

ADVANCED GEOTHERMAL RESEARCH AND
 DEVELOPMENT ACT OF 2019

SEPTEMBER 11, 2020.—Committed to the Committee of the Whole House on the
 State of the Union and ordered to be printed

Ms. JOHNSON of Texas, from the Committee on Science, Space, and
 Technology, submitted the following

R E P O R T

[To accompany H.R. 5374]

[Including cost estimate of the Congressional Budget Office]

The Committee on Science, Space, and Technology, to whom was
 referred the bill (H.R. 5374) to establish and support advanced geo-
 thermal research and development programs at the Department of
 Energy, and for other purposes, having considered the same, re-
 ports favorably thereon with an amendment and recommends that
 the bill as amended do pass.

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I. AMENDMENT

The amendment is as follows:

Strike all after the enacting clause and insert the following:

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the “Advanced Geothermal Research and Development Act of 2019”.

(b) TABLE OF CONTENTS.—The table of contents for this Act is as follows:

Sec. 1. Short title; table of contents.
Sec. 2. Definitions.
Sec. 3. Hydrothermal research and development.
Sec. 4. General geothermal systems research and development.
Sec. 5. Enhanced geothermal systems research and development.
Sec. 6. Geothermal heat pumps and direct use.
Sec. 7. Cost sharing and proposal evaluation.
Sec. 8. Advanced geothermal computing and data science research and development.
Sec. 9. Geothermal workforce development.
Sec. 10. Organization and administration of programs.
Sec. 11. Repeals.
Sec. 12. Authorization of appropriations.
Sec. 13. International geothermal energy development.
Sec. 14. Reauthorization of High Cost Region Geothermal Energy Grant Program.

SEC. 2. DEFINITIONS.

Section 612 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17191) is amended—

(1) by amending paragraph (1) to read as follows:

“(1) ENGINEERED.—When referring to enhanced geothermal systems, the term ‘engineered’ means designed to access subsurface heat, including stimulation and nonstimulation technologies to address one or more of the following issues:

“(A) Lack of effective permeability, porosity or open fracture connectivity within the heat reservoir.

“(B) Insufficient contained geofluid in the heat reservoir.

“(C) A low average geothermal gradient which necessitates deeper drilling, or the use of alternative heat sources or heat generation processes.”;

(2) by redesignating paragraphs (2) through (7) as paragraphs (3) through (8), respectively; and

(3) by adding after paragraph (1) the following:

“(2) ELIGIBLE ENTITY.—The term ‘eligible entity’ means any of the following entities:

“(A) An institution of higher education.

“(B) A National laboratory.

“(C) A Federal research agency.

“(D) A State research agency.

“(E) A nonprofit research organization.

“(F) An industrial entity.

“(G) A consortium of 2 or more entities described in subparagraphs (A) through (F).”.

SEC. 3. HYDROTHERMAL RESEARCH AND DEVELOPMENT.

Section 613 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17192) is amended to read as follows:

“SEC. 613. HYDROTHERMAL RESEARCH AND DEVELOPMENT.

“(a) IN GENERAL.—The Secretary shall carry out a program of research, development, demonstration, and commercial application for geothermal energy production from hydrothermal systems.

“(b) PROGRAMS.—The program authorized in subsection (a) shall include the following:

“(1) ADVANCED HYDROTHERMAL RESOURCE TOOLS.—The research and development of advanced geologic tools to assist in locating hydrothermal resources, and to increase the reliability of site characterization, including the development of new imaging and sensing technologies and techniques to assist in prioritization of targets for characterization;

“(2) EXPLORATORY DRILLING FOR GEOTHERMAL RESOURCES.—The demonstration of advanced technologies and techniques of siting and exploratory drilling for undiscovered resources in a variety of geologic settings, carried out in collaboration with industry partners that will assist in the acquisition of high

quality data sets relevant for hydrothermal subsurface characterization activities”.

SEC. 4. GENERAL GEOTHERMAL SYSTEMS RESEARCH AND DEVELOPMENT.

Section 614 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17193) is amended to read as follows:

“SEC. 614. GENERAL GEOTHERMAL SYSTEMS RESEARCH AND DEVELOPMENT.

“(a) **SUBSURFACE COMPONENTS AND SYSTEMS.**—The Secretary shall support a program of research, development, demonstration, and commercial application of components and systems capable of withstanding geothermal environments and necessary to develop, produce, and monitor geothermal reservoirs and produce geothermal energy.

“(b) **ENVIRONMENTAL IMPACTS.**—The Secretary shall—

“(1) support a program of research, development, demonstration, and commercial application of technologies and practices designed to mitigate or preclude potential adverse environmental impacts of geothermal energy development, production or use; and

“(2) support a research program to identify potential environmental impacts, including induced seismicity, and environmental benefits of geothermal energy development, production, and use, and ensure that the program described in paragraph (1) addresses such impacts, including water use and effects on groundwater and local hydrology;

“(3) support a program of research to compare the potential environmental impacts and environmental benefits identified as part of the development, production, and use of geothermal energy with the potential emission reductions of greenhouse gases gained by geothermal energy development, production, and use; and

“(4) in carrying out this section, the Secretary shall, to the maximum extent practicable, consult with relevant federal agencies, including the Environmental Protection Agency.

“(c) **RESERVOIR THERMAL ENERGY STORAGE.**—The Secretary shall support a program of research, development, and demonstration of reservoir thermal energy storage, emphasizing cost-effective improvements through deep direct use engineering, design, and systems research.

“(d) **OIL AND GAS TECHNOLOGY TRANSFER INITIATIVE.**—

“(1) **IN GENERAL.**—The Secretary shall support an initiative among the Office of Fossil Energy, the Office of Energy Efficiency and Renewable Energy, and the private sector to research, develop, and demonstrate relevant advanced technologies and operation techniques used in the oil and gas sector for use in geothermal energy development.

“(2) **PRIORITIES.**—In carrying out paragraph (1), the Secretary shall prioritize technologies with the greatest potential to significantly increase the use and lower the cost of geothermal energy in the United States, including the cost and speed of geothermal drilling surface technologies, and well construction.

“(e) **COPRODUCTION OF GEOTHERMAL ENERGY AND MINERALS PRODUCTION RESEARCH AND DEVELOPMENT INITIATIVE.**—

“(1) **IN GENERAL.**—The Secretary shall carry out a research and development initiative under which the Secretary shall award grants to demonstrate the coproduction of critical minerals from geothermal resources.

“(2) **REQUIREMENTS.**—An award made under paragraph (1) shall—

“(A) improve the cost effectiveness of removing minerals from geothermal brines as part of the coproduction process;

“(B) increase recovery rates of the targeted mineral commodity;

“(C) decrease water use and other environmental impacts, as determined by the Secretary; and

“(D) demonstrate a path to commercial viability.

“(f) **FLEXIBLE OPERATIONS.**—The Secretary shall support a research initiative on flexible operation of geothermal power plants.

“(g) **HYBRID ENERGY SYSTEMS.**—The Secretary shall identify opportunities for joint research, development, and demonstration programs between geothermal systems and other energy generation or storage systems.”.

SEC. 5. ENHANCED GEOTHERMAL SYSTEMS RESEARCH AND DEVELOPMENT.

Section 615 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17194) is amended to read as follows:

“SEC. 615. ENHANCED GEOTHERMAL SYSTEMS RESEARCH AND DEVELOPMENT.

“(a) **IN GENERAL.**—The Secretary shall support a program of research, development, demonstration, and commercial application for enhanced geothermal systems, including the programs described in subsection (b).

“(b) ENHANCED GEOTHERMAL SYSTEMS TECHNOLOGIES.—In collaboration with industry partners, institutions of higher education, and the national laboratories, the Secretary shall support a program of research, development, demonstration, and commercial application of the technologies to achieve higher efficiency and lower cost enhanced geothermal systems, including—

- “(1) reservoir stimulation;
- “(2) drilled, non-stimulated (e.g. closed-loop) reservoir technologies;
- “(3) reservoir characterization, monitoring, and modeling and understanding of the surface area and volume of fractures;
- “(4) stress and fracture mapping including real time monitoring and modeling;
- “(5) tracer development;
- “(6) three and four-dimensional seismic imaging and tomography;
- “(7) well placement and orientation;
- “(8) long-term reservoir management;
- “(9) drilling technologies, methods, and tools;
- “(10) improved exploration tools;
- “(11) zonal isolation; and
- “(12) understanding induced seismicity risks from reservoir engineering and stimulation.

“(c) FRONTIER OBSERVATORY FOR RESEARCH IN GEOTHERMAL ENERGY.—The Secretary shall support the establishment and construction of up to 3 field research sites, which shall each be known as a ‘Frontier Observatory for Research in Geothermal Energy’ or ‘FORGE’ site to develop, test, and enhance techniques and tools for enhanced geothermal energy.

“(1) DUTIES.—The Secretary shall—

- “(A) award grants in support of research and development projects focused on advanced monitoring technologies, new technologies and approaches for implementing multi-zone stimulations, nonstimulation techniques, and dynamic reservoir modeling that incorporates all available high-fidelity characterization data; and
- “(B) seek opportunities to coordinate efforts and share information with domestic and international partners engaged in research and development of geothermal systems and related technology, including coordination between FORGE sites.

“(2) SITE SELECTION.—Of the FORGE sites referred to in paragraph (1), the Secretary shall—

- “(A) consider applications through a competitive, merit-reviewed process, from National Laboratories, multi-institutional collaborations, institutes of higher education and other appropriate entities best suited to provide national leadership on geothermal related issues and perform the duties enumerated under this subsection; and
- “(B) prioritize existing field sites and facilities with capabilities relevant to the duties enumerated under this subsection.

“(3) EXISTING FORGE SITES.—A FORGE site already in existence on the date of enactment of this Act may continue to receive support.

“(4) FUNDING.—Out of funds authorized to be appropriated under section 12 of the ‘Advanced Geothermal Research and Development Act of 2019’, there shall be made available to the Secretary to carry out the FORGE activities under this paragraph—

- “(A) \$45,000,000 for fiscal year 2021;
- “(B) \$55,000,000 for fiscal year 2022;
- “(C) \$65,000,000 for fiscal year 2023;
- “(D) \$70,000,000 for fiscal year 2024; and
- “(E) \$70,000,000 for fiscal year 2025.

In carrying out this section, the Secretary shall consider the balance between funds dedicated to construction and operations and research activities to reflect the state of site development.

“(d) ENHANCED GEOTHERMAL SYSTEMS DEMONSTRATIONS.—

“(1) IN GENERAL.—Beginning on the date of enactment of the ‘Advanced Geothermal Research and Development Act of 2019’, the Secretary, in collaboration with industry partners, institutions of higher education, and the national laboratories, shall support an initiative for demonstration of enhanced geothermal systems for power production or direct use.

“(2) PROJECTS.—

- “(A) IN GENERAL.—Under the initiative described in paragraph (1), demonstration projects shall be carried out in locations that are commercially viable for enhanced geothermal systems development, while also consid-

ering environmental impacts to the maximum extent practicable, as determined by the Secretary.

“(B) REQUIREMENTS.—Demonstration projects under subparagraph (A) shall—

“(i) collectively demonstrate—

“(I) different geologic settings, such as hot sedimentary aquifers, layered geologic systems, supercritical systems, and basement rock systems; and

“(II) a variety of development techniques, including open hole and cased hole completions, differing well orientations, and stimulation and nonstimulation mechanisms; and

“(ii) to the extent practicable, use existing sites where subsurface characterization or geothermal energy integration analysis has been conducted.

“(C) EASTERN DEMONSTRATION.—Not fewer than 1 of the demonstration projects carried out under subparagraph (A) shall be located an area east of the Mississippi that is suitable for enhanced geothermal demonstration for power, heat, or a combination of power and heat.”.

SEC. 6. GEOTHERMAL HEAT PUMPS AND DIRECT USE.

(a) IN GENERAL.—Title VI of the Energy Independence and Security Act of 2007 is amended by inserting after section 616 (42 U.S.C. 17195) the following:

“SEC. 616A. GEOTHERMAL HEAT PUMPS AND DIRECT USE RESEARCH AND DEVELOPMENT.

“(a) PURPOSES.—The purposes of this section are—

“(1) to improve the understanding of related earth sciences, components, processes, and systems used for geothermal heat pumps and the direct use of geothermal energy; and

“(2) to increase the energy efficiency, lower the cost, increase the use, and improve and demonstrate the effectiveness of geothermal heat pumps and the direct use of geothermal energy.

“(b) DEFINITIONS.—In this section:

“(1) DIRECT USE OF GEOTHERMAL ENERGY.—The term ‘direct use of geothermal energy’ means geothermal systems that use water directly or through a heat exchanger to provide—

“(A) heating and cooling to buildings, commercial districts, residential communities, and large municipal, or industrial projects; or

“(B) heat required for industrial processes, agriculture, aquaculture, and other facilities.

“(2) ECONOMICALLY DISTRESSED AREA.—The term ‘economically distressed area’ means an area described in section 301(a) of the Public Works and Economic Development Act of 1965 (42 U.S.C. 3161(a)).

“(3) GEOTHERMAL HEAT PUMP.—The term ‘geothermal heat pump’ means a system that provides heating and cooling by exchanging heat from shallow geology, groundwater, or surface water using—

“(A) a closed loop system, which transfers heat by way of buried or immersed pipes that contain a mix of water and working fluid; or

“(B) an open loop system, which circulates ground or surface water directly into the building and returns the water to the same aquifer or surface water source.

“(c) PROGRAM.—

“(1) IN GENERAL.—The Secretary shall support within the Geothermal Technologies Office a program of research, development, and demonstration for geothermal heat pumps and the direct use of geothermal energy.

“(2) AREAS.—The program under paragraph (1) may include research, development, demonstration, and commercial application of—

“(A) geothermal ground loop efficiency improvements, cost reductions, and improved installation and operations methods;

“(B) the use of geothermal energy for building-scale energy storage;

“(C) the use of geothermal energy as a grid management resource or seasonal energy storage;

“(D) geothermal heat pump efficiency improvements;

“(E) the use of alternative fluids as a heat exchange medium, such as hot water found in mines and mine shafts, graywater, or other fluids that may improve the economics of geothermal heat pumps;

“(F) heating of districts, neighborhoods, communities, large commercial or public buildings, and industrial and manufacturing facilities;

“(G) the use of low temperature groundwater for direct use; and

“(H) system integration of direct use with geothermal electricity production.

“(3) ENVIRONMENTAL IMPACTS.—In carrying out the program, the Secretary shall identify and mitigate potential environmental impacts in accordance with section 614(c).

“(d) GRANTS.—

“(1) IN GENERAL.—The Secretary shall carry out the program established in subsection (c) by making grants available to State, local, and Tribal governments, institutions of higher education, nonprofit entities, National Laboratories, utilities, and for-profit companies.

“(2) PRIORITY.—In making grants under this subsection, the Secretary may give priority to proposals that apply to large buildings, commercial districts, and residential communities that are located in economically distressed areas and areas that the Secretary determines to have high economic potential for geothermal district heating based on the report, ‘Geovision: Harnessing the Heat Beneath our Feet’ published by the Department in 2019, or a successor report.”.

(b) CONFORMING AMENDMENT.—Section 1(b) of the Energy Independence and Security Act of 2007 (42 U.S.C. 17001 note) is amended in the table of contents by inserting after the item relating to section 616 the following:

“616A. Geothermal heat pumps and direct use research and development.”.

SEC. 7. COST SHARING AND PROPOSAL EVALUATION.

Section 617(b) of the Energy Independence and Security Act of 2007 (42 U.S.C. 17196) is amended by striking paragraph (2) and redesignating paragraphs (3) and (4) as paragraphs (2) and (3), respectively.

SEC. 8. ADVANCED GEOTHERMAL COMPUTING AND DATA SCIENCE RESEARCH AND DEVELOPMENT.

(a) IN GENERAL.—Section 618 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17197) is amended to read as follows:

“SEC. 618. ADVANCED GEOTHERMAL COMPUTING AND DATA SCIENCE RESEARCH AND DEVELOPMENT.

“(a) IN GENERAL.—The Secretary shall carry out a program of research and development of advanced computing and data science tools for geothermal energy.

“(b) PROGRAMS.—The program authorized in subsection (a) shall include the following:

“(1) ADVANCED COMPUTING FOR GEOTHERMAL SYSTEMS TECHNOLOGIES.—Research, development, and demonstration of technologies to develop advanced data, machine learning, artificial intelligence, and related computing tools to assist in locating geothermal resources, to increase the reliability of site characterization, to increase the rate and efficiency of drilling, to improve induced seismicity mitigation, and to support enhanced geothermal systems technologies.

