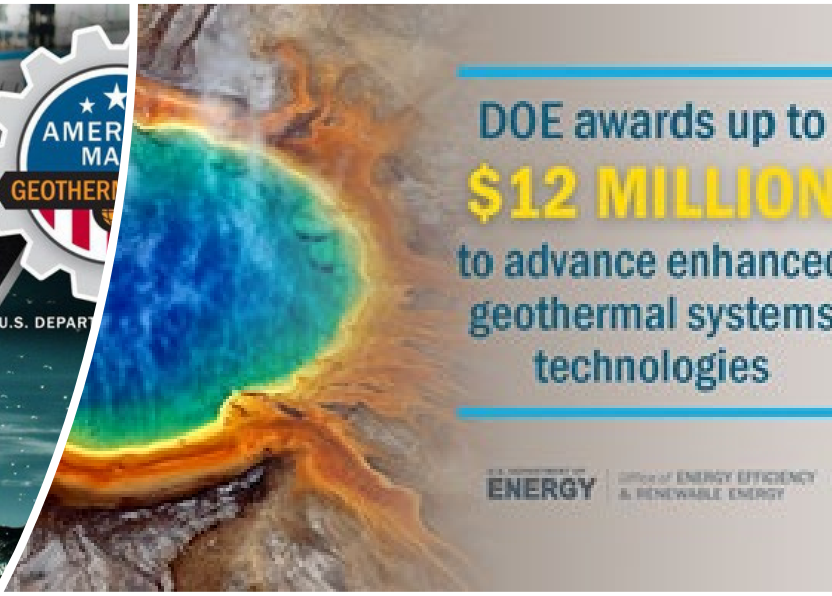
Geothermal Technologies Office Mission

Increase geothermal energy deployment through research and development in innovative technologies that enhance exploration and production

Enhanced Geothermal Systems (EGS)	Obtain understanding of basic and applied science challenges surrounding long-term subsurface heat flow, permeability enhancement, and stress evolution to support the development of replicable, sustainable heat exchangers.
Hydrothermal Resources	Support improvement of geothermal exploration, subsurface characterization, and drilling to reduce overall geothermal deployment costs.
Low Temperature and Coproduced Resources	Conduct RD&D on technologies for geothermal resources below 300°F (150°C) as well as valuable critical materials extraction from geothermal brines and hybrid energy technologies that use geothermal in combination with other clean energy technologies..
Data, Modeling, and Analysis	Work to identify and address barriers to geothermal adoption in the United States and validates and assesses technical progress across the geothermal sector.

Status of Ongoing Initiatives

- **GEOFLIGHT,** a joint effort with the U.S. Geological Survey (USGS), kicked off in the fall of 2021
- **2021 Geothermal Market Report** Released by National Renewable Energy Lab (NREL) + GTO
- **EGS Collab** 4100 level experimental test bed designed, constructed and completed
- **Lithium Extraction from Geothermal Brines Prize Phase 1** winners were announced at in November 2021
- **Geothermal Manufacturing Prize Make! Phase** Winners announced in January 2022
- Apply to the **Geothermal Collegiate Competition** are open through Feb. 17.
  Apply on the competition website.



Status of Ongoing Initiatives: FY 2021 EGS FOAs

Innovative Methods To Control Hydraulic Properties Of Enhanced Geothermal Systems

Applications Due: June 14, 2021
Selections Announced: September 22, 2021

CORNELL UNIVERSITY
Temperature-responsive Swelling Particles for Elimination of Cooled Short Circuits in a Discrete Fracture

LAWRENCE BERKELEY NATIONAL LABORATORY
Reversible Reservoir Permeability Modification Via In-situ Formation of Silicate Gel Plugs from Micro/Nano-Encapsulated Reactant Fluids

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY
Innovative Particle Gels for Controlling Preferential Fluid Flow Within Geothermal Reservoirs to Enhance Heat Recovery

MONTANA STATE UNIVERSITY
Thermally Induced Calcite Precipitation (TICP) as a Method to Control Hydraulic Properties in Enhanced Geothermal Systems

OKLAHOMA STATE UNIVERSITY
Development of Ionic Based Fluid to Improve Fluid Hydraulics in Enhanced Geothermal Systems

PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK
Temperature-sensitive Hydraulic Conductivity Controller Proppants for Enhanced Geothermal Systems

UNIVERSITY OF NEW MEXICO
Porous Polymer to Modify Fracture Permeability

Wells Of Opportunity (Woo): Amplify II & ReAmplify

Applications Due: August 16, 2021
Selections Announced: January 12, 2022

GEOTHERMIX, LLC
Thermoelectric Power Generation from Hot Oilfield Fluids: A Field Demonstration in the Austin Chalk in Texas

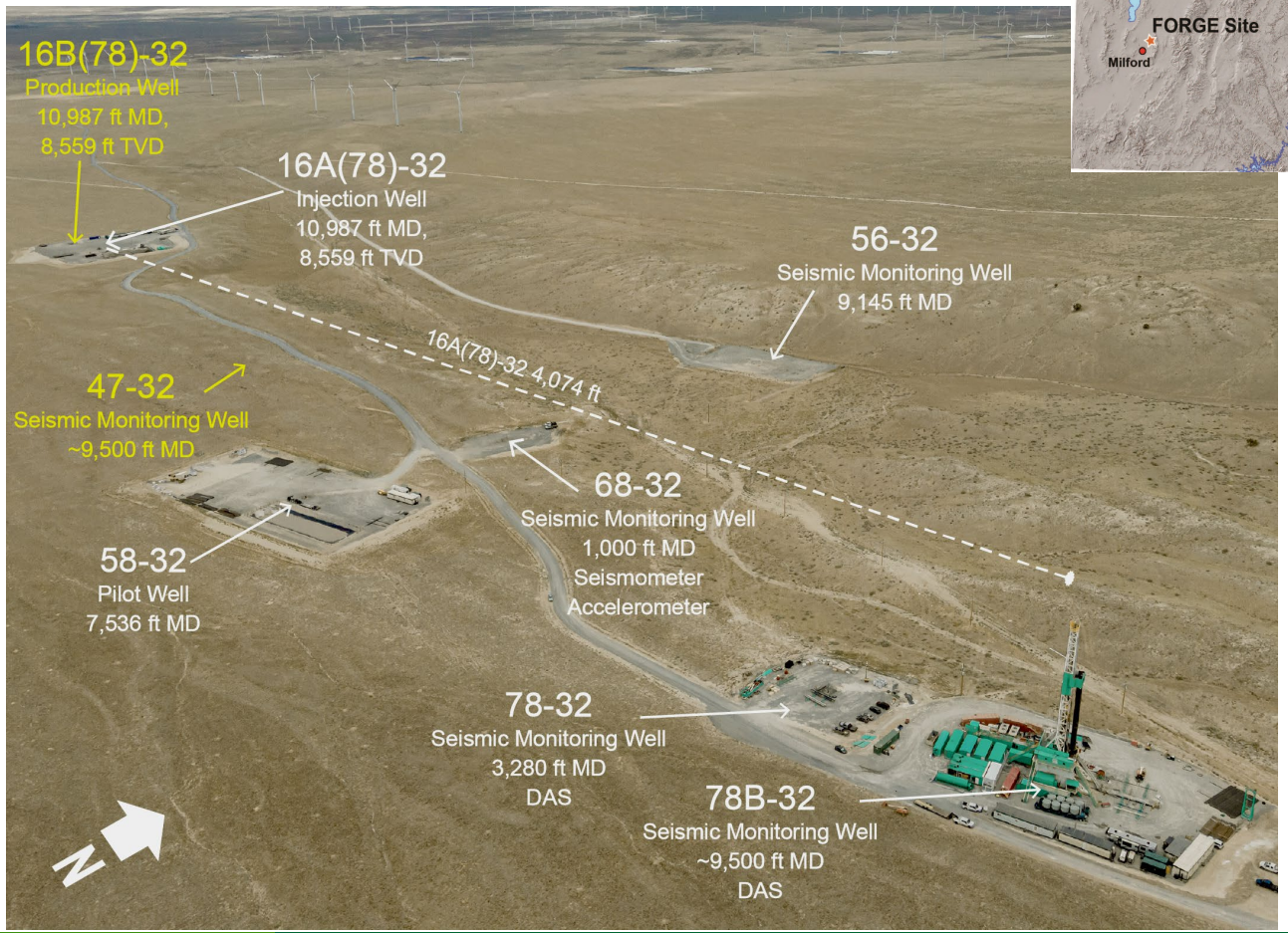
ICE THERMAL HARVESTING
Zero-emission Power Generation from Oil and Gas Production Streams