“(2) GEOTHERMAL SYSTEMS RESERVOIR MODELING.—Research, development, and demonstration of models of geothermal reservoir performance and enhanced geothermal systems reservoir stimulation technologies and techniques, with an emphasis on accurately modeling fluid and heat flow, permeability evolution, geomechanics, geochemistry, seismicity, and operational performance over time, including collaboration with industry and field validation.

“(c) COORDINATION.—In carrying out these programs, the Secretary shall ensure coordination and consultation with the Department of Energy’s Office of Science. The Secretary shall ensure, to the maximum extent practicable, coordination of these activities with the Department of Energy National Laboratories, institutes of higher education, and the private sector.”.

(b) CONFORMING AMENDMENT.—Section 1(b) of the Energy Independence and Security Act of 2007 (42 U.S.C. 17001 note) is amended in the table of contents by amending the item related to section 618 to read as follows:

“Sec. 618. Advanced geothermal computing and data science research and development.”.

SEC. 9. GEOTHERMAL WORKFORCE DEVELOPMENT.

(a) IN GENERAL.—Section 619 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17198) is amended to read as follows:

“SEC. 619. GEOTHERMAL WORKFORCE DEVELOPMENT.

“The Secretary shall support the development of a geothermal energy workforce through a program that—

“(1) facilitates collaboration between university students and researchers at the national laboratories; and

“(2) prioritizes science in areas relevant to the mission of the Department through the application of geothermal energy tools and technologies.”.

(b) CONFORMING AMENDMENT.—Section 1(b) of the Energy Independence and Security Act of 2007 (42 U.S.C. 17001 note) is amended in the table of contents by amending the item related to section 619 to read as follows:

“Sec. 619. Geothermal workforce development.”.

SEC. 10. ORGANIZATION AND ADMINISTRATION OF PROGRAMS.

Section 621 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17200) is amended to read as follows:

“SEC. 621. ORGANIZATION AND ADMINISTRATION OF PROGRAMS.

“(a) EDUCATION AND OUTREACH.—In carrying out the activities described in this subtitle, the Secretary shall support education and outreach activities to disseminate information on geothermal energy technologies and the geothermal energy workforce, including activities at the Frontier Observatory for Research in Geothermal Energy site(s).

“(b) TECHNICAL ASSISTANCE.—In carrying out this subtitle, the Secretary shall also conduct technical assistance and analysis activities with eligible entities for the purpose of supporting the commercial application of advances in geothermal energy systems development and operations, which may include activities that support expanding access to advanced geothermal energy technologies for rural, Tribal, and low-income communities.

“(c) REPORT.—Every 5 years after the date of enactment of Advanced Geothermal Research and Development Act of 2019 , the Secretary shall report to the Committee on Science and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate on advanced concepts and technologies to maximize the geothermal resource potential of the United States.

“(d) PROGRESS REPORTS.—Not later than 1 year after the date of enactment of the ‘Advanced Geothermal Research and Development Act of 2019’, and every 2 years thereafter, the Secretary shall submit to the Committee on Science and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate a report on the results of projects undertaken under this part and other such information the Secretary considers appropriate.”.

SEC. 11. REPEALS.

(a) IN GENERAL.—Subtitle B of title VI of the Energy Independence and Security Act of 2007 (42 U.S.C. 17191 et seq.) is amended by striking section 620.

(b) CONFORMING AMENDMENT.—Section 1(b) of the Energy Independence and Security Act of 2007 (42 U.S.C. 17001 note) is amended in the table of contents by striking the item related to section 620.

SEC. 12. AUTHORIZATION OF APPROPRIATIONS.

Section 623 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17202) is amended to read as follows:

“SEC. 623. AUTHORIZATION OF APPROPRIATIONS.

“There are authorized to be appropriated to the Secretary to carry out the programs under the ‘Advanced Geothermal Research and Development Act of 2019’—

“(1) \$121,375,000 for fiscal year 2021;

“(2) \$132,750,000 for fiscal year 2022;

“(3) \$144,125,000 for fiscal year 2023;

“(4) \$150,500,000 for fiscal year 2024; and

“(5) \$151,875,000 for fiscal year 2025.”.

SEC. 13. INTERNATIONAL GEOTHERMAL ENERGY DEVELOPMENT.

Section 624 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17203) is amended—

(1) by amending subsection (a) to read as follows:

“(a) IN GENERAL.—The Secretary of Energy, in coordination with other appropriate Federal and multilateral agencies (including the United States Agency for International Development) shall support collaborative efforts with international partners to promote the research, development, and demonstration of geothermal technologies used to develop hydrothermal and enhanced geothermal system resources.”; and

(2) by striking subsection (c).

SEC. 14. REAUTHORIZATION OF HIGH COST REGION GEOTHERMAL ENERGY GRANT PROGRAM.

Section 625 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17204) is amended—

(1) in subsection (a)(2), by inserting “ or heat” after “electrical power”; and

(2) by amending subsection (e) to read as follows:

“(e) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized under section 12 of the ‘Advanced Geothermal Research and Development Act of 2019’, there is authorized to be appropriated to carry out this section \$5,000,000 for each of fiscal years 2021 through 2025.”.

II. PURPOSE OF THE BILL

The purpose of the Advanced Geothermal Research and Development Act of 2019 (H.R. 5374), sponsored by Mr. Lucas and cosponsored by Ms. Johnson, is to amend the Energy Independence and Security Act of 2007 to establish and support advanced geothermal research, development, demonstration, and commercial application programs at the Department of Energy (DOE).

III. BACKGROUND AND NEED FOR THE LEGISLATION

Geothermal energy is a clean, renewable, and abundant domestic energy source which can be used both for utility-scale electricity generation and to meet a range of residential heating and cooling demands. Geothermal energy is a low-emissions energy source, and its development typically has a relatively small environmental footprint. The United States has significant geothermal energy resources and leads the world in installed geothermal capacity. If harnessed correctly, these resources have the potential to provide reliable and secure power for Americans across the country.

According to DOE, improvements in geothermal technology could lead to a nearly 26-fold increase in U.S. geothermal electric power generation, reaching 60 gigawatts of installed capacity by 2050. The DOE Geothermal Technologies Office (GTO) supports research to develop new technologies and methods to advance geothermal energy production. Research supported by GTO focuses on developing technologies and tools to locate and access geothermal resources in the U.S., including research and development activities focused on hydrothermal resources, low temperature and coproduced resources, geothermal systems analysis, and enhanced geothermal systems.

According to the U.S. Geological Survey, undiscovered hydrothermal resources could contribute up to 30 gigawatts of installed capacity on the grid. GTO supports advanced exploration tools and technologies to accelerate the discovery of these resources. Once they are located and characterized, the potential electricity generated from these sources could be brought online quickly with existing technology. Similarly, GTO supports research and development into the growth of low-temperature geothermal energy production, which is most useful in direct-use applications, such as heating and cooling. This includes research into the utilization of hot geothermal fluid by-products from oil and gas drilling in these low-temperature applications. GTO’s geothermal systems analysis program focuses on understanding the potential environmental impact of geothermal technologies and enabling the development of data validation and analysis tools to support geothermal exploration and development.

One of GTO’s research priorities is in Enhanced Geothermal Systems (EGS), advanced technologies that can greatly increase the magnitude and feasibility of widespread geothermal energy production in the United States. Through the creation of man-made permeable pathways in naturally isolated, deep geothermal heat

sources, EGS technologies hold the potential to extract geothermal energy tens of thousands of feet below the surface nationwide. In 2014, GTO announced a funding opportunity for an initiative entitled the Frontier Observatory for Research in Geothermal Energy (FORGE). FORGE's mission is to enable first-of-a-kind collaborative demonstrations of EGS technologies and techniques that will reduce EGS commercialization risk for U.S. industry. In 2018, DOE selected its first FORGE site in Milford, Utah, which will demonstrate operational EGS technologies and test instrumentation and disseminate data through industry collaboration.

The Advanced Geothermal Research and Development Act of 2019 supports GTO's existing work and provides further guidance to ensure a robust U.S. research, development, demonstration, and commercial application program on geothermal energy.

IV. COMMITTEE HEARINGS

Pursuant to Section 103 (i) of H. Res. 6, the Committee designates the following hearings as having been used to develop or consider the legislation:

On November 14, 2019, the Honorable Connor Lamb presiding, the Energy Subcommittee of the Committee on Science, Space, and Technology held a hearing to examine research, development, demonstration, and commercial application needs in the geothermal energy and water power industries. Witnesses and Members discussed the need for developing advanced geothermal energy, including the specific technical areas to focus funding on and the need for demonstration projects.

WITNESSES

Dr. David Solan, Deputy Assistant Secretary for Renewable Power, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy;

Dr. Bryson Robertson, Co-Director, Pacific Marine Energy Center, Associate Professor, Civil and Construction Engineering, Oregon State University;

Dr. Joseph Moore, Manager, Utah Frontier Observatory for Research in Geothermal Energy (FORGE), Research Professor, University of Utah;

Ms. Maria Richards, Director, Geothermal Laboratory, Roy M. Huffington Department of Earth Sciences, Southern Methodist University;

Mr. Sander Cohan, Director, Innovation, Enel Green Power North America, Inc.

V. COMMITTEE CONSIDERATION AND VOTES

As summarized in Section IV of this report, the Energy Subcommittee heard testimony in the 116th Congress relevant to the activities authorized in H.R. 5374 at a hearing held on November 14, 2019.

On December 10, 2019, Ranking Member Frank Lucas of the Committee on Science, Space, and Technology, for himself and Chairwoman Eddie Bernice Johnson, introduced H.R. 5374, *the Advanced Geothermal Research and Development Act of 2019*, to es-

establish a program to conduct research, development, and demonstration on advanced geothermal technologies.

The Energy Subcommittee of the Committee on Science, Space, and Technology met to consider H.R. 5374 on December 19, 2019 and considered the following amendment to the bill:

Mr. Lipinski offered an amendment that would authorize a geothermal heat pump and direct use research and development program at DOE. The amendment was agreed to by a voice vote.

Mr. Lamb moved that the Committee favorably report the bill, H.R. 5374, as amended, to the Full Committee with the recommendation that the bill be approved. The motion was agreed to by a voice vote.

The Committee on Science, Space, and Technology met to consider H.R. 5374 on February 12, 2020 and considered the following amendments to the bill:

Mr. Tonko offered an amendment that would prioritize demonstration projects in areas that the Secretary determines to have high economic potential for district heating. The amendment was agreed to by a voice vote.

Mr. Lucas offered a Manager’s amendment that made clarifying and technical fixes throughout the bill. It also added research focus areas of flexible operations and hybrid energy systems, as well as education and outreach and technical assistance programs. Additionally, it updated authorization levels. The amendment was agreed to by a voice vote.

Mr. Lamb moved that the Committee favorably report the bill, H.R. 5374, as amended, to the Full House. The motion was agreed to by a voice vote.

VI. SUMMARY OF MAJOR PROVISIONS OF THE BILL

The Advanced Geothermal Research and Development Act of 2019 (H.R. 5374) would authorize a research, development, demonstration, and commercial application program at the Department of Energy for the development of advanced geothermal technologies. It includes research initiatives on oil and gas technology transfer to geothermal research, secondary use research areas such as minerals recovery and storage, and new areas of research in enhanced geothermal systems. It also authorizes a new area of advanced geothermal computing and data science research and development as well as a direct use and heat pump research area. Further, the Act authorizes the construction of up to three FORGE sites, in addition to authorizing an enhanced geothermal demonstration initiative.

VII. SECTION-BY-SECTION ANALYSIS (BY TITLE AND SECTION)

H.R. 5374—ADVANCED GEOTHERMAL RESEARCH AND DEVELOPMENT ACT OF 2019

Sec. 1 Short Title; Table of Contents

“Advanced Geothermal Research and Development Act of 2019”

Sec. 2 Definitions

Defines terms used throughout the bill.

Sec. 3. Hydrothermal Research and Development

Reauthorizes a research, development, demonstration, and commercial application program for geothermal energy production from hydrothermal systems as well as advanced technologies and techniques for exploratory drilling for undiscovered resources.

Sec. 4. General Geothermal Systems Research and Development

Reauthorizes a research, development, demonstration, and commercial application program for various geothermal systems, including subsurface components and systems, reservoir thermal energy storage, and environmental impacts of geothermal energy systems. This section also authorizes an oil and gas technology transfer initiative and a coproduction initiative between geothermal energy and minerals production.

Sec. 5. Enhanced Geothermal Systems Research and Development

Reauthorizes a research, development, demonstration, and commercial application program for enhanced geothermal systems research and development. It also authorizes the construction of up to three FORGE sites, including authorization of funding for these sites beginning at \$45 million for fiscal year 2020 and increasing to \$70 million by fiscal year 2025. Additionally, it supports an initiative for demonstration of enhanced geothermal systems technologies with projects taking into account a variety of development techniques and different geologic settings, including at least 1 demonstration carried out in an area east of the Mississippi River.

Sec. 6. Geothermal Heat Pumps and Direct Use

Authorizes a research, development, demonstration, and commercial application grant program for geothermal heat pumps and the direct use of geothermal energy, including consideration of environmental impacts of such technologies.

Sec. 7. Cost Sharing and Proposal Evaluation

Amends existing code related to cost sharing and proposal evaluation to reflect current practice.

Sec. 8. Advanced Geothermal Computing and Data Science Research and Development

Authorizes a research and development program of advanced computing and data science tools for geothermal energy. This program includes advanced computing for geothermal systems technologies and geothermal systems reservoir modeling. Additionally, this section directs the Secretary to coordinate with DOE Office of Science in carrying out the activities authorized in this program.

Sec. 9. Geothermal Workforce Development

Establishes a geothermal energy workforce development program that facilitates collaboration between universities and the national labs.

Sec. 10. Organization and Administration of Programs

Establishes an education and outreach program to disseminate information on geothermal energy technologies and the geothermal energy workforce. Establishes a technical assistance program for el-

eligible entities to support commercial application of geothermal energy systems. Establishes reporting requirements for activities described in the bill, which include a report to be completed every 5 years on the concepts and technologies to maximize geothermal potential in the U.S., and progress reports every two years on the results of projects undertaken under this bill.

Sec. 11. Repeals

Makes conforming amendments to the existing code pursuant to the bill content.

Sec. 12. Authorization of Appropriations

Authorizes five years of funding for the activities and programs described in the bill, which begins at \$121.375 million for fiscal year 2021 and increases to \$151.875 million for fiscal year 2025, including funding for FORGE sites and a high cost region geothermal energy grant program.

Sec. 13. International Geothermal Energy Development

Reauthorizes an international collaborative effort to promote research, development, and demonstration of geothermal technologies.

Sec. 14. Reauthorization of High Cost Region Geothermal Energy Grant Program

Reauthorizes a high cost region geothermal energy grant program, including authorization of funding for this program.

VIII. COMMITTEE VIEWS

The Committee intends that the research, development, demonstration, and commercial application programs authorized in this legislation include various geographies, including those in the Eastern United States. Additionally, the Secretary should consider geothermal educational curriculum development as part of geothermal energy workforce development. The Committee intends that any supercritical systems research, development, demonstration, and commercial application refers to supercritical water or carbon dioxide systems.

The Committee finds that high performance computing and modeling supports nearly every area of technological advancement and encourages DOE to leverage its computing resources including supercomputing user facilities and strategic computational partnerships like the Scientific Discovery through Advanced Computing (SciDAC) program, the Energy Sciences Network (ESnet), and the National Energy Research Scientific Computing Center (NERSC) to the maximum extent practicable. The Committee intends for the research, development, demonstration, and commercial application programs authorized in this legislation to make use of the Department's unique computing capabilities and infrastructure to support advanced geothermal research and development activities.

IX. COST ESTIMATE

Pursuant to clause 3(c)(2) of rule XIII of the Rules of the House of Representatives, the Committee adopts as its own the estimate

of new budget authority, entitlement authority, or tax expenditures or revenues contained in the cost estimate prepared by the Director of the Congressional Budget Office pursuant to section 402 of the Congressional Budget Act of 1974.

X. CONGRESSIONAL BUDGET OFFICE COST ESTIMATE

H.R. 5374, Advanced Geothermal Research and Development Act of 2019			
As ordered reported by the House Committee on Science, Space, and Technology on February 12, 2020			
By Fiscal Year, Millions of Dollars	2020	2020-2025	2020-2030
Direct Spending (Outlays)	0	0	0
Revenues	0	0	0
Increase or Decrease (-) in the Deficit	0	0	0
Spending Subject to Appropriation (Outlays)	0	451	701
Statutory pay-as-you-go procedures apply?	No	Mandate Effects	
Increases on-budget deficits in any of the four consecutive 10-year periods beginning in 2031?	No	Contains intergovernmental mandate?	No
		Contains private-sector mandate?	No

H.R. 5374 would authorize the appropriation of specific amounts each year over the 2021–2025 period for the Department of Energy (DOE) to conduct research and development (R&D) on geothermal energy. In addition to reauthorizing and amending existing programs, the bill would direct DOE to establish new R&D projects to expand and promote the use of geothermal energy.

In 2020, DOE allocated \$110 million for activities related to geothermal technologies. Based on historical spending patterns for similar programs, and assuming appropriation of the specified amounts, CBO estimates that implementing H.R. 5374 would cost \$451 million over the 2020–2025 period and \$250 million after 2025. The costs of the legislation, detailed in Table 1, fall within budget function 270 (energy).

TABLE 1.—ESTIMATED INCREASES IN SPENDING SUBJECT TO APPROPRIATION UNDER H.R. 5374

	By fiscal year, millions of dollars—						
	2020	2021	2022	2023	2024	2025	2020–2025
Authorization	0	121	133	144	151	152	701
Estimated Outlays	0	24	63	99	125	140	451

On March 2, 2020, CBO transmitted a cost estimate for S. 2657, the AGILE Act of 2019, as reported by the Senate Committee on Energy and Natural Resources on December 17, 2019. The two pieces of legislation are similar but would authorize the appropriation of different amounts over different time periods for geothermal energy R&D. Additionally, S. 2657 contains other provisions that are not in H.R. 5374. CBO's cost estimates reflect those differences in the legislative language.

The CBO staff contact for this estimate is Aaron Krupkin. The estimate was reviewed by H. Samuel Papenfuss, Deputy Director of Budget Analysis.

XI. FEDERAL MANDATES STATEMENT

H.R. 5374 contains no unfunded mandates.

XII. COMMITTEE OVERSIGHT FINDINGS AND RECOMMENDATIONS

The Committee's oversight findings and recommendations are reflected in the body of this report.

XIII. STATEMENT ON GENERAL PERFORMANCE GOALS AND OBJECTIVES

Pursuant to clause (3)(c) of House rule XIII, the goals of H.R. 5374 are to establish and support advanced geothermal research, development, demonstration, and commercial application programs at the Department of Energy, and identify and improve geothermal resource potential in the U.S.

XIV. FEDERAL ADVISORY COMMITTEE STATEMENT

This legislation does not authorize any federal advisory committees.

XV. DUPLICATION OF FEDERAL PROGRAMS

Pursuant to clause 3(c)(5) of rule XIII of the Rules of the House of Representatives, the Committee finds that no provision of H.R. 5374 establishes or reauthorizes a program of the federal government known to be duplicative of another federal program, including any program that was included in a report to Congress pursuant to section 21 of Public Law 111-139 or the most recent Catalog of Federal Domestic Assistance.

XVI. EARMARK IDENTIFICATION

Pursuant to clause 9(e), 9(f), and 9(g) of rule XXI, the Committee finds that H.R. 5374 contains no earmarks, limited tax benefits, or limited tariff benefits.

XVII. APPLICABILITY TO THE LEGISLATIVE BRANCH

The Committee finds that H.R. 5374 does not relate to the terms and conditions of employment or access to public services or accommodations within the meaning of section 102(b)(3) of the Congressional Accountability Act (Public Law 104-1).

XVIII. STATEMENT ON PREEMPTION OF STATE, LOCAL, OR TRIBAL LAW

This bill is not intended to preempt any state, local, or tribal law.

XIX. CHANGES IN EXISTING LAW MADE BY THE BILL, AS REPORTED

In compliance with clause 3(e) of rule XIII of the Rules of the House of Representatives, changes in existing law made by the bill, as reported, are shown as follows (existing law proposed to be omit-

ted is enclosed in black brackets, new matter is printed in italics, and existing law in which no change is proposed is shown in roman):

ENERGY INDEPENDENCE AND SECURITY ACT OF 2007

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) **SHORT TITLE.**—This Act may be cited as the “Energy Independence and Security Act of 2007”.

(b) **TABLE OF CONTENTS.**—The table of contents of this Act is as follows:

Sec. 1. Short title; table of contents.

* * * * *

TITLE VI—ACCELERATED RESEARCH AND DEVELOPMENT

* * * * *

Subtitle B—Geothermal Energy

Sec. 611. Short title.

* * * * *

Sec. 616A. Geothermal heat pumps and direct use research and development.

* * * * *

[Sec. 618. Center for geothermal technology transfer.]

Sec. 618. Advanced geothermal computing and data science research and development.

[Sec. 619. GeoPowering America.]

Sec. 619. Geothermal workforce development.

[Sec. 620. Educational pilot program.]

* * * * *

TITLE VI—ACCELERATED RESEARCH AND DEVELOPMENT

* * * * *

Subtitle B—Geothermal Energy

* * * * *

SEC. 612. DEFINITIONS.

For purposes of this subtitle:

[(1) ENGINEERED.—When referring to enhanced geothermal systems, the term “engineered” means subjected to intervention, including intervention to address one or more of the following issues:

[(A) Lack of effective permeability or porosity or open fracture connectivity within the reservoir.

[(B) Insufficient contained geofluid in the reservoir.

[(C) A low average geothermal gradient, which necessitates deeper drilling.]

(1) ENGINEERED.—When referring to enhanced geothermal systems, the term “engineered” means designed to access subsurface heat, including stimulation and nonstimulation technologies to address one or more of the following issues:

(A) *Lack of effective permeability, porosity or open fracture connectivity within the heat reservoir.*

(B) *Insufficient contained geofluid in the heat reservoir.*

(C) *A low average geothermal gradient which necessitates deeper drilling, or the use of alternative heat sources or heat generation processes.*

(2) **ELIGIBLE ENTITY.**—*The term ‘eligible entity’ means any of the following entities:*

(A) *An institution of higher education.*

(B) *A National laboratory.*

(C) *A Federal research agency.*

(D) *A State research agency.*

(E) *A nonprofit research organization.*

(F) *An industrial entity.*

(G) *A consortium of 2 or more entities described in subparagraphs (A) through (F).*

[(2)] (3) **ENHANCED GEOTHERMAL SYSTEMS.**—The term “enhanced geothermal systems” means geothermal reservoir systems that are engineered, as opposed to occurring naturally.

[(3)] (4) **GEOFLUID.**—The term “geofluid” means any fluid used to extract thermal energy from the Earth which is transported to the surface for direct use or electric power generation, except that such term shall not include oil or natural gas.

[(4)] (5) **GEOPRESSURED RESOURCES.**—The term “geopressured resources” mean geothermal deposits found in sedimentary rocks under higher than normal pressure and saturated with gas or methane.

[(5)] (6) **GEOTHERMAL.**—The term “geothermal” refers to heat energy stored in the Earth’s crust that can be accessed for direct use or electric power generation.

[(6)] (7) **HYDROTHERMAL.**—The term “hydrothermal” refers to naturally occurring subsurface reservoirs of hot water or steam.

[(7)] (8) **SYSTEMS APPROACH.**—The term “systems approach” means an approach to solving problems or designing systems that attempts to optimize the performance of the overall system, rather than a particular component of the system.

[SEC. 613. HYDROTHERMAL RESEARCH AND DEVELOPMENT.

[(a)] **IN GENERAL.**—The Secretary shall support programs of research, development, demonstration, and commercial application to expand the use of geothermal energy production from hydrothermal systems, including the programs described in subsection (b).

[(b)] **PROGRAMS.**—

[(1)] **ADVANCED HYDROTHERMAL RESOURCE TOOLS.**—The Secretary, in consultation with other appropriate agencies, shall support a program to develop advanced geophysical, geochemical, and geologic tools to assist in locating hidden hydrothermal resources, and to increase the reliability of site characterization before, during, and after initial drilling. The program shall develop new prospecting techniques to assist in prioritization of targets for characterization. The program shall include a field component.

[(2)] **INDUSTRY COUPLED EXPLORATORY DRILLING.**—The Secretary shall support a program of cost-shared field demonstration programs, to be pursued, simultaneously and independ-

ently, in collaboration with industry partners, for the demonstration of advanced technologies and techniques of siting and exploratory drilling for undiscovered resources in a variety of geologic settings. The program shall include incentives to encourage the use of advanced technologies and techniques.

[SEC. 614. GENERAL GEOTHERMAL SYSTEMS RESEARCH AND DEVELOPMENT.

[(a) SUBSURFACE COMPONENTS AND SYSTEMS.—The Secretary shall support a program of research, development, demonstration, and commercial application of components and systems capable of withstanding extreme geothermal environments and necessary to cost-effectively develop, produce, and monitor geothermal reservoirs and produce geothermal energy. These components and systems shall include advanced casing systems (expandable tubular casing, low-clearance casing designs, and others), high-temperature cements, high-temperature submersible pumps, and high-temperature packers, as well as technologies for under-reaming, multilateral completions, high-temperature and high-pressure logging, logging while drilling, deep fracture stimulation, and reservoir system diagnostics.

[(b) RESERVOIR PERFORMANCE MODELING.—The Secretary shall support a program of research, development, demonstration, and commercial application of models of geothermal reservoir performance, with an emphasis on accurately modeling performance over time. Models shall be developed to assist both in the development of geothermal reservoirs and to more accurately account for stress-related effects in stimulated hydrothermal and enhanced geothermal systems production environments.

[(c) ENVIRONMENTAL IMPACTS.—The Secretary shall—

[(1) support a program of research, development, demonstration, and commercial application of technologies and practices designed to mitigate or preclude potential adverse environmental impacts of geothermal energy development, production or use, and seek to ensure that geothermal energy development is consistent with the highest practicable standards of environmental stewardship;

[(2) in conjunction with the Assistant Administrator for Research and Development at the Environmental Protection Agency, support a research program to identify potential environmental impacts of geothermal energy development, production, and use, and ensure that the program described in paragraph (1) addresses such impacts, including effects on groundwater and local hydrology; and

[(3) support a program of research to compare the potential environmental impacts identified as part of the development, production, and use of geothermal energy with the potential emission reductions of greenhouse gases gained by geothermal energy development, production, and use.

[SEC. 615. ENHANCED GEOTHERMAL SYSTEMS RESEARCH AND DEVELOPMENT.

[(a) IN GENERAL.—The Secretary shall support a program of research, development, demonstration, and commercial application for enhanced geothermal systems, including the programs described in subsection (b).

[(b) PROGRAMS.—

【(1) ENHANCED GEOTHERMAL SYSTEMS TECHNOLOGIES.—The Secretary shall support a program of research, development, demonstration, and commercial application of the technologies and knowledge necessary for enhanced geothermal systems to advance to a state of commercial readiness, including advances in—

- 【(A) reservoir stimulation;
- 【(B) reservoir characterization, monitoring, and modeling;
- 【(C) stress mapping;
- 【(D) tracer development;
- 【(E) three-dimensional tomography; and
- 【(F) understanding seismic effects of reservoir engineering and stimulation.

【(2) ENHANCED GEOTHERMAL SYSTEMS RESERVOIR STIMULATION.—

【(A) PROGRAM.—In collaboration with industry partners, the Secretary shall support a program of research, development, and demonstration of enhanced geothermal systems reservoir stimulation technologies and techniques. A minimum of 4 sites shall be selected in locations that show particular promise for enhanced geothermal systems development. Each site shall—

- 【(i) represent a different class of subsurface geologic environments; and
- 【(ii) take advantage of an existing site where subsurface characterization has been conducted or existing drill holes can be utilized, if possible.

【(B) CONSIDERATION OF EXISTING SITE.—The Desert Peak, Nevada, site, where a Department of Energy and industry cooperative enhanced geothermal systems project is already underway, may be considered for inclusion among the sites selected under subparagraph (A).】

SEC. 613. HYDROTHERMAL RESEARCH AND DEVELOPMENT.

(a) *IN GENERAL.*—The Secretary shall carry out a program of research, development, demonstration, and commercial application for geothermal energy production from hydrothermal systems.

(b) *PROGRAMS.*—The program authorized in subsection (a) shall include the following:

(1) *ADVANCED HYDROTHERMAL RESOURCE TOOLS.*—The research and development of advanced geologic tools to assist in locating hydrothermal resources, and to increase the reliability of site characterization, including the development of new imaging and sensing technologies and techniques to assist in prioritization of targets for characterization;

(2) *EXPLORATORY DRILLING FOR GEOTHERMAL RESOURCES.*—The demonstration of advanced technologies and techniques of siting and exploratory drilling for undiscovered resources in a variety of geologic settings, carried out in collaboration with industry partners that will assist in the acquisition of high quality data sets relevant for hydrothermal subsurface characterization activities

SEC. 614. GENERAL GEOTHERMAL SYSTEMS RESEARCH AND DEVELOPMENT.

(a) *SUBSURFACE COMPONENTS AND SYSTEMS.*—The Secretary shall support a program of research, development, demonstration, and commercial application of components and systems capable of withstanding geothermal environments and necessary to develop, produce, and monitor geothermal reservoirs and produce geothermal energy.

(b) *ENVIRONMENTAL IMPACTS.*—The Secretary shall—

(1) support a program of research, development, demonstration, and commercial application of technologies and practices designed to mitigate or preclude potential adverse environmental impacts of geothermal energy development, production or use; and

(2) support a research program to identify potential environmental impacts, including induced seismicity, and environmental benefits of geothermal energy development, production, and use, and ensure that the program described in paragraph (1) addresses such impacts, including water use and effects on groundwater and local hydrology;

(3) support a program of research to compare the potential environmental impacts and environmental benefits identified as part of the development, production, and use of geothermal energy with the potential emission reductions of greenhouse gases gained by geothermal energy development, production, and use; and

(4) in carrying out this section, the Secretary shall, to the maximum extent practicable, consult with relevant federal agencies, including the Environmental Protection Agency.

(c) *RESERVOIR THERMAL ENERGY STORAGE.*—The Secretary shall support a program of research, development, and demonstration of reservoir thermal energy storage, emphasizing cost-effective improvements through deep direct use engineering, design, and systems research.

(d) *OIL AND GAS TECHNOLOGY TRANSFER INITIATIVE.*—

(1) *IN GENERAL.*—The Secretary shall support an initiative among the Office of Fossil Energy, the Office of Energy Efficiency and Renewable Energy, and the private sector to research, develop, and demonstrate relevant advanced technologies and operation techniques used in the oil and gas sector for use in geothermal energy development.

(2) *PRIORITIES.*—In carrying out paragraph (1), the Secretary shall prioritize technologies with the greatest potential to significantly increase the use and lower the cost of geothermal energy in the United States, including the cost and speed of geothermal drilling surface technologies, and well construction.

(e) *COPRODUCTION OF GEOTHERMAL ENERGY AND MINERALS PRODUCTION RESEARCH AND DEVELOPMENT INITIATIVE.*—

(1) *IN GENERAL.*—The Secretary shall carry out a research and development initiative under which the Secretary shall award grants to demonstrate the coproduction of critical minerals from geothermal resources.

(2) *REQUIREMENTS.*—An award made under paragraph (1) shall—

- (A) improve the cost effectiveness of removing minerals from geothermal brines as part of the coproduction process;
- (B) increase recovery rates of the targeted mineral commodity;
- (C) decrease water use and other environmental impacts, as determined by the Secretary; and
- (D) demonstrate a path to commercial viability.

(f) **FLEXIBLE OPERATIONS.**—The Secretary shall support a research initiative on flexible operation of geothermal power plants.

(g) **HYBRID ENERGY SYSTEMS.**—The Secretary shall identify opportunities for joint research, development, and demonstration programs between geothermal systems and other energy generation or storage systems.

SEC. 615. ENHANCED GEOTHERMAL SYSTEMS RESEARCH AND DEVELOPMENT.

(a) **IN GENERAL.**—The Secretary shall support a program of research, development, demonstration, and commercial application for enhanced geothermal systems, including the programs described in subsection (b).

(b) **ENHANCED GEOTHERMAL SYSTEMS TECHNOLOGIES.**—In collaboration with industry partners, institutions of higher education, and the national laboratories, the Secretary shall support a program of research, development, demonstration, and commercial application of the technologies to achieve higher efficiency and lower cost enhanced geothermal systems, including—

- (1) reservoir stimulation;
- (2) drilled, non-stimulated (e.g. closed-loop) reservoir technologies;
- (3) reservoir characterization, monitoring, and modeling and understanding of the surface area and volume of fractures;
- (4) stress and fracture mapping including real time monitoring and modeling;
- (5) tracer development;
- (6) three and four-dimensional seismic imaging and tomography;
- (7) well placement and orientation;
- (8) long-term reservoir management;
- (9) drilling technologies, methods, and tools;
- (10) improved exploration tools;
- (11) zonal isolation; and
- (12) understanding induced seismicity risks from reservoir engineering and stimulation.

(c) **FRONTIER OBSERVATORY FOR RESEARCH IN GEOTHERMAL ENERGY.**—The Secretary shall support the establishment and construction of up to 3 field research sites, which shall each be known as a “Frontier Observatory for Research in Geothermal Energy” or “FORGE” site to develop, test, and enhance techniques and tools for enhanced geothermal energy.