TRANSITIONAL ENERGY
Geothermal Coproduction at Blackburn Oil Field, Nevada

UNIVERSITY OF OKLAHOMA
Intelligent Repurposing of Hydrocarbon Wells System to Harness the Geothermal Potential of Oklahoma Sedimentary Basin

Status of Ongoing Initiatives: FORGE

The FORGE site in Milford, Utah is a field laboratory for testing ideas and methods to make enhanced geothermal system (EGS) a commercial reality.



FORGE PRINCIPLES

- Gain fundamental understanding of the **key mechanisms controlling Enhanced Geothermal System (EGS) success**.
- **Develop**, **test**, and **improve** new technologies and techniques in an ideal EGS environment.
- Make integrated **comparison of technologies and tools** in a controlled environment.
- Rapidly **disseminate technical data and communicate** to the research community, developers, and other interested parties

Photo by U of U

Status of Ongoing Initiatives: FORGE – cont.

ZONAL ISOLATION

WELLTEC	Development of a Smart Completion & Stimulation Solution
Petroquip Energy Services, LLC	Zonal Isolation Solution for Geothermal Wells
Colorado School of Mines	Development of Multi-Stage Fracturing System and Wellbore Tractor to Enable Zonal Isolation During Stimulation and EGS Operations in Horizontal Wellbores

STRESS PARAMETERS

Battelle Memorial Institute	Battelle - FORGE Topic 2
Lawrence Livermore National Laboratory	Closing the Loop Between In-Situ Stress Complexity and EGS Fracture Complexity
The University of Oklahoma	Application of Advanced Techniques for Determination of Reservoir-Scale Stress State at FORGE

FIELD SCALE CHARACTERIZATION

Clemson University	A Strain Sensing Array to Characterize Deformation at the FORGE Site
Stanford University	Wellbore Fracture Imaging Using Inflow Detection Measurements
Lawrence Berkeley National Laboratory	Joint Electromagnetic/Seismic/InSAR Imaging of Spatial-Temporal Fracture Growth and Estimation of Physical Fracture Properties During EGS Resource Development
Rice University	Fiber-Optic Geophysical Monitoring of Reservoir Evolution at the FORGE Milford Site