(1) **DUTIES.**—The Secretary shall—

- (A) award grants in support of research and development projects focused on advanced monitoring technologies, new technologies and approaches for implementing multi-zone stimulations, nonstimulation techniques, and dynamic reservoir modeling that incorporates all available high-fidelity characterization data; and

(B) seek opportunities to coordinate efforts and share information with domestic and international partners engaged in research and development of geothermal systems and related technology, including coordination between FORGE sites.

(2) *SITE SELECTION.*—Of the FORGE sites referred to in paragraph (1), the Secretary shall—

(A) consider applications through a competitive, merit-reviewed process, from National Laboratories, multi-institutional collaborations, institutes of higher education and other appropriate entities best suited to provide national leadership on geothermal related issues and perform the duties enumerated under this subsection; and

(B) prioritize existing field sites and facilities with capabilities relevant to the duties enumerated under this subsection.

(3) *EXISTING FORGE SITES.*—A FORGE site already in existence on the date of enactment of this Act may continue to receive support.

(4) *FUNDING.*—Out of funds authorized to be appropriated under section 12 of the “Advanced Geothermal Research and Development Act of 2019”, there shall be made available to the Secretary to carry out the FORGE activities under this paragraph—

(A) \$45,000,000 for fiscal year 2021;

(B) \$55,000,000 for fiscal year 2022;

(C) \$65,000,000 for fiscal year 2023;

(D) \$70,000,000 for fiscal year 2024; and

(E) \$70,000,000 for fiscal year 2025.

In carrying out this section, the Secretary shall consider the balance between funds dedicated to construction and operations and research activities to reflect the state of site development.

(d) *ENHANCED GEOTHERMAL SYSTEMS DEMONSTRATIONS.*—

(1) *IN GENERAL.*—Beginning on the date of enactment of the “Advanced Geothermal Research and Development Act of 2019”, the Secretary, in collaboration with industry partners, institutions of higher education, and the national laboratories, shall support an initiative for demonstration of enhanced geothermal systems for power production or direct use.

(2) *PROJECTS.*—

(A) *IN GENERAL.*—Under the initiative described in paragraph (1), demonstration projects shall be carried out in locations that are commercially viable for enhanced geothermal systems development, while also considering environmental impacts to the maximum extent practicable, as determined by the Secretary.

(B) *REQUIREMENTS.*—Demonstration projects under subparagraph (A) shall—

(i) collectively demonstrate—

(I) different geologic settings, such as hot sedimentary aquifers, layered geologic systems, supercritical systems, and basement rock systems; and

(II) a variety of development techniques, including open hole and cased hole completions, differing

well orientations, and stimulation and nonstimulation mechanisms; and

(ii) to the extent practicable, use existing sites where subsurface characterization or geothermal energy integration analysis has been conducted.

(C) EASTERN DEMONSTRATION.—Not fewer than 1 of the demonstration projects carried out under subparagraph (A) shall be located an area east of the Mississippi that is suitable for enhanced geothermal demonstration for power, heat, or a combination of power and heat.

* * * * *

SEC. 616A. GEOTHERMAL HEAT PUMPS AND DIRECT USE RESEARCH AND DEVELOPMENT.

(a) PURPOSES.—The purposes of this section are—

(1) to improve the understanding of related earth sciences, components, processes, and systems used for geothermal heat pumps and the direct use of geothermal energy; and

(2) to increase the energy efficiency, lower the cost, increase the use, and improve and demonstrate the effectiveness of geothermal heat pumps and the direct use of geothermal energy.

(b) DEFINITIONS.—In this section:

(1) DIRECT USE OF GEOTHERMAL ENERGY.—The term “direct use of geothermal energy” means geothermal systems that use water directly or through a heat exchanger to provide—

(A) heating and cooling to buildings, commercial districts, residential communities, and large municipal, or industrial projects; or

(B) heat required for industrial processes, agriculture, aquaculture, and other facilities.

(2) ECONOMICALLY DISTRESSED AREA.—The term “economically distressed area” means an area described in section 301(a) of the Public Works and Economic Development Act of 1965 (42 U.S.C. 3161(a)).

(3) GEOTHERMAL HEAT PUMP.—The term “geothermal heat pump” means a system that provides heating and cooling by exchanging heat from shallow geology, groundwater, or surface water using—

(A) a closed loop system, which transfers heat by way of buried or immersed pipes that contain a mix of water and working fluid; or

(B) an open loop system, which circulates ground or surface water directly into the building and returns the water to the same aquifer or surface water source.

(c) PROGRAM.—

(1) IN GENERAL.—The Secretary shall support within the Geothermal Technologies Office a program of research, development, and demonstration for geothermal heat pumps and the direct use of geothermal energy.

(2) AREAS.—The program under paragraph (1) may include research, development, demonstration, and commercial application of—

(A) geothermal ground loop efficiency improvements, cost reductions, and improved installation and operations methods;

(B) *the use of geothermal energy for building-scale energy storage;*

(C) *the use of geothermal energy as a grid management resource or seasonal energy storage;*

(D) *geothermal heat pump efficiency improvements;*

(E) *the use of alternative fluids as a heat exchange medium, such as hot water found in mines and mine shafts, graywater, or other fluids that may improve the economics of geothermal heat pumps;*

(F) *heating of districts, neighborhoods, communities, large commercial or public buildings, and industrial and manufacturing facilities;*

(G) *the use of low temperature groundwater for direct use; and*

(H) *system integration of direct use with geothermal electricity production.*

(3) **ENVIRONMENTAL IMPACTS.**—*In carrying out the program, the Secretary shall identify and mitigate potential environmental impacts in accordance with section 614(c).*

(d) **GRANTS.**—

(1) **IN GENERAL.**—*The Secretary shall carry out the program established in subsection (c) by making grants available to State, local, and Tribal governments, institutions of higher education, nonprofit entities, National Laboratories, utilities, and for-profit companies.*

(2) **PRIORITY.**—*In making grants under this subsection, the Secretary may give priority to proposals that apply to large buildings, commercial districts, and residential communities that are located in economically distressed areas and areas that the Secretary determines to have high economic potential for geothermal district heating based on the report, “Geovision: Harnessing the Heat Beneath our Feet” published by the Department in 2019, or a successor report.*

SEC. 617. COST SHARING AND PROPOSAL EVALUATION.

(a) **FEDERAL SHARE.**—*The Federal share of costs of projects funded under this subtitle shall be in accordance with section 988 of the Energy Policy Act of 2005.*

(b) **ORGANIZATION AND ADMINISTRATION OF PROGRAMS.**—*Programs under this subtitle shall incorporate the following elements:*

(1) *The Secretary shall coordinate with, and where appropriate may provide funds in furtherance of the purposes of this subtitle to, other Department of Energy research and development programs focused on drilling, subsurface characterization, and other related technologies.*

【(2) *In evaluating proposals, the Secretary shall give priority to proposals that demonstrate clear evidence of employing a systems approach.*】

【(3) (2) *The Secretary shall coordinate and consult with the appropriate Federal land management agencies in selecting proposals for funding under this subtitle.*

【(4) (3) *Nothing in this subtitle shall be construed to alter or affect any law relating to the management or protection of Federal lands.*

[SEC. 618. CENTER FOR GEOTHERMAL TECHNOLOGY TRANSFER.

[(a) IN GENERAL.—The Secretary shall award to an institution of higher education (or consortium thereof) a grant to establish a Center for Geothermal Technology Transfer (referred to in this section as the “Center”).

[(b) DUTIES.—The Center shall—

[(1) serve as an information clearinghouse for the geothermal industry by collecting and disseminating information on best practices in all areas relating to developing and utilizing geothermal resources;

[(2) make data collected by the Center available to the public; and

[(3) seek opportunities to coordinate efforts and share information with domestic and international partners engaged in research and development of geothermal systems and related technology.

[(c) SELECTION CRITERIA.—In awarding the grant under subsection (a) the Secretary shall select an institution of higher education (or consortium thereof) best suited to provide national leadership on geothermal related issues and perform the duties enumerated under subsection (b).

[(d) DURATION OF GRANT.—A grant made under subsection (a)—

[(1) shall be for an initial period of 5 years; and

[(2) may be renewed for additional 5-year periods on the basis of—

[(A) satisfactory performance in meeting the duties outlined in subsection (b); and

[(B) any other requirements specified by the Secretary.

[SEC. 619. GEOPOWERING AMERICA.

[The Secretary shall expand the Department of Energy’s GeoPowering the West program to extend its geothermal technology transfer activities throughout the entire United States. The program shall be renamed “GeoPowering America”. The program shall continue to be based in the Department of Energy office in Golden, Colorado.

[SEC. 620. EDUCATIONAL PILOT PROGRAM.

[The Secretary shall seek to award grant funding, on a competitive basis, to an institution of higher education for a geothermal-powered energy generation facility on the institution’s campus. The purpose of the facility shall be to provide electricity and space heating. The facility shall also serve as an educational resource to students in relevant fields of study, and the data generated by the facility shall be available to students and the general public. The total funding award shall not exceed \$2,000,000.

[SEC. 621. REPORTS.

[(a) REPORTS ON ADVANCED USES OF GEOTHERMAL ENERGY.—Not later than 3 years and 5 years after the date of enactment of this Act, the Secretary shall report to the Committee on Science and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate on advanced concepts and technologies to maximize the geothermal resource potential of the United States. The reports shall include—

[(1) the use of carbon dioxide as an alternative geofluid with potential carbon sequestration benefits;

- [(2) mineral recovery from geofluids;
- [(3) use of geothermal energy to produce hydrogen;
- [(4) use of geothermal energy to produce biofuels;
- [(5) use of geothermal heat for oil recovery from oil shales and tar sands; and
- [(6) other advanced geothermal technologies, including advanced drilling technologies and advanced power conversion technologies.

[(b) PROGRESS REPORTS.—(1) Not later than 36 months after the date of enactment of this Act, the Secretary shall submit to the Committee on Science and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate an interim report describing the progress made under this subtitle. At the end of 60 months, the Secretary shall submit to Congress a report on the results of projects undertaken under this subtitle and other such information the Secretary considers appropriate.

[(2) As necessary, the Secretary shall report to the Congress on any legal, regulatory, or other barriers encountered that hinder economic development of these resources, and provide recommendations on legislative or other actions needed to address such impediments.]

SEC. 618. ADVANCED GEOTHERMAL COMPUTING AND DATA SCIENCE RESEARCH AND DEVELOPMENT.

(a) *IN GENERAL.*—The Secretary shall carry out a program of research and development of advanced computing and data science tools for geothermal energy.

(b) *PROGRAMS.*—The program authorized in subsection (a) shall include the following:

(1) *ADVANCED COMPUTING FOR GEOTHERMAL SYSTEMS TECHNOLOGIES.*—Research, development, and demonstration of technologies to develop advanced data, machine learning, artificial intelligence, and related computing tools to assist in locating geothermal resources, to increase the reliability of site characterization, to increase the rate and efficiency of drilling, to improve induced seismicity mitigation, and to support enhanced geothermal systems technologies.

(2) *GEOTHERMAL SYSTEMS RESERVOIR MODELING.*—Research, development, and demonstration of models of geothermal reservoir performance and enhanced geothermal systems reservoir stimulation technologies and techniques, with an emphasis on accurately modeling fluid and heat flow, permeability evolution, geomechanics, geochemistry, seismicity, and operational performance over time, including collaboration with industry and field validation.

(c) *COORDINATION.*—In carrying out these programs, the Secretary shall ensure coordination and consultation with the Department of Energy’s Office of Science. The Secretary shall ensure, to the maximum extent practicable, coordination of these activities with the Department of Energy National Laboratories, institutes of higher education, and the private sector.

SEC. 619. GEOTHERMAL WORKFORCE DEVELOPMENT.

The Secretary shall support the development of a geothermal energy workforce through a program that—

(1) facilitates collaboration between university students and researchers at the national laboratories; and

(2) prioritizes science in areas relevant to the mission of the Department through the application of geothermal energy tools and technologies.

SEC. 621. ORGANIZATION AND ADMINISTRATION OF PROGRAMS.

(a) *EDUCATION AND OUTREACH.*—In carrying out the activities described in this subtitle, the Secretary shall support education and outreach activities to disseminate information on geothermal energy technologies and the geothermal energy workforce, including activities at the Frontier Observatory for Research in Geothermal Energy site(s).

(b) *TECHNICAL ASSISTANCE.*—In carrying out this subtitle, the Secretary shall also conduct technical assistance and analysis activities with eligible entities for the purpose of supporting the commercial application of advances in geothermal energy systems development and operations, which may include activities that support expanding access to advanced geothermal energy technologies for rural, Tribal, and low-income communities.

(c) *REPORT.*—Every 5 years after the date of enactment of Advanced Geothermal Research and Development Act of 2019, the Secretary shall report to the Committee on Science and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate on advanced concepts and technologies to maximize the geothermal resource potential of the United States.

(d) *PROGRESS REPORTS.*—Not later than 1 year after the date of enactment of the “Advanced Geothermal Research and Development Act of 2019”, and every 2 years thereafter, the Secretary shall submit to the Committee on Science and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate a report on the results of projects undertaken under this part and other such information the Secretary considers appropriate.

* * * * *

[SEC. 623. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to the Secretary to carry out this subtitle \$90,000,000 for each of the fiscal years 2008 through 2012, of which \$10,000,000 for each fiscal year shall be for carrying out section 616. There are also authorized to be appropriated to the Secretary for the Intermountain West Geothermal Consortium \$5,000,000 for each of the fiscal years 2008 through 2012.]

SEC. 623. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to the Secretary to carry out the programs under the “Advanced Geothermal Research and Development Act of 2019”—

- (1) \$121,375,000 for fiscal year 2021;
- (2) \$132,750,000 for fiscal year 2022;
- (3) \$144,125,000 for fiscal year 2023;
- (4) \$150,500,000 for fiscal year 2024; and
- (5) \$151,875,000 for fiscal year 2025.

SEC. 624. INTERNATIONAL GEOTHERMAL ENERGY DEVELOPMENT.

[(a) *IN GENERAL.*—The Secretary of Energy, in coordination with other appropriate Federal and multilateral agencies (including the United States Agency for International Development) shall support international collaborative efforts to promote the research, development, and deployment of geothermal technologies used to develop hydrothermal and enhanced geothermal system resources, including as partners (as appropriate) the African Rift Geothermal Development Facility, Australia, China, France, the Republic of Iceland, India, Japan, and the United Kingdom.]

(a) *IN GENERAL.*—*The Secretary of Energy, in coordination with other appropriate Federal and multilateral agencies (including the United States Agency for International Development) shall support collaborative efforts with international partners to promote the research, development, and demonstration of geothermal technologies used to develop hydrothermal and enhanced geothermal system resources.*

(b) **UNITED STATES TRADE AND DEVELOPMENT AGENCY.**—The Director of the United States Trade and Development Agency may—

(1) encourage participation by United States firms in actions taken to carry out subsection (a); and

(2) provide grants and other financial support for feasibility and resource assessment studies conducted in, or intended to benefit, less developed countries.

[(c) **AUTHORIZATION OF APPROPRIATIONS.**—There are authorized to be appropriated to carry out this section \$5,000,000 for each of fiscal years 2008 through 2012.]

SEC. 625. HIGH COST REGION GEOTHERMAL ENERGY GRANT PROGRAM.

(a) **DEFINITIONS.**—In this section:

(1) **ELIGIBLE ENTITY.**—The term “eligible entity” means—

(A) a utility;

(B) an electric cooperative;

(C) a State;

(D) a political subdivision of a State;

(E) an Indian tribe; or

(F) a Native corporation.

(2) **HIGH-COST REGION.**—The term “high-cost region” means a region in which the average cost of electrical power *or heat* exceeds 150 percent of the national average retail cost, as determined by the Secretary.

(b) **PROGRAM.**—The Secretary shall use amounts made available to carry out this section to make grants to eligible entities for activities described in subsection (c).

(c) **ELIGIBLE ACTIVITIES.**—An eligible entity may use grant funds under this section, with respect to a geothermal energy project in a high-cost region, only—

(1) to conduct a feasibility study, including a study of exploration, geochemical testing, geomagnetic surveys, geologic information gathering, baseline environmental studies, well drilling, resource characterization, permitting, and economic analysis;

(2) for design and engineering costs, relating to the project; and

(3) to demonstrate and promote commercial application of technologies related to geothermal energy as part of the project.

(d) COST SHARING.—The cost-sharing requirements of section 988 of the Energy Policy Act of 2005 (42 U.S.C. 16352) shall apply to any project carried out under this section.

[(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated such sums as are necessary to carry out this section.]

(e) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized under section 12 of the “Advanced Geothermal Research and Development Act of 2019”, there is authorized to be appropriated to carry out this section \$5,000,000 for each of fiscal years 2021 through 2025.