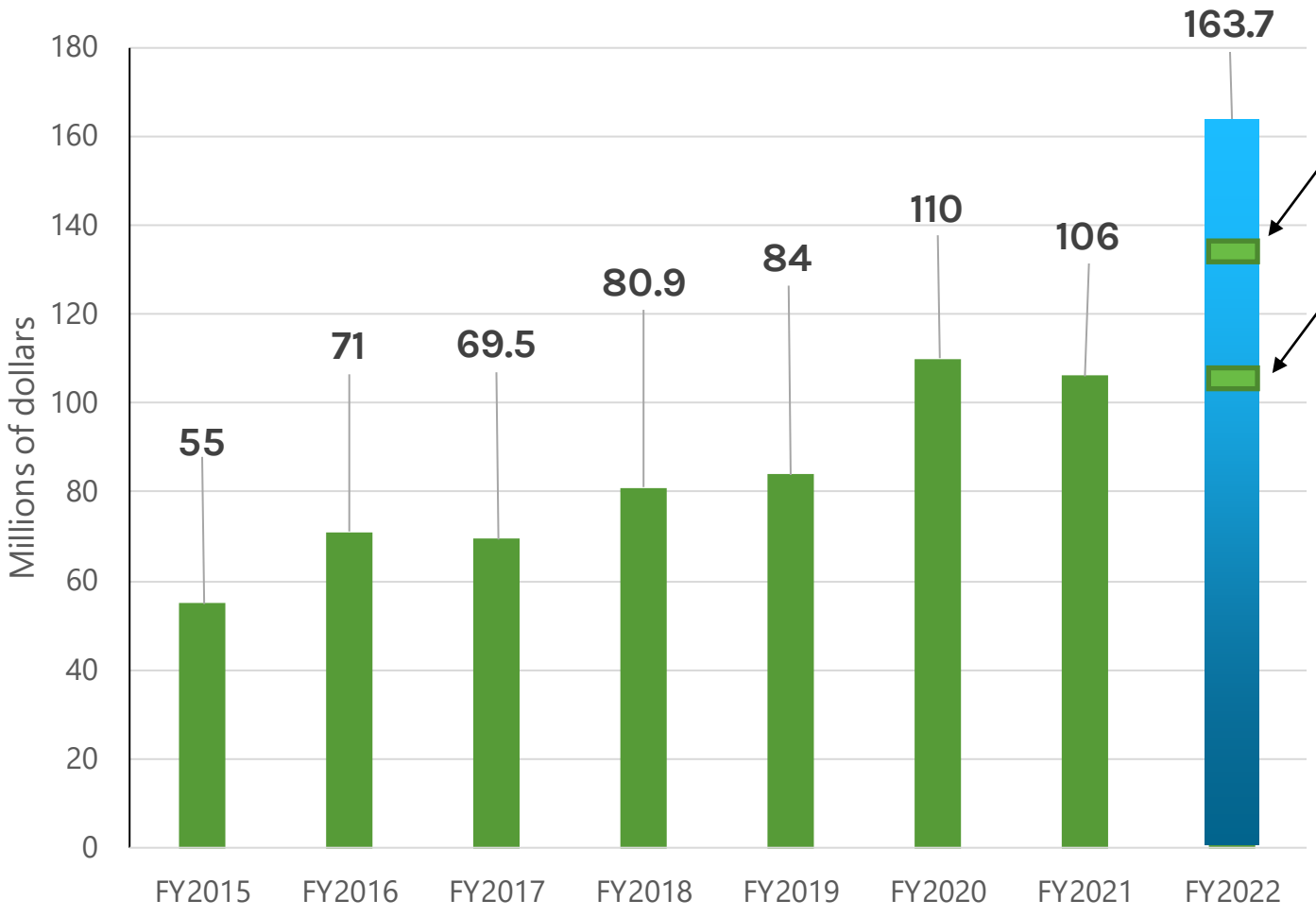
WELL STIMULATION

Fervo Energy Company	Optimization and validation of a plug-and perf stimulation treatment design at FORGE
The University of Texas at Austin	Design and Implementation of Innovative Stimulation Treatments to Maximize Energy Recovery Efficiency at the Utah Forge Site

LABORATORY AND MODELING STUDIES

Pennsylvania State University	Seismicity-Permeability Relationships Probed Via Nonlinear Acoustic Imaging
Lawrence Livermore National Laboratory	Coupled Investigation of Fracture Permeability Impact on Reservoir Stress and Seismic Slip Behavior
U.S. Geological Survey	Evolution of Permeability and Strength Recovery of Shear Fractures under Hydrothermal Conditions
The University of Oklahoma	Experimental Determination, and Modeling-Informed Analysis of Thermo-Poromechanical Response of Fractured Rock for Application to FORGE
Purdue University	Role of Fluid and Temperature in Fracture Mechanics and Coupled THMC Processes for Enhanced Geothermal Systems

GTO Budget in FY 2022



GTO's FY 2022 Budget Request:

- Exceeds previous appropriations.
  - Up 54% from FY 2021 and nearly tripled from FY 2015
- Focus on driving down the cost of geothermal and ensure that it's integrated into a resilient power system.
- Follows on years of growth that will help geothermal reach its potential.

GTO Budget in FY 2022: Status

- **FY 2022 budget cycle** – Continuing Resolution
- **Infrastructure Investment and Jobs Act** or Bipartisan Infrastructure Law Passed!
  - SEC. 41007. Enhanced Geothermal Systems Demonstrations

Union Calendar No. 49

117TH CONGRESS
1ST SESSION

H. R. 3684

[Report No. 117–70]

To authorize funds for Federal-aid highways, highway safety programs, and transit programs, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

JUNE 4, 2021

Mr. DEFAZIO (for himself, Ms. NORTON, and Mr. PAYNE) introduced the following bill; which was referred to the Committee on Transportation and Infrastructure

JUNE 22, 2021

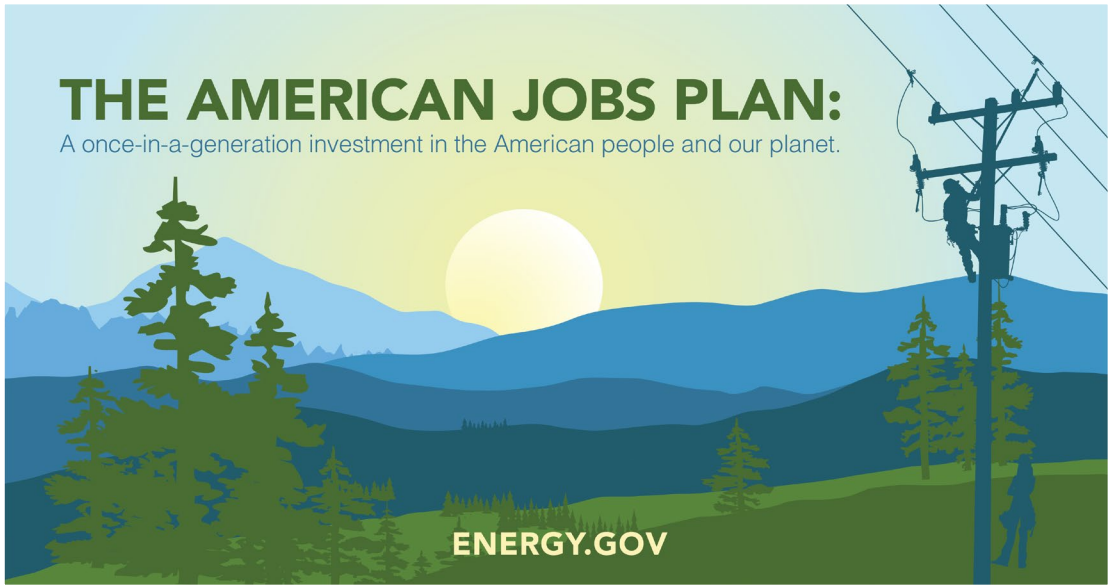
Additional sponsors: Mr. GARAMENDI, Ms. WILSON of Florida, and Ms. WILLIAMS of Georgia

JUNE 22, 2021

Reported with an amendment, committed to the Committee of the Whole House on the State of the Union, and ordered to be printed