* * * * *

XX. EXCHANGE OF COMMITTEE CORRESPONDENCE



COMMITTEE ON
EDUCATION AND LABOR
U.S. HOUSE OF REPRESENTATIVES
2176 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-8100

September 10, 2020

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The Honorable Eddie Bernice Johnson
Chairwoman
Committee on Science, Space, and Technology
U.S. House of Representatives
2321 Rayburn House Office Building
Washington, DC 20515

Dear Chairwoman Johnson:

I write concerning H.R. 5374, the *Advanced Geothermal Research and Development Act of 2019*. This bill was primarily referred to the Committee on Science, Space, and Technology, and additionally to the Committee on Education and Labor. As a result of Leadership and the Committee on Science, Space, and Technology having consulted with me concerning this bill generally, I agree to forgo formal consideration of the bill so the bill may proceed expeditiously to the House floor.

The Committee on Education and Labor takes this action with our mutual understanding that by forgoing formal consideration of H.R. 5374, we do not waive any jurisdiction over the subject matter contained in this or similar legislation, and we will be appropriately consulted and involved as the bill or similar legislation moves forward so we may address any remaining issues within our Rule X jurisdiction. I also request that you support my request to name members of the Committee on Education and Labor to any conference committee to consider such provisions.

Finally, I would appreciate a response confirming this understanding and ask that a copy of our exchange of letters on this matter be included in the committee report for H.R. 5374 and in the *Congressional Record* during floor consideration thereof.

Sincerely,

Robert C. "Bobby" Scott
Chairman

cc: The Honorable Virginia Foxx, Ranking Member, Committee on Education and Labor
The Honorable Frank D. Lucas, Ranking Member, Committee on Science, Space, and Technology
The Honorable Nancy Pelosi, Speaker
The Honorable Steny Hoyer, Majority Leader
The Honorable Thomas Wickham, Jr., Parliamentarian

EDDIE BERNICE JOHNSON, Texas
CHAIRWOMAN

FRANK D. LUCAS, Oklahoma
RANKING MEMBER

Congress of the United States
House of Representatives

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

2321 RAYBURN HOUSE OFFICE BUILDING

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September 10, 2020

Chairman Robert C. "Bobby" Scott
Committee on Education and Labor
U.S. House of Representatives
2176 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairman Scott,

I am writing to you concerning H.R. 5374, the "Advanced Geothermal Research and Development Act of 2019," which was referred to the Committee on Science, Space, and Technology, and in addition to the Committee on Education and Labor on December 10, 2020.

I appreciate your willingness to work cooperatively on this bill. I recognize that the bill contains provisions that fall within the jurisdiction of the Committee on Education and Labor. I appreciate that your Committee will waive further consideration of H.R. 5374 and that this action is not a waiver of future jurisdictional claims by the Committee on Education and Labor over this subject matter.

I will make sure to include our exchange of letters in the legislative report for H.R. 5374 and in the *Congressional Record*. Thank you for your cooperation on this legislation.

Sincerely,



Eddie Bernice Johnson
Chairwoman
Committee on Science, Space, and Technology

cc:
Ranking Member Frank D. Lucas, Committee on Science, Space, and Technology
Ranking Member Virginia Foxx, Committee on Education and Labor
Tom Wickham, Parliamentarian

XXI. PROCEEDINGS OF THE SUBCOMMITTEE MARKUP

MARKUPS:
H.R. 2986, BEST ACT;
H.R. 5374, ADVANCED GEOTHERMAL
RESEARCH AND DEVELOPMENT ACT OF 2019;
AND H.R. 5428, GRID MODERNIZATION
RESEARCH AND DEVELOPMENT ACT OF 2019

MARKUP
BEFORE THE
SUBCOMMITTEE ON ENERGY
COMMITTEE ON SCIENCE, SPACE, AND
TECHNOLOGY
HOUSE OF REPRESENTATIVES
ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

DECEMBER 19, 2019

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C O N T E N T S

Thursday, December 19, 2019

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Appendix I: Additional Material for the Record

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**Markups on H.R. 2986, BEST Act;
H.R. 5374, Advanced Geothermal Research and
Development Act of 2019; and
H.R. 5428, Grid Modernization Research and
Development Act of 2019**

THURSDAY, DECEMBER 19, 2019

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to notice, at 10:46 a.m., in room 2318 of the Rayburn House Office Building, Hon. Conor Lamb [Chairman of the Subcommittee] presiding.

Chairman LAMB. Good morning. The Subcommittee will come to order. Without objection, the Chair is authorized to declare a recess at any time. Pursuant to Committee Rule 2(e) and House Rule 11, the Chair announces that he may postpone roll call votes. Pursuant to notice, the Subcommittee on Energy meets to consider the following measures: H.R. 2986, the *BEST Act*; H.R. 5374, the *Advanced Geothermal Research and Development Act of 2019*; and H.R. 5428, the *Grid Modernization Research and Development Act of 2019*.

We meet today to mark up three good bipartisan bills. The *BEST Act* is authored by our colleague from Illinois, Dr. Foster. It will authorize research, development, and demonstration of energy storage technologies, specifically aiming at advanced technologies with varying energy storage durations, and ensuring that the research covers a diverse set of technologies, including batteries, pumped hydro, and others. National labs, academia, private industry, and environmental groups all deserve credit because they were all engaged in the making of this bill. It is endorsed by the Energy Storage Association, Chamber of Commerce, ClearPath, and Duke Energy, among others.

Next is the *Advanced Geothermal Research and Development Act of 2019*, and we are authorizing DOE (Department of Energy) to research, develop, demonstrate geothermal energy technologies, and it's sponsored by our Ranking Member of the full Committee, Mr. Lucas. He will talk more about it, I'm sure, but it requires DOE to explore oil and gas technologies that could be used for geothermal, advancing the use of computer modeling, establishing up to three field research sites to advance the development and demonstration of enhanced geothermal energy technologies in varying geographies across the U.S. It's particularly important for encouraging exploration of this resource in the eastern U.S. We have received a lot of input supported by the Geothermal Resources Council, Chamber of Commerce, ClearPath, and Third Way. Very much appreciate Ranking Member Lucas' effort to reach across the aisle on this one, and that is why the Chair of the full Committee, Ms. Johnson, is an original co-sponsor. This week of all weeks I think we can applaud that bipartisan work.

Finally we will consider the *Grid Modernization Research and Development Act of 2019*. In order for us to use all the new energy technologies that we've been talking about and authorizing on this Committee all year, we also need to seriously advance our electric grid. This bill seeks to do that, addressing the R&D (research and development). I would like to thank my colleague from Washington, Ms. Herrera Beutler, for joining me in introducing this legislation, and I urge my colleagues on both sides of the aisle to support it. Look forward to advancing it out of our Subcommittee today.

[The prepared statement of Chairman Lamb follows:]

We meet today to markup three good bipartisan bills.

The first we will consider today, the *Better Energy Storage Technology Act*, or *BEST Act*, is authored by our colleague from Illinois, Dr. Foster. The bill will authorize DOE to conduct cross-cutting research, development, and demonstration of energy storage technologies. Specifically, the bill authorizes research aimed to advance technologies with varying energy storage durations, and ensures research covers a diverse set of technologies, including batteries, pumped hydro systems, and others. National labs, academia, private industry, and environmental groups were

all engaged in the making of this bill. The bill is now endorsed by the Energy Storage Association, the Chamber of Commerce, ClearPath, and Duke Energy, just to name a few.

The next bill on the roster is H.R. 5374. As its title suggests, the *Advanced Geothermal Research and Development Act of 2019* authorizes DOE to pursue research, development, and demonstration of geothermal energy technologies and is sponsored by the Ranking Member, Mr. Lucas. Amongst other activities, it requires DOE to explore oil and gas technologies that could be used for geothermal applications and advances the use of computer modeling to explore geothermal resources and systems.

The bill also authorizes DOE to establish up to three field research sites that will advance the development and demonstration of enhanced geothermal energy technologies in varying geographies across the U.S. This is a particularly important activity for spurring the exploration of this resource in the eastern U.S. The bill has received extensive stakeholder input and is supported by the Geothermal Resources Council, Chamber of Commerce, ClearPath, and Third Way. I appreciate Ranking Member Lucas's effort to reach across the aisle to cooperatively construct this bill, and that is why the Chair of the Full Committee, Ms. Johnson, is an original cosponsor. I applaud their continued bipartisan work on this committee.

Finally, we will consider my own legislation: the *Grid Modernization Research and Development Act of 2019*. In order for our country to utilize all the new energy technologies that we are developing and moving to market, we will need serious advancements to our electric grid. This bill seeks to address the research and development required to make those grid advancements. I'll speak more about this bill in just a minute, but I would like to thank my colleague from Washington, Ms. Herrera Beutler, for joining me in introducing this legislation.

I urge my colleagues on both sides of the aisle to support these bills and look forward to advancing them out of our Subcommittee today.

Chairman LAMB. I would now normally recognize the Ranking Member of the Subcommittee, Mr. Weber, for opening remarks, but I believe he's going to submit a statement for the record before he joins us.

[The prepared statement of Mr. Weber follows:]

Good morning. Thank you, Chairman Lamb, for the opportunity to speak on the three bills before us today: H.R. 2986, the *Better Energy Storage Technology Act*, H.R. 5374, the *Advanced Geothermal Research and Development Act*, and H.R. 5428, the *Grid Modernization Research and Development Act*.

H.R. 2986, the *Better Energy Storage Technology*, or *BEST Act*, directs the Department of Energy (DOE) to develop energy storage technologies through a cross-cutting research, development, and demonstration program.

Today, advanced renewable and distributed energy resources are changing the way that U.S. electricity is produced and delivered.

But as we all know, these sources are intermittent and dependent on the sun to shine or the wind to blow.

Without the capacity to efficiently store this energy at the grid scale, we limit the ability of renewable energy sources to meet U.S. energy needs. It is clear that advanced energy storage technology is the key to maximizing our clean energy resources and modernizing our electric grid, without sacrificing energy reliability and security.

That is why I'm pleased to see that the *BEST Act* authorizes critical, fundamental research that will enable U.S. researchers to test and validate grid-scale systems that can store and generate energy over a range of time, from 6 hours to several months.

I want to thank my colleagues Mr. Foster, Ms. Herrera Beutler, Mr. Casten, and Mr. Gonzalez for working together to produce this bipartisan legislation.

The next bill on the docket is H.R. 5374, the *Advanced Geothermal Energy Research and Development Act of 2019*. Introduced by Ranking Member Lucas and cosponsored by Chairwoman Johnson, H.R. 5374 authorizes DOE programs in a number of high-priority geothermal technology areas including, enhanced geothermal energy systems, subsurface technologies for geothermal energy production, reservoir thermal energy storage, and advanced computing to accelerate the development of geothermal energy.

This legislation also supports innovative experimental user facilities known as "Frontier Observatory for Research in Geothermal Energy" or FORGE sites.

With limited Federal dollars and a responsibility to spend those resources wisely, I believe that user facilities, like those authorized in this bill, can give us the high-

est return on our investment and produce advanced energy technologies that will greatly accelerate innovation in the private sector.

By making these strategic investments in advanced geothermal energy technologies, we can tap into a truly renewable source of baseload power that will help diversify our energy portfolio and strengthen American energy independence.

The final bill we will consider today is H.R. 5428, the *Grid Modernization Research and Development Act of 2019*, which was introduced by Chairman Lamb and co-sponsored by Representative Herrera Beutler.

H.R. 5428, establishes a research, development, and demonstration program at the Department of Energy, focused on grid modeling, sensing, resilience, reliability, and emergency response.

This work is already a critical priority for the Administration and the Department. Through the Department-wide Grid Modernization Initiative (GMI) and the Grid Modernization Lab Consortium (GMLC), DOE is uniquely positioned to drive innovation in technologies that will help counter grid vulnerabilities and provide necessary updates to our energy infrastructure.

Modernizing our grid will also require cooperation from many federal agencies, states, and industry partners. That is why I am glad to see that this legislation includes a technical assistance program to identify the evolving R&D needs of U.S. industry and the electric grid.

I want to thank all of my colleagues involved today for putting forward 3 bipartisan bills today that have been thoroughly reviewed by stakeholders and the Department. Thank you and I yield back the balance of my time.

Chairman LAMB. If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

[The prepared statement of Chairwoman Johnson follows:]

Good afternoon and thank you, Chairman Lamb, for holding this mark-up to advance legislation that prioritizes research activities in geothermal energy production.

Americans have used various forms of geothermal energy since the 1800s. Despite this long history, geothermal energy technologies have largely struggled to become or remain competitive in modern energy markets, yet huge potential exists for further advancement and commercialization.

In my home state of Texas, there is great potential for geothermal energy production that remains untapped, with naturally occurring large wells of hot water as well as other promising heat reservoirs below the ground.

Energy produced by geothermal technologies does not emit greenhouse gases. Just this Congress alone, this Committee has passed several bills that would reduce the impacts of climate change. I am hoping we can help a few more along today. Additionally, not only can geothermal technologies produce clean electricity, but they can also be used for industrial applications, such as through heat production for manufacturing processes or critical mineral extraction.

These are all reasons why I am pleased these issues received serious attention during a Subcommittee hearing held last month. That hearing brought together esteemed experts - one of which from the Great State of Texas I might add - who reinforced our understanding that geothermal energy production has huge potential as an essential resource in our clean energy technology portfolio.

I am glad that we are addressing this important issue today by considering the *Advanced Geothermal Research and Development Act* introduced by my friend Ranking Member Lucas, which I am proud to co-sponsor. Thank you, Mr. Lucas, for working with us and introducing this great piece of legislation. The bill includes research initiatives on oil and gas technology transfer to geothermal research, secondary use research areas such as minerals recovery and storage, and new areas of research in enhanced geothermal systems. It also authorizes groundbreaking new research activities in advanced geothermal computing and data science.

I want to thank Chairman Lamb once again for convening this mark-up, and I look forward to continuing to work together with my colleagues on both sides of the aisle to pass legislation that helps advance geothermal energy as well as a broad range of other clean energy technologies.

With that, I yield back.

[The prepared statement of Mr. Lucas follows:]

Thank you, Chairman Lamb. This morning, I am grateful for the opportunity to discuss my bill, H.R. 5374, the *Advanced Geothermal Research and Development Act of 2019*, which is cosponsored by Chairwoman Johnson and authorizes research, de-

velopment, and demonstration of innovative geothermal energy technologies at the Department of Energy (DOE).

Geothermal energy systems draw from the constant and naturally occurring heat that radiates beneath the surface of the earth. This heat is a source of clean and renewable energy that is always "on." Our country has significant geothermal energy resources, and if harnessed correctly, these resources can provide secure, base-load power and energy storage for Americans across the country.

Yet although the United States leads the world in installed geothermal capacity, geothermal energy contributes less than one percent to the total utility-scale U.S. electricity generation.

This is because today's geothermal energy technologies are often too expensive, time-consuming, or risky for industry to take to scale. While I've seen the potential of geothermal energy in my district in Oklahoma, more work needs to be done to allow the rest of the country to access the full power of this resource.

In order to effectively leverage these vast untapped energy resources, geothermal technologies and techniques must become more efficient and less expensive for American consumers. Fortunately, we are uniquely positioned to prioritize the basic and early stage research that leads to groundbreaking technology.

Federally funded research programs have a history of paving the way for industry innovation. So I am pleased to see DOE and its Geothermal Technologies Office taking the lead in this valuable science.

It is critically important to our clean energy future that they have the support they need to pursue research that industry cannot undertake.

My legislation will provide DOE with critical funding and program direction to enable innovative research in advanced geothermal technologies, strengthen the U.S. geothermal workforce, and encourage international collaboration. More specifically, it will authorize and expand the Department's early-stage research in enhanced geothermal systems and the major user facilities needed to support this work.

H.R. 5374 will also authorize a new program in advanced geothermal computing and data science R&D. This will leverage DOE's best-in-the-world computational capabilities to provide geothermal researchers with modeling and simulation tools that will allow them to more accurately understand complex subsurface systems.

With these tools, industry can improve the next generation of geothermal energy technologies, using advanced designs to save time and money in planning, and producing power more efficiently with less impact on the environment.

We know that American industry has the resources to successfully commercialize new technology. What they often lack is the infrastructure to conduct early stage research and test new technologies. This is where DOE, the national labs, and academia can help, providing experimental facilities and computational tools that will drive costs down and innovation forward.

If we want to ensure a diverse portfolio of clean energy technologies now and in the future, we in Congress should prioritize this important fundamental research.

I want to thank Chairwoman Johnson and her staff for working with me on this legislation. I believe this bill is an excellent example of our shared goals on this Committee, and I look forward to continuing to work with you all to support this common sense, productive, and bipartisan legislation. I yield back the balance of my time.

H.R. 2986

Chairman LAMB. And we will move on to consider H.R. 2986, the *BEST Act*. The Clerk will report the bill.

The CLERK. H.R. 2986, a bill—

[The bill follows:]

to incorporate many of the key provisions from that bill into this amendment in the nature of a substitute.

I'm glad we were able to come together on this legislation. I'd like to sincerely thank my colleagues and their dedicated staffs for working with me and my team to incorporate these provisions into this amendment. I believe this makes an already important piece of legislation all the more impactful in accomplishing the critical goal of developing, de-risking, and deploying energy storage to the grid. I applaud the Committee for taking up this critical issue, and I urge my colleagues to vote yes on this amendment and the *BEST Act*. I yield back.

Chairman LAMB. Is there any further discussion on the amendment? The vote will occur on the amendment. All in favor say aye. Those opposed say no. The ayes have it, and the amendment is agreed to.

A reporting quorum being present, I move that the Energy Subcommittee of the Science, Space, and Technology Committee report H.R. 2986, as amended, to the full Committee, with the recommendation that the bill be approved. Those in favor of the motion will signify by saying aye. Opposed, no. The ayes have it, and the bill is favorably reported.

Without objection, the motion to reconsider is laid upon the table. I ask unanimous consent that staff be authorized to make any necessary technical and conforming changes to the bill. Without objection, so ordered. Members will have 2 subsequent calendar days in which to submit supplemental, minority, or additional views on the measure.

H.R. 5374

Chairman LAMB. We will now consider H.R. 5374, the *Advanced Geothermal Research and Development Act of 2019*. The Clerk will report the bill.

The CLERK. H.R. 5374, a bill—

[The bill follows:]

.....
(Original Signature of Member)

116TH CONGRESS
1ST SESSION

H. R. _____

To establish and support advanced geothermal research and development programs at the Department of Energy, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

Mr. LUCAS introduced the following bill; which was referred to the Committee on _____

A BILL

To establish and support advanced geothermal research and development programs at the Department of Energy, and for other purposes.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*

3 **SECTION 1. SHORT TITLE; TABLE OF CONTENTS.**

4 (a) **SHORT TITLE.**—This Act may be cited as the
5 “Advanced Geothermal Research and Development Act of
6 2019”.

7 (b) **TABLE OF CONTENTS.**—The table of contents for
8 this Act is as follows:

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- Sec. 1. Short title; table of contents.
- Sec. 2. Definitions.
- Sec. 3. Hydrothermal research and development.
- Sec. 4. General geothermal systems research and development.
- Sec. 5. Enhanced geothermal systems research and development.
- Sec. 6. Cost sharing and proposal evaluation.
- Sec. 7. Advanced geothermal computing and data science research and development.
- Sec. 8. Geothermal workforce development.
- Sec. 9. Reporting requirements.
- Sec. 10. Repeals.
- Sec. 11. Authorization of appropriations.
- Sec. 12. International geothermal energy development.
- Sec. 13. Reauthorization of High Cost Region Geothermal Energy Grant Program.

1 **SEC. 2. DEFINITIONS.**

2 Section 612(1) of the Energy Independence and Se-
 3 curity Act of 2007 (42 U.S.C. 17191(1)) is amended to
 4 read as follows:

5 “(1) ENGINEERED.—When referring to en-
 6 hanced geothermal systems, the term ‘engineered’
 7 means designed to access subsurface heat, including
 8 stimulation and nonstimulation technologies to ad-
 9 dress one or more of the following issues:

10 “(A) Lack of effective permeability, poros-
 11 ity or open fracture connectivity within the heat
 12 reservoir.

13 “(B) Insufficient contained geofluid in the
 14 heat reservoir.

15 “(C) A low average geothermal gradient
 16 which necessitates deeper drilling, or the use of
 17 alternative heat sources or heat generation
 18 processes.”

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1 **SEC. 3. HYDROTHERMAL RESEARCH AND DEVELOPMENT.**

2 Section 613 of the Energy Independence and Security
3 Act of 2007 (42 U.S.C. 17192) is amended to read as
4 follows:

5 **“SEC. 613. HYDROTHERMAL RESEARCH AND DEVELOP-**
6 **MENT.**

7 **“(a) IN GENERAL.**—The Secretary shall carry out a
8 program of research, development, demonstration, and
9 commercial application for geothermal energy production
10 from hydrothermal systems.

11 **“(b) PROGRAMS.**—The program authorized in sub-
12 section (a) shall include the following:

13 **“(1) ADVANCED HYDROTHERMAL RESOURCE**
14 **TOOLS.**—The research and development of advanced
15 geologic tools to assist in locating hydrothermal re-
16 sources, and to increase the reliability of site charac-
17 terization, including the development of new imaging
18 and sensing technologies and techniques to assist in
19 prioritization of targets for characterization;

20 **“(2) EXPLORATORY DRILLING FOR GEO-**
21 **THERMAL RESOURCES.**—The demonstration of ad-
22 vanced technologies and techniques of siting and ex-
23 ploratory drilling for undiscovered resources in a va-
24 riety of geologic settings, carried out in collaboration
25 with industry partners that will assist in the acquisi-

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1 tion of high quality data sets relevant for hydro-
2 thermal subsurface characterization activities”.

3 **SEC. 4. GENERAL GEOTHERMAL SYSTEMS RESEARCH AND**
4 **DEVELOPMENT.**

5 Section 614 of the Energy Independence and Security
6 Act of 2007 (42 U.S.C. 17193) is amended to read as
7 follows:

8 **“SEC. 614. GENERAL GEOTHERMAL SYSTEMS RESEARCH**
9 **AND DEVELOPMENT.**

10 **“(a) SUBSURFACE COMPONENTS AND SYSTEMS.—**

11 The Secretary shall support a program of research, devel-
12 opment, demonstration, and commercial application of
13 components and systems capable of withstanding geo-
14 thermal environments and necessary to develop, produce,
15 and monitor geothermal reservoirs and produce geo-
16 thermal energy.

17 **“(b) ENVIRONMENTAL IMPACTS.—**The Secretary
18 shall—

19 **“(1)** support a program of research, develop-
20 ment, demonstration, and commercial application of
21 technologies and practices designed to mitigate or
22 preclude potential adverse environmental impacts of
23 geothermal energy development, production or use;
24 and

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1 “(2) support a research program to identify po-
2 tential environmental impacts and environmental
3 benefits of geothermal energy development, produc-
4 tion, and use, and ensure that the program de-
5 scribed in paragraph (1) addresses such impacts, in-
6 cluding effects on groundwater and local hydrology;

7 “(3) support a program of research to compare
8 the potential environmental impacts and environ-
9 mental benefits identified as part of the develop-
10 ment, production, and use of geothermal energy with
11 the potential emission reductions of greenhouse
12 gases gained by geothermal energy development,
13 production, and use; and

14 “(4) in carrying out this section, the Secretary
15 shall, to the maximum extent practicable, consult
16 with relevant federal agencies, including the Envi-
17 ronmental Protection Agency.

18 “(c) RESERVOIR THERMAL ENERGY STORAGE.—The
19 Secretary shall support a program of research, develop-
20 ment, and demonstration of reservoir thermal energy stor-
21 age, emphasizing cost-effective improvements through
22 deep direct use engineering, design, and systems research.

23 “(d) OIL AND GAS TECHNOLOGY TRANSFER INITIA-
24 TIVE.—

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1 “(1) IN GENERAL.—The Secretary shall sup-
2 port an initiative among the Office of Fossil Energy,
3 the Office of Energy Efficiency and Renewable En-
4 ergy, and the private sector to research, develop, and
5 demonstrate relevant advanced technologies and op-
6 eration techniques used in the oil and gas sector for
7 use in geothermal energy development.

8 “(2) PRIORITIES.—In carrying out paragraph
9 (1), the Secretary shall prioritize technologies with
10 the greatest potential to significantly increase the
11 use and lower the cost of geothermal energy in the
12 United States, including the cost and speed of geo-
13 thermal drilling.

14 “(3) COPRODUCTION OF GEOTHERMAL ENERGY
15 AND MINERALS PRODUCTION RESEARCH AND DE-
16 VELOPMENT INITIATIVE.—

17 “(A) IN GENERAL.—The Secretary shall
18 carry out a research and development initiative
19 under which the Secretary shall award grants
20 to demonstrate the coproduction of critical min-
21 erals from geothermal resources.

22 “(B) REQUIREMENTS.—An award made
23 under subparagraph (A) shall—

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- 1 “(i) improve the cost effectiveness of
2 removing minerals from geothermal brines
3 as part of the coproduction process;
4 “(ii) increase recovery rates of the
5 targets mineral commodity;
6 “(iii) decrease water use and other en-
7 vironmental impacts, as determined by the
8 Secretary; and
9 “(iv) demonstrate a path to commer-
10 cial viability.”.

11 **SEC. 5. ENHANCED GEOTHERMAL SYSTEMS RESEARCH**
12 **AND DEVELOPMENT.**

13 Section 615 of the Energy Independence and Security
14 Act of 2007 (42 U.S.C. 17194) is amended to read as
15 follows:

16 **“SEC. 615. ENHANCED GEOTHERMAL SYSTEMS RESEARCH**
17 **AND DEVELOPMENT.**

18 “(a) IN GENERAL.—The Secretary shall support a
19 program of research, development, demonstration, and
20 commercial application for enhanced geothermal systems,
21 including the programs described in subsection (b).

22 “(b) ENHANCED GEOTHERMAL SYSTEMS TECH-
23 NOLOGIES.—In collaboration with industry partners, the
24 Secretary shall support a program of research, develop-
25 ment, demonstration, and commercial application of the

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1 technologies to achieve higher efficiency and lower cost en-
2 hanced geothermal systems, including—

- 3 “(1) reservoir stimulation;
- 4 “(2) reservoir characterization, monitoring, and
5 modeling;
- 6 “(3) stress and fracture mapping including real
7 time monitoring and modeling;
- 8 “(4) tracer development;
- 9 “(5) three and four-dimensional seismic imag-
10 ing and tomography;
- 11 “(6) well placement and orientation;
- 12 “(7) long-term reservoir management;
- 13 “(8) drilling technologies, methods, and tools;
- 14 “(9) improved exploration tools;
- 15 “(10) zonal isolation; and
- 16 “(11) understanding induced seismicity risks
17 from reservoir engineering and stimulation.

18 “(c) FRONTIER OBSERVATORY FOR RESEARCH IN
19 GEOTHERMAL ENERGY.—The Secretary shall support the
20 establishment and construction of up to 3 field research
21 sites operated by public or academic entities, which shall
22 each be known as a ‘Frontier Observatory for Research
23 in Geothermal Energy’ or ‘FORGE’ site to develop, test,
24 and enhance techniques and tools for enhanced geothermal
25 energy.

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1 “(1) DUTIES.—The Secretary shall—

2 “(A) award grants in support of research
3 and development projects focused on advanced
4 monitoring technologies, new technologies and
5 approaches for implementing multi-zone stimu-
6 lations, and dynamic reservoir modeling that in-
7 corporates all available high-fidelity character-
8 ization data; and

9 “(B) seek opportunities to coordinate ef-
10 forts and share information with domestic and
11 international partners engaged in research and
12 development of geothermal systems and related
13 technology.

14 “(2) SITE SELECTION.—Of the FORGE sites
15 referred to in paragraph (1), the Secretary shall—

16 “(A) consider applications through a com-
17 petitive, merit-reviewed process, from National
18 Laboratories, multi-institutional collaborations,
19 institutes of higher education and other appro-
20 priate entities best suited to provide national
21 leadership on geothermal related issues and
22 perform the duties enumerated under this sub-
23 section; and

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1 “(B) prioritize existing field sites and fa-
2 cilities with capabilities relevant to the duties
3 enumerated under this subsection.

4 “(3) FUNDING.—Out of funds authorized to be
5 appropriated under section 11 of the ‘Advanced Geo-
6 thermal Research and Development Act of 2019’,
7 there shall be made available to the Secretary to
8 carry out the FORGE activities under this para-
9 graph—

10 “(A) \$45,000,000 for fiscal year 2020;

11 “(B) \$55,000,000 for fiscal year 2021;

12 “(C) \$65,000,000 for fiscal year 2022;

13 “(D) \$70,000,000 for fiscal year 2023;

14 and

15 “(E) \$70,000,000 for fiscal year 2024.

16 In carrying out this section, the Secretary shall con-
17 sider the balance between funds dedicated to con-
18 struction and operations and research activities to
19 reflect the state of site development.

20 “(4) ENHANCED GEOTHERMAL SYSTEMS DEM-
21 ONSTRATIONS.—

22 “(A) IN GENERAL.—Beginning on the date
23 of enactment of the ‘Advanced Geothermal En-
24 ergy Research and Development Act of 2019’,
25 the Secretary, in collaboration with industry

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1 partners and institutions of higher education,
2 shall support an initiative for demonstration of
3 enhanced geothermal systems for power produc-
4 tion or direct use.

5 “(B) PROJECTS.—

6 “(i) IN GENERAL.—Under the initia-
7 tive described in subparagraph (A), dem-
8 onstration projects shall be carried out in
9 locations that are commercially viable for
10 enhanced geothermal systems development,
11 while also considering environmental im-
12 pacts to the maximum extent practicable,
13 as determined by the Secretary.

14 “(ii) REQUIREMENTS.—Demonstra-
15 tion projects under clause (i) shall—

16 “(I) collectively demonstrate—

17 “(aa) different geologic set-
18 tings, such as hot sedimentary
19 aquifers, layered geologic sys-
20 tems, supercritical systems, and
21 basement rock systems; and

22 “(bb) a variety of develop-
23 ment techniques, including open
24 hole and cased hole completions,

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1 differing well orientations, and
2 stimulation mechanisms; and

3 “(II) to the extent practicable,
4 use existing sites where subsurface
5 characterization or geothermal energy
6 integration analysis has been con-
7 ducted.

8 “(iii) **EASTERN DEMONSTRATION.**—
9 Not less than 1 demonstration project car-
10 ried out under clause (i) shall be located in
11 an area east of the Mississippi River that
12 is suitable for enhanced geothermal dem-
13 onstration for power, heat, or a combina-
14 tion of power and heat.”.

15 **SEC. 6. COST SHARING AND PROPOSAL EVALUATION.**

16 Section 617(b) of the Energy Independence and Se-
17 curity Act of 2007 (42 U.S.C. 17196) is amended by strik-
18 ing paragraph (2) and redesignating paragraphs (3) and
19 (4) as paragraphs (2) and (3), respectively.

20 **SEC. 7. ADVANCED GEOTHERMAL COMPUTING AND DATA
21 SCIENCE RESEARCH AND DEVELOPMENT.**

22 (a) **IN GENERAL.**—Section 618 of the Energy Inde-
23 pendence and Security Act of 2007 (42 U.S.C. 17197) is
24 amended to read as follows:

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1 **“SEC. 618. ADVANCED GEOTHERMAL COMPUTING AND**
2 **DATA SCIENCE RESEARCH AND DEVELOP-**
3 **MENT.**

4 “(a) **IN GENERAL.**—The Secretary shall carry out a
5 program of research and development of advanced com-
6 puting and data science tools for geothermal energy.

7 “(b) **PROGRAMS.**—The program authorized in sub-
8 section (a) shall include the following:

9 “(1) **ADVANCED COMPUTING FOR GEOTHERMAL**
10 **SYSTEMS TECHNOLOGIES.**—Research, development,
11 and demonstration of technologies to develop ad-
12 vanced data, machine learning, artificial intelligence,
13 and related computing tools to assist in locating geo-
14 thermal resources, to increase the reliability of site
15 characterization, to increase the rate and efficiency
16 of drilling, to improve induced seismicity mitigation,
17 and to support enhanced geothermal systems tech-
18 nologies.

19 “(2) **GEOTHERMAL SYSTEMS RESERVOIR MOD-**
20 **ELING.**—Research, development, and demonstration
21 of models of geothermal reservoir performance and
22 enhanced geothermal systems reservoir stimulation
23 technologies and techniques, with an emphasis on
24 accurately modeling heat flow, permeability evo-
25 lution, seismicity, and operational performance over

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1 time, including collaboration with industry and field
2 validation.

3 “(c) COORDINATION.—In carrying out these pro-
4 grams, the Secretary shall ensure coordination and con-
5 sultation with the Department of Energy’s Office of
6 Science. The Secretary shall ensure, to the maximum ex-
7 tent practicable, coordination of these activities with the
8 Department of Energy National Laboratories, institutes
9 of higher education, and the private sector.”

10 (b) CONFORMING AMENDMENT.—Section 1(b) of the
11 Energy Independence and Security Act of 2007 (42
12 U.S.C. 17001 note) is amended in the table of contents
13 by amending the item related to section 618 to read as
14 follows:

“Sec. 618. Advanced geothermal computing and data science research and de-
velopment.”