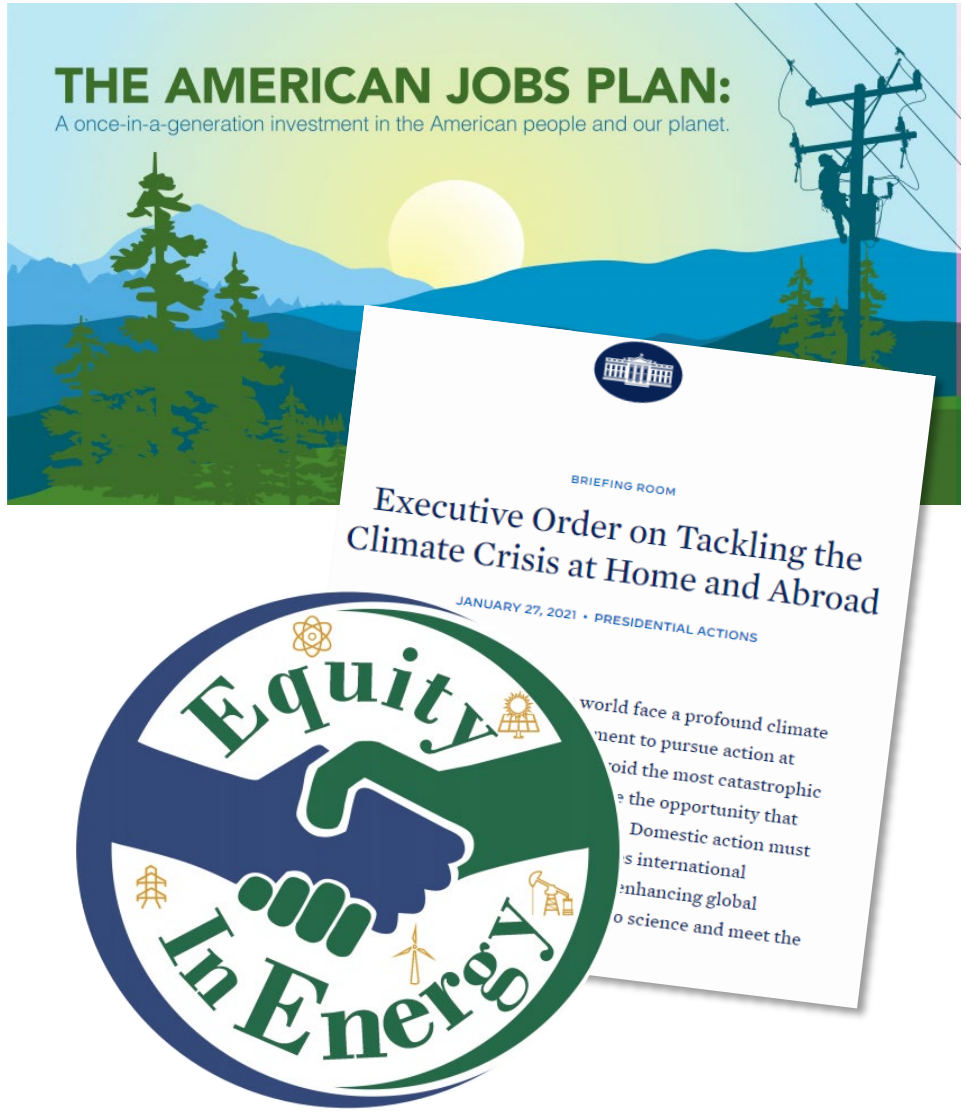
[Strike out all after the enacting clause and insert the part printed in italic]

[For text of introduced bill, see copy of bill as introduced on June 4, 2021]



FY 2022 GTO Emphases

- **Renew the focus** on demonstration and deployment along with continued support of research and development.
- **Tackle the climate crisis head on -** work to achieve the Administration's goals of a carbon free grid by 2035 and a 100% clean energy economy by 2050.
  - Geothermal offers near-term renewable electricity deployment for 2035 goal.
  - Geothermal offers grid efficiency through geothermal heating and cooling, mapping to 2050 goal.
- **Incorporate tenets** of DEI, EJ, workforce development, diversity in STEM, just transitions for disadvantaged communities.
  - DEI merit review criteria, observers
  - New projects dedicated to deployment, modeling, utility outreach, Alaska outreach



FY 2022 Request Initiatives

Drilling Technology Demonstration Campaign ($20M)

This initiative targets technology developments that will provide significant improvements in drilling performance in commercial geothermal settings.

Letters of intent: 4/4/22

Frontier Observatory in Research in Geothermal Energy (FORGE) ($20M)

Utah FORGE drilled the first-ever highly deviated geothermal well at a rate twice the industry standard. In FY 2022, GTO will support the next R&D solicitation, contributing to meeting Administration goals for a carbon-free electric grid.

Geothermal Energy from Oil and gas Demonstrated Engineering (GEODE) ($10M)

This is a new consortium designed to leverage the oil & gas subsurface industry to help solve geothermal energy's toughest challenges.

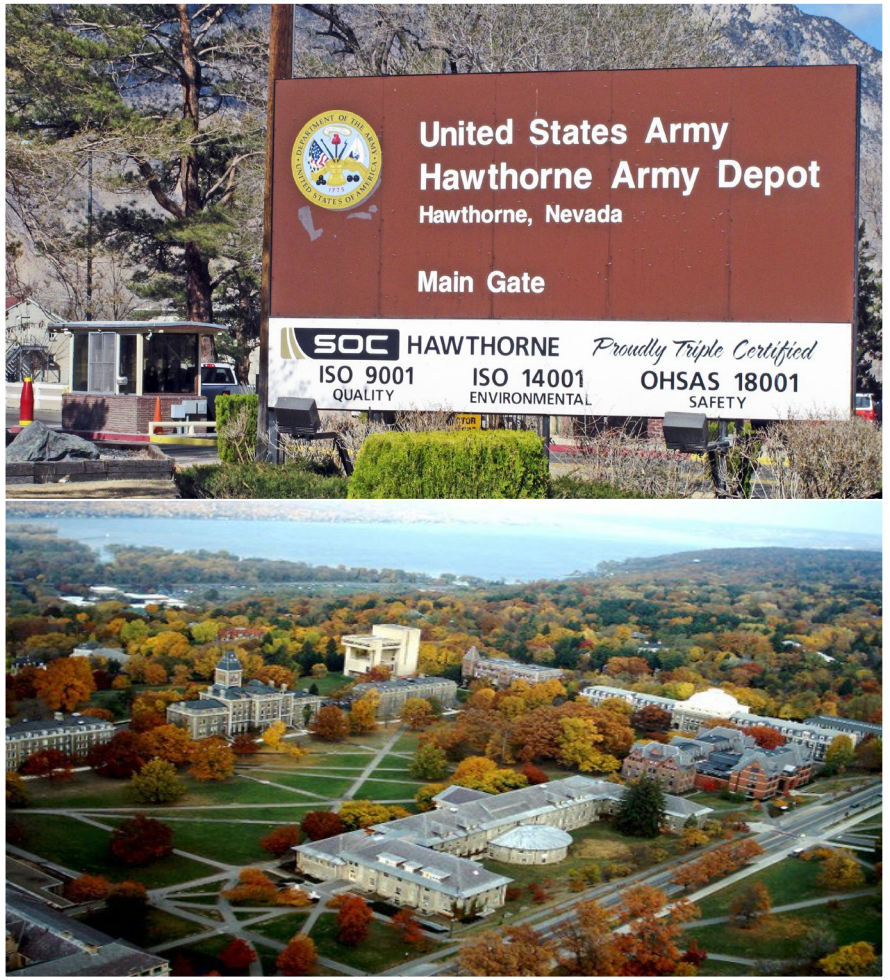
Shown here is a drilling rig at the FORGE site outside of Milford, Utah. RD&D at FORGE continues through 2024 and will drive technological advances in enhanced geothermal systems. Photo: Eric Larson / FORGE Utah

FY 2022 Request Initiatives – cont.

Community Geothermal Heating & Cooling Technical Assistance & Deployment ($15M)
This initiative funds technical assistance to demonstrate, deploy, and implement community-scale direct use geothermal district energy systems through installation of geothermal heat pumps (GHP) and/or direct use of geothermal fluids.

Federal Partnerships for Geothermal Installations ($5.4M)
GTO and FEMP will make it possible for Federal agencies (DOD, GSA, State, NASA, DOE Labs, Park Service) to consider geothermal energy to heat/cool (and in some limited cases, potentially power) their installations.

Next Generation Connected Communities ($5M)
GTO will collaborate with the Building Technologies Office to demonstrate the market viability of highly energy-efficient, demand-flexible, low-carbon buildings integrated with distributed energy resources (DERs) to cost-effectively contribute to America's transition to a zero-carbon grid.



Military installations and university campuses are among the variety of locations that can benefit from direct use geothermal. Shown here are the Hawthorne Army Depot in Nevada and Cornell University in New York.

Upcoming GTO Meetings

February 24, 2022, 2:30PM-3:30PM EST

Geothermal Technologies Office Quarterly Webinar

- Register at https://www.energy.gov/eere/geothermal/events/geothermal-technologies-office-quarterly-webinar

May 2022 (5/10, 5/12, 5/16, 5/18, 5/24, and 5/26)

Geothermal Technologies Office Peer Review

- GTO will conduct a VIRTUAL review meeting via half-day sessions throughout the month of May.


...and with your help we can usher in a new world of
geothermal opportunities.

Thank You!

The Drill Down

Get the hottest geothermal news from *The Drill Down,* the new monthly newsletter from GTO!

Sign up today:
geothermal.energy.gov

Interested in serving as a merit reviewer for GTO RD&D projects?

Send us your resume or CV:
doe.geothermal@ee.doe.gov