15 **SEC. 8. GEOTHERMAL WORKFORCE DEVELOPMENT.**

16 (a) IN GENERAL.—Section 619 of the Energy Inde-
17 pendence and Security Act of 2007 (42 U.S.C. 17198) is
18 amended to read as follows:

19 **“SEC. 619. GEOTHERMAL WORKFORCE DEVELOPMENT.**

20 “The Secretary shall support the development of a
21 geothermal energy workforce through a program that—

22 “(1) facilitates collaboration between university
23 students and researchers at the national labora-
24 tories; and

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1 “(2) prioritizes science in areas relevant to the
2 mission of the Department through the application
3 of geothermal energy tools and technologies.”.

4 (b) CONFORMING AMENDMENT.—Section 1(b) of the
5 Energy Independence and Security Act of 2007 (42
6 U.S.C. 17001 note) is amended in the table of contents
7 by amending the item related to section 619 to read as
8 follows:

 “Sec. 619. Geothermal workforce development.”.

9 **SEC. 9. REPORTING REQUIREMENTS.**

10 Section 621 of the Energy Independence and Security
11 Act of 2007 (42 U.S.C. 17200) is amended to read as
12 follows:

13 **“SEC. 621. REPORTS.**

14 “(a) REPORT.—Every 5 years after the date of enact-
15 ment of Advanced Geothermal Research and Development
16 Act of 2019 , the Secretary shall report to the Committee
17 on Science and Technology of the House of Representa-
18 tives and the Committee on Energy and Natural Re-
19 sources of the Senate on advanced concepts and tech-
20 nologies to maximize the geothermal resource potential of
21 the United States.

22 “(b) PROGRESS REPORTS.—Not later than 1 year
23 after the date of enactment of the ‘Advanced Geothermal
24 Research and Development Act of 2019’, and every 2
25 years thereafter, the Secretary shall submit to the Com-

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1 mittee on Science and Technology of the House of Rep-
2 resentatives and the Committee on Energy and Natural
3 Resources of the Senate a report on the results of projects
4 undertaken under this part and other such information
5 the Secretary considers appropriate.”.

6 **SEC. 10. REPEALS.**

7 (a) IN GENERAL.—Subtitle B of title VI of the En-
8 ergy Independence and Security Act of 2007 (42 U.S.C.
9 17191 et seq.) is amended by striking section 620.

10 (b) CONFORMING AMENDMENT.—Section 1(b) of the
11 Energy Independence and Security Act of 2007 (42
12 U.S.C. 17001 note) is amended in the table of contents
13 by striking the item related to section 620.

14 **SEC. 11. AUTHORIZATION OF APPROPRIATIONS.**

15 Section 623 of the Energy Independence and Security
16 Act of 2007 (42 U.S.C. 17202) is amended to read as
17 follows:

18 **“SEC. 623. AUTHORIZATION OF APPROPRIATIONS.**

19 “There are authorized to be appropriated to the Sec-
20 retary to carry out the programs under the ‘Advanced
21 Geothermal Research and Development Act of 2019’—

22 “(1) \$100,000,000 for fiscal year 2020;

23 “(2) \$111,125,000 for fiscal year 2021;

24 “(3) \$122,250,000 for fiscal year 2022;

25 “(4) \$128,375,000 for fiscal year 2023; and

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1 “(5) \$129,500,000 for fiscal year 2024.”.

2 **SEC. 12. INTERNATIONAL GEOTHERMAL ENERGY DEVELOP-**
3 **MENT.**

4 Section 624 of the Energy Independence and Security
5 Act of 2007 (42 U.S.C. 17203) is amended—

6 (1) in subsection (a), to read as follows:

7 “(a) IN GENERAL.—The Secretary of Energy, in co-
8 ordination with other appropriate Federal and multilateral
9 agencies (including the United States Agency for Inter-
10 national Development) shall support collaborative efforts
11 with international partners to promote the research, devel-
12 opment, and demonstration of geothermal technologies
13 used to develop hydrothermal and enhanced geothermal
14 system resources.”; and

15 (2) by striking subsection (c).

16 **SEC. 13. REAUTHORIZATION OF HIGH COST REGION GEO-**
17 **THERMAL ENERGY GRANT PROGRAM.**

18 Section 625 of the Energy Independence and Security
19 Act of 2007 (42 U.S.C. 17204) is amended—

20 (1) in subsection (a)(2), by inserting “ or heat”
21 after “electrical power”; and

22 (2) in subsection (e), to read as follows:

23 “(e) AUTHORIZATION OF APPROPRIATIONS.—Out of
24 funds authorized under section 11 of the ‘Advanced Geo-
25 thermal Research and Development Act of 2019’, there

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1 is authorized to be appropriated to carry out this section
2 \$5,000,000 for each of fiscal years 2020 through 2024.”.

Chairman LAMB. Without objection, the bill is considered as read, and open to amendment at any point. I recognize Ranking Member Lucas to present his remarks on the bill.

Mr. LUCAS. Thank you, Chairman Lamb. This morning I'm grateful for the opportunity to discuss my bill, H.R. 5374, the *Advanced Geothermal Research and Development Act of 2019*, which is co-sponsored by Chairwoman Johnson, and authorizes research, development, and demonstration of innovative geothermal energy technologies at the Department of Energy.

Geothermal energy systems draw from the constant and natural occurring heat that radiates beneath the surface of the Earth. This heat is a source of clean, renewable energy that is always on. Our country has significant geothermal resources, and, if harnessed correctly, these resources could provide secure baseload power and energy storage for Americans across the country. Yet although the United States leads the world in installed geothermal capacity, geothermal energy contributes less than 1 percent of the total utility-scale U.S. electrical generation. This is because today's geothermal energy technologies are often too expensive, time-consuming, or risky for industry to take to scale.

While I've seen the potential for geothermal in my district in Oklahoma, more work needs to be done to allow the rest of the country to access the full power of this resource. In order to effectively leverage these vast untapped energy resources, geothermal technologies and techniques must become more efficient, and less expensive for American consumers. Fortunately, we are uniquely positioned to prioritize the basic and early-stage research that leads to groundbreaking technology. Federally funded research programs have a history of paving the way for industry innovation, so I am pleased to see DOE and its Geothermal Technologies Office taking the lead in this valuable science. It's critically important to our clean energy future that we have the support they need to pursue research that industry cannot undertake. My legislation will provide DOE with critical funding and program direction to enable innovative research in advanced geothermal technologies, strengthening the U.S. geothermal workforce, and encourage international collaboration. More specifically, it will authorize and expand the Department's early-stage research in enhanced geothermal systems and the major user facilities needed to support this work.

H.R. 5374 will also authorize a new program to advance geothermal computing and data science R&D. This will leverage DOE's best-in-the-world computerization capacities to provide geothermal researchers with modeling and simulation tools that will allow them to more accurately understand complex sub-surface systems. With these tools, industry can improve the next generation of geothermal technologies, using advanced designs to save time, and money, and planning, and produce more power efficiently with less impact on the environment.

We know that American industry has the resources to successfully commercialize new technology. What they often lack is the infrastructure to conduct early stage research and test new technologies. This is where DOD (Department of Defense), DOE, the national labs, and academia can help provide experimental facilities and computerization tools that will drive costs down, and inno-

vation forward. If we want to ensure a diverse portfolio of clean energy technologies now and in the future, we in Congress should prioritize this important fundamental research.

I want to thank Chairwoman Johnson and her staff for working with me on this legislation. I believe this bill is an excellent example of our shared goals on this Committee, and I will look forward to continue to work with you all to support this common sense, productive, bipartisan legislation. And I yield back the balance of my time, Mr. Chairman.

Chairman LAMB. Does anyone else wish to be recognized?

Mr. CASTEN. Move to strike the last word.

Chairman LAMB. Mr. Casten is recognized for 5 minutes.

Mr. CASTEN. I'd like to thank Chairwoman Johnson and Ranking Member Lucas for their leadership on this bill to help advance geothermal energy resource. It is a good bill, and it takes important steps toward advancing a woefully underutilized source of energy.

I'd like to see if we could, before we get to full Committee markup, though, if we could work together to ensure the bill develops geothermal energy where the potential is highest. And this is going to be a little bit counterintuitive. We don't often think of the, you know, the places like Illinois and the Northeast as places where there's a big geothermal potential because we don't have a lot of volcanoes, or hot springs, or those sorts of things, but the market potential for geothermal energy was a function of the source of the heat, the load, and the temperature delta.

And so when you've got a lot of residential homes, and not super high-grade heat coming down from under the sub-surface area, but you do have a nice delta T in the wintertime, there's actually a really good potential for geothermal energy. And that's actually consistent with the recent Department of Energy report. Their GeoVision Report shows that the geothermal heat potential is highest in midwestern States like Illinois, and northeastern States like New York. I was talking with Congressman Tonko about this recently, and we're both interested in making sure that this novel research in geothermal energy does occur where it can be most useful, so, as we move forward, I'd be grateful if we could consider more provisions that ensure geothermal research occurs in those high potential areas in the Northeast and Midwest.

Thank you again the Chairwoman Johnson and Ranking Member Lucas for your work on this. I really do appreciate your leadership and commitment to developing this important area of energy, and I hope we can work together to ensure those provisions are included. I yield the remainder of my time.

Chairman LAMB. Does anyone else wish to be recognized? We will now proceed with the amendments in the order of the roster. The first amendment on the roster is an amendment offered by the gentleman from Illinois. He is recognized to offer an amendment.

Mr. LIPINSKI. Mr. Chairman, I have an amendment at the desk.

Chairman LAMB. The Clerk will report the amendment.

The CLERK. Amendment No. 1, amendment to H.R. 5374, offered by Mr. Lipinski.

[The amendment follows:]

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AMENDMENT TO H.R. 5374
OFFERED BY Mr. Lipinski

Page 12, after line 14, insert the following (and re-designate succeeding sections accordingly):

1 **SEC. 6. GEOTHERMAL HEAT PUMPS AND DIRECT USE.**

2 (a) IN GENERAL.—Title VI of the Energy Independ-
3 ence and Security Act of 2007 is amended by inserting
4 after section 616 (42 U.S.C. 17195) the following:

5 **“SEC. 616A. GEOTHERMAL HEAT PUMPS AND DIRECT USE**
6 **RESEARCH AND DEVELOPMENT.**

7 “(a) PURPOSES.—The purposes of this section are—

8 “(1) to improve the components, processes, and
9 systems used for geothermal heat pumps and the di-
10 rect use of geothermal energy; and

11 “(2) to increase the energy efficiency, lower the
12 cost, increase the use, and improve and demonstrate
13 the effectiveness of geothermal heat pumps and the
14 direct use of geothermal energy.

15 “(b) DEFINITIONS.—In this section:

16 “(1) DIRECT USE OF GEOTHERMAL ENERGY.—
17 The term ‘direct use of geothermal energy’ means
18 geothermal systems that use water directly or
19 through a heat exchanger to provide—

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1 “(A) heating to buildings, commercial dis-
2 tricts, residential communities, and large mu-
3 nicipal, or industrial projects; or

4 “(B) heat required for industrial processes,
5 agriculture, aquaculture, and other facilities.

6 “(2) ECONOMICALLY DISTRESSED AREA.—The
7 term ‘economically distressed area’ means an area
8 described in section 301(a) of the Public Works and
9 Economic Development Act of 1965 (42 U.S.C.
10 3161(a)).

11 “(3) GEOTHERMAL HEAT PUMP.—The term
12 ‘geothermal heat pump’ means a system that pro-
13 vides heating and cooling by exchanging heat from
14 shallow ground or surface water using—

15 “(A) a closed loop system, which transfers
16 heat by way of buried or immersed pipes that
17 contain a mix of water and working fluid; or

18 “(B) an open loop system, which circulates
19 ground or surface water directly into the build-
20 ing and returns the water to the same aquifer
21 or surface water source.

22 “(c) PROGRAM.—

23 “(1) IN GENERAL.—The Secretary shall sup-
24 port within the Geothermal Technologies Office a
25 program of research, development, and demonstra-

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1 tion for geothermal heat pumps and the direct use
2 of geothermal energy.

3 “(2) AREAS.—The program under paragraph
4 (1) may include research, development, demonstra-
5 tion, and commercial application of—

6 “(A) geothermal ground loop efficiency im-
7 provements, cost reductions, and improved in-
8 stallation and operations methods;

9 “(B) the use of geothermal energy for
10 building-scale energy storage;

11 “(C) the use of geothermal energy as a
12 grid management resource or seasonal energy
13 storage;

14 “(D) geothermal heat pump efficiency im-
15 provements;

16 “(E) the use of alternative fluids as a heat
17 exchange medium, such as hot water found in
18 mines and mine shafts, graywater, or other
19 fluids that may improve the economics of geo-
20 thermal heat pumps;

21 “(F) heating of districts, neighborhoods,
22 communities, large commercial or public build-
23 ings, and industrial and manufacturing facili-
24 ties;

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4

1 “(G) the use of water sources at a tem-
2 perature of less than 150 degrees Celsius for di-
3 rect use; and

4 “(H) system integration of direct use with
5 geothermal electricity production.

6 “(3) ENVIRONMENTAL IMPACTS.—In carrying
7 out the program, the Secretary shall identify and
8 mitigate potential environmental impacts in accord-
9 ance with section 614(c).

10 “(d) GRANTS.—

11 “(1) IN GENERAL.—The Secretary shall carry
12 out the program established in subsection (c) by
13 making grants available to State, local, and Tribal
14 governments, institutions of higher education, non-
15 profit entities, National Laboratories, utilities, and
16 for-profit companies.

17 “(2) PRIORITY.—In making grants under this
18 subsection, the Secretary may give priority to pro-
19 posals that apply to large buildings, commercial dis-
20 tricts, and residential communities that are located
21 in economically distressed areas.”

22 (b) CONFORMING AMENDMENT.—Section 1(b) of the
23 Energy Independence and Security Act of 2007 (42
24 U.S.C. 17001 note) is amended in the table of contents

65

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5

1 by inserting after the item relating to section 616 the fol-

2 lowing:

“616A. Geothermal heat pumps and direct use research and development.”.



Chairman LAMB. I ask unanimous consent to dispense with the reading. Without objection, so ordered. Recognize the gentleman for 5 minutes to explain the amendment.

Mr. LIPINSKI. Thank you, Mr. Chairman. I want to commend the Committee for the bipartisan work on this bill, Ranking Member Lucas for introducing this bill, and Chairwoman Johnson for also working together with Mr. Lucas to move this forward.

Climate change has long been among my greatest concerns, and efforts like this to promote alternative energy sources will contribute to a cleaner future with lower greenhouse gas emissions. As we discuss geothermal energy, most immediately the geysers of Yellowstone come to mind. Much of this bill emphasizes a pathway to harness that dramatic energy into an electricity generation source. While we don't have any geysers like that in my home State of Illinois, we do have researchers working to advance direct-use applications of lower temperature geothermal energy, such as heating and cooling buildings. As Mr. Casten mentioned, the applications are great all across the country.

Illinois has abundant groundwater resources that are well-suited for direct geothermal heat exchange systems that could meet our heating needs during cold midwest winters. The University of Illinois is currently advancing research in these areas. The University even designed a novel geothermal heating and cooling system on the Engineering Campus. It is also conducting a feasibility study to convert the University president's house to be heated and cooled by a geothermal system as part of its strategy to reduce campus greenhouse gas emissions.

I believe that these low-temperature direct applications should be part of the climate change solution, and be part of this bill. A study was published just last week, led by researchers from Columbia University Center on Global Energy Policy, which suggests that further innovation on heat pumps, combined with regulatory measures, could reduce global greenhouse gas emissions from the heating and cooling sectors by 12 percent. I thank the Committee staff for working with my office to identify ways to expand research and demonstration in these areas.

I'm offering this amendment to direct the Department of Energy's Geothermal Technologies Office to support a research, development, and demonstration program into geothermal heat pumps, and the direct use of geothermal energy. The program will investigate new geothermal technologies for building-scale energy storage, seasonal energy storage, heating for neighborhoods and large commercial buildings, among other areas. This program also directs the Department of Energy to consider and mitigate any environmental impacts from these geothermal projects.

I thank the Committee for considering this amendment, and I urge my colleagues to support it, and I yield back my time.

Chairman LAMB. Any further discussion on the amendment? Mr. Ranking Member, you are recognized.

Mr. WEBER. Thank you, sir. The gentleman's amendment, on page 3, line 18? I'll give you a minute to get there, Daniel. Page 3, line 18.

Mr. LIPINSKI. OK.

Mr. WEBER. You're calling for use of alternative fluids as a heat exchange medium, such as hot water found in mines and mine shafts, gray water, or other fluids that may improve the economics of geothermal heat pumps. Under the other mediums you've got mines and mine shafts, and on line 18 it says gray water. What do you anticipate is the source of that gray water?

Mr. LIPINSKI. Well, I'm going to have to refer to staff to give me a good answer on that one.

Mr. WEBER. I thank the gentleman. I yield back.

Chairman LAMB. Any further discussion on the amendment? The vote will occur on the amendment. All in favor, say aye. Those opposed say no. The ayes have it, the amendment is agreed to. Are there any other amendments? If not, a reporting quorum being present, I move that the Energy Subcommittee on the Committee on Science, Space, and Technology report H.R. 5374, as amended, to the full Committee, with the recommendation that the bill be approved. Those in favor of the motion will signify by saying aye. Opposed, no. The ayes have it, and the bill is favorably reported.

Without objection, the motion to reconsider is laid upon the table. I ask unanimous consent that staff be authorized to make any necessary technical and conforming changes to the bill. Without objection, so ordered. Members will have 2 subsequent calendar days in which to submit supplemental, minority, or additional views on the measure.

H.R. 5428

Chairman LAMB. We will now consider H.R. 5428, the *Grid Modernization Research and Development Act of 2019*. The Clerk will report the bill.

The CLERK. H.R. 5428, a bill to amend the *Energy Independence and Security Act of 2007*, and the *Energy Policy Act of 2005*, to direct Federal research in grid modernization and security, and for other purposes.

[The bill follows:]

XXII. PROCEEDINGS OF THE FULL COMMITTEE MARKUP

MARKUPS:
**H.R. 2986, THE BETTER ENERGY STORAGE
TECHNOLOGY (BEST) ACT;**
**H.R. 4230, THE CLEAN INDUSTRIAL
TECHNOLOGY (CIT) ACT OF 2019;**
**H.R. 5374, THE ADVANCED GEOTHERMAL
RESEARCH AND DEVELOPMENT ACT OF 2019;**
**H.R. 5428, THE GRID MODERNIZATION
RESEARCH AND DEVELOPMENT
ACT OF 2019; AND**
**H.R. 5760, THE GRID SECURITY RESEARCH
AND DEVELOPMENT ACT**

MARKUP
BEFORE THE
**COMMITTEE ON SCIENCE, SPACE, AND
TECHNOLOGY**
HOUSE OF REPRESENTATIVES

ONE HUNDRED SIXTEENTH CONGRESS

SECOND SESSION

FEBRUARY 12, 2020

Serial No. CP: 116-15

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COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HON. EDDIE BERNICE JOHNSON, Texas, *Chairwoman*

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JENNIFER WEXTON, Virginia	
CONOR LAMB, Pennsylvania	
VACANCY	

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Wednesday, February 12, 2020

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**Markup on H.R. 2986,
Better Energy Storage Technology Act
or the BEST Act**

**Markup on H.R. 4230, Clean Industrial
Technology Act of 2019 or CIT Act of 2019**

**Markup on H.R. 5374,
Advanced Geothermal Research
and Development Act of 2019**

**Markup on H.R. 5428,
Grid Modernization Research
and Development Act of 2019**

**Markup on H.R. 5760,
Grid Security Research and Development Act**

WEDNESDAY, FEBRUARY 12, 2020

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, DC.

The Committee met, pursuant to notice, at 10 o'clock a.m., in room 2318 of the Rayburn House Office Building, Hon. Eddie Bernice Johnson [Chairwoman of the Committee] presiding.

Chairwoman JOHNSON. Good morning. The Committee will come to order. Without objection, the Chair is authorized to declare recess at any time. Pursuant to Committee rule and the House rules, the Chair announces that she may postpone roll call votes.

Pursuant to notice, the Committee meets to consider the following measures: H.R. 2986, *Better Energy Storage Technology Act*; H.R. 4230, *Clean Industrial Technology Act of 2019*; H.R. 5374, *Advanced Geothermal Research and Development Act of 2019*; H.R. 5428, *Grid Modernization Research and Development Act of 2019*; H.R. 5760, *Grid Security Research and Development Act*.

We welcome all to the Science Committee markup of five good, bipartisan bills. First, we will consider the *Better Energy Storage Technology Act (BEST ACT)*. The *BEST Act* authorizes the Department of Energy to conduct a crosscutting research, development, and demonstration program on energy storage technologies, including batteries and pumped hydro systems. The act requires DOE (Department of Energy) to create a 5-year strategic plan to coordinate research activities among DOE's technology offices.

Renewable energy technology can be intermittent. Strong winds die down, and sunny days turn cloudy. According to the Congressional Research Service, energy storage systems may be a key technology to enabling a reliable, low greenhouse-gas-emitting electric grid comprised of energy generation sources like wind and solar.

Next, we have H.R. 4230, the *Clean Industrial Technology Act of 2019*. The act authorizes an interagency, DOE-led research, development, and demonstration program to advance technologies that will help reduce emissions from the manufacturing sector, including steel and cement production, chemical production, and industrial heat. The research program will be carried out in collaboration with the stakeholders from industry and labor groups. Allowing American manufacturers to access technologies that make them increasingly sustainable will ensure that the domestic manufacturing industry will remain competitive throughout the 21st century.

We will then move to H.R. 5374, the *Advanced Geothermal Research and Development Act of 2019*. I will speak about this bill a little bit later.

Next is H.R. 5428, the *Grid Modernization Research and Development Act of 2019*, which authorizes a broad research, development, and demonstration program on a wide variety of topics pertaining to grid modernization, including smart grid modeling, planning, and controls; hybrid energy systems; and enhanced electric grid integration of technologies like vehicles and building components. Our Nation's electricity grid is undergoing a series of transformations, which includes adapting to a changing electricity generation mix, an increase in smart-grid technologies, and a growing need for improved resilience of the electric power grid. This bill will help lead our Nation in developing the technologies we need by setting forth a comprehensive research agenda by the DOE.

Finally, we'll be considering H.R. 5760, the *Grid Security Research and Development Act*. This bill is an updated version of a bill that Mr. Bera and I introduced, along with many of our Science Committee colleagues, in the previous two Congresses. H.R. 5760 will provide legislative guidance to activities carried out by the re-

cently established DOE Office of Cybersecurity, Energy Security, and Emergency Response. The bill authorizes an interagency research and development program to advance electric grid cybersecurity, physical security, grid resilience, and emergency response efforts. In particular, the bill authorizes activities on the cybersecurity testbeds, education and workforce training and standards, and guidance documents for energy sector cybersecurity practices.

I'm proud that today's bills are supported by a cross-section of interested groups. One or more of today's bills has been endorsed by organizations that include the National Audubon Society, the U.S. Chamber of Commerce, the Information Technology and Innovation Foundation, the Environmental Defense Fund, the National Rural Electric Cooperatives Association, Duke Energy, the Union of Concerned Scientists, the Natural Resources Defense Fund, and the National Association of Manufacturers.

Thank you.

[The statement of Chairwoman Johnson follows.]

Good morning, and welcome to today's Science Committee markup of five good, bipartisan bills.

First, we will consider H.R. 2986, the Better Energy Storage Technology Act. The BEST Act authorizes the Department of Energy to conduct a cross-cutting research, development, and demonstration program on energy storage technologies, including batteries and pumped hydro systems. The Act requires DOE create a 5-year strategic plan to coordinate research activities among DOE's technology offices.

Renewable energy technology can be intermittent. Strong winds die down, and sunny days turn cloudy. According to the Congressional Research Service, energy storage systems may be a key technology to enabling a reliable, low greenhouse gas emitting electric grid comprised of energy generation sources like wind and solar.

Next we have H.R. 4230, the Clean Industrial Technology Act of 2019. This act authorizes an intra-agency, DOE-led research, development, and demonstration program to advance technologies that will help reduce emissions from the manufacturing sector, including steel and cement production, chemical production, and industrial heat. The research program will be carried out in collaboration with stakeholders from industry and labor groups.

Allowing American manufacturers to access technologies that make them increasingly sustainable will ensure that the domestic manufacturing industry will remain competitive through the 21st Century.

We will then move on to H.R. 5374, the Advanced Geothermal Research and Development Act of 2019. I will speak about this bill a little later.

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Our nation's electricity grid is undergoing a series of transformations, which include adapting to a changing electricity generation mix, an increase in "smart grid" technologies, and a growing need to improve the resilience of the electric power grid. This bill will help lead our nation in developing the technologies we need by setting forth a comprehensive research agenda led by the DOE.

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I am proud that today's bills are supported by a cross-section of interested groups. One or more of today's bills has been endorsed by organizations that include: the

National Audubon Society, the U.S. Chamber of Commerce, the Information Technology & Innovation Foundation (ITIF), the Environmental Defense Fund (EDF), the National Rural Electric Cooperative Association, Duke Energy, the Union of Concerned Scientists, the Natural Resources Defense Fund, and the National Association of Manufacturers.

Chairwoman JOHNSON. I now recognize our Ranking Member for his opening remarks.

Mr. LUCAS. Thank you, Chairwoman Johnson, for holding today's full Committee markup.

The Science Committee has one of the best records in Congress for passing productive, bipartisan legislation, and I'm very pleased to see us upholding that tradition this morning. We've reached bipartisan agreement on the five energy bills being considered today.

Currently, the U.S. energy sector faces a number of critical challenges, and it can be difficult to find the best path forward in a world that increasingly demands cleaner, more reliable, and more affordable energy sources. But it is our job in Congress to set the priorities to address these challenges and focus our limited Federal resources where we can see the best return on investment.

To deliver truly effective solutions, we must take the long-term and big-picture approach. We must support research in fundamental science that drives innovation over a broad range of energy applications and strategically invest in the early stage clean-energy technologies that industry cannot support. We must also provide for R&D (research and development) to modernize and defend our critical energy infrastructure and address the complex energy needs of our Nation's industrial sectors. These are the initiatives that today's bills will address.

First, we'll consider this morning H.R. 2986, the *BEST Energy Storage Technology Act of 2019*. This legislation authorizes a cross-cutting research and development program at the Department of Energy to provide necessary direction on high-priority energy storage technology research and development activities. Advanced grid scale energy storage is an essential component of any comprehensive clean-energy strategy and a priority of the current Administration. Developing our grid scale energy storage ability will accelerate the growth in all kinds of energy production, which can make use of this technology.

Our second bill this morning is H.R. 4230, the *Clean Industrial Technology Act of 2019*. Our Nation's economic stability and national security are tied to the growth of the U.S. industrial sector, yet the demanding energy needs of industry can represent a unique challenge for our clean and secure future energy. This bill establishes a DOE program to support the development of innovative technologies and practices that will reduce industrial sector emissions while maintaining the effectiveness and competitiveness of U.S. industry. It also requires the Secretary to establish a comprehensive strategy to develop the mission and goals for this new program.

While I can't say I agree with every aspect of this legislation, I'd like to thank our friends across the aisle for meeting us at the table to come to an agreement. By having a good-faith discussion, we were able to add responsible funding levels and good governance provisions to H.R. 4230 that will make this legislation a bipartisan product.

Next, we'll consider my bill, H.R. 5374, the *Advanced Geothermal Research and Development Act of 2019*, which authorizes DOE's cutting-edge geothermal research and development activities. This bill establishes a geothermal computing program and includes funding for critical geothermal user facilities that will support the next generation of electricity generation from these vast and largely untapped renewable resources. I would like to thank Chairwoman Johnson for cosponsoring this legislation and working with me to refine it.

While many renewables like wind and solar are already seeing success in the market, early stage technologies like geothermal, which are often far too expensive and risky for industry to take to scale, require Federal support for R&D. By strategically investing in these promising technologies, we can continue to enhance our diverse domestic energy portfolio and bolster U.S. energy independence. While we support next-generation energy technologies and clean-energy strategies, we must also increase our investment in our critical energy infrastructure.

So, finally, the Committee will consider H.R. 5428, the *Grid Modernization Research and Development Act of 2019*, and H.R. 5760, the *Grid Security Research and Development Act*. Together, these two bills authorize DOE's critical work in strengthening our Nation's electric grid against rapidly changing technological challenges. The *Grid Security Research and Development Act* authorizes the Department's critical cybersecurity and emergency response R&D activities and directs DOE to work with relevant Federal agencies to develop cybersecurity best practices. The *Grid Modernization Research and Development Act* authorizes R&D into hybrid energy systems, grid integration, and smart grid modeling, modernizing the grid to improve its overall resilience and flexibility.

I'd like to take this opportunity to thank my good friends across the aisle for working with us on these bills. I appreciate that we can come together to focus on our shared interest in supporting commonsense legislation to maintain U.S. national security, environmental stewardship, economic prosperity, and energy security for years to come. And I'd like to again thank Chairwoman Johnson for holding this markup, and I yield back the balance of my time.

[The statement of Mr. Lucas follows:]

Thank you, Chairwoman Johnson, for holding today's full Committee mark-up,

The Science Committee has one of the best track records in Congress for passing productive, bipartisan legislation, and I'm very pleased to see us upholding that tradition this morning. We've reached bipartisan agreement on the five energy bills being considered today.

Currently, the U.S. energy sector faces a number of critical challenges, and it can be difficult to find the best path forward in a world that increasingly demands cleaner, more reliable, and more affordable energy sources. But it is our job in Congress to set the priorities to address these challenges and focus our limited federal funds where we can see the best return on investment.

To deliver truly effective solutions, we must take the long-term and big picture approach. We must support research in fundamental science that drives innovation over a broad range of energy applications, and strategically invest in the early-stage clean energy technologies that industry cannot support. We must also provide for R&D to modernize and defend our critical energy infrastructure and address the complex energy needs of our nation's industrial sectors. These are the initiatives that today's bills will address.

The first bill we will consider this morning is H.R. 2986, the "Better Energy Storage Technology Act of 2019." This legislation authorizes a cross-cutting research and development program at the Department of Energy (DOE) to provide necessary direction on high-priority energy storage technology research and development activities.

Advanced grid scale energy storage is an essential component of any comprehensive clean energy strategy and a priority of the current administration. Developing our grid scale energy storage ability will accelerate growth in all kinds of energy production, which can make use of this technology.

Our second bill this morning is H.R. 4230, the "Clean Industrial Technology Act of 2019." Our nation's economic stability and national security are tied to the growth of the U.S. industrial sector.

Yet the demanding energy needs of industry can represent a unique challenge for our clean and secure energy future. This bill establishes a DOE program to support the development of innovative technologies and practices that will reduce industrial sector emissions while maintaining the effectiveness and competitiveness of U.S. industry. It also requires the Secretary to establish a comprehensive strategy to develop the mission and goals for this new program.

While I can't say I agree with every aspect of this legislation, I would like to thank our friends across the aisle for meeting us at the table to come to an agreement. By having a good-faith discussion, we were able to add responsible funding levels and good governance provisions to H.R. 4230 that will make this legislation a bipartisan product.

Next we will consider my bill, H.R. 5374, the "Advanced Geothermal Research and Development Act of 2019" which authorizes DOE's cutting-edge geothermal research and development activities. This bill establishes a geothermal computing program and includes funding for critical geothermal energy user facilities that will support the next generation of electricity generation from these vast and largely untapped renewable resources. I would like to thank Chairwoman Johnson for cosponsoring this legislation and for working with me to refine it.

While many renewables like wind and solar are already seeing success in the market, early stage technologies like geothermal, which are often far too expensive and risky for industry to take to scale, require federal support for R&D. By strategically investing in these promising technologies we can continue to enhance our diverse domestic energy portfolio and bolster U.S. energy independence.

While we support next-generation energy technologies and clean energy strategies, we must also increase our investment in our critical energy infrastructure. So finally, the Committee will consider H.R. 5428, the "Grid Modernization Research and Development Act of 2019" and H.R. 5760, the "Grid Security Research and Development Act."

Together, these two bills authorize DOE's critical work in strengthening our nation's electric grid against rapidly changing technological challenges. The Grid Security Research and Development Act authorizes the Department's crucial cybersecurity and emergency response R&D activities and directs DOE to work with relevant Federal agencies to develop cybersecurity best practices. The Grid Modernization Research and Development Act authorizes R&D into hybrid energy systems, grid integration, and smart grid modeling - modernizing the grid to improve its overall resilience and flexibility.

I'd like to take this opportunity to thank my good friends across the aisle for working with us on these bills. I appreciate that we can come together to focus on our shared interest in supporting commonsense legislation to maintain U.S. national security, environmental stewardship, economic prosperity, and energy security for years to come. I'd like to again thank Chairwoman Johnson for holding this markup and I yield back the balance of my time.

Chairwoman JOHNSON. Thank you very much.

We will now consider H.R. 2986, the *Better Energy Storage Technology Act*. The clerk will report the bill.

The CLERK. Committee print of H.R. 2986, section 1—
[The bill follows:]

A recording—reporting quorum being present, I move that the Committee on Science, Space, and Technology report H.R. 4230, as amended, to the House with the recommendation that the bill will be approved.

Those in favor of the motion will signify by saying aye.

Those opposed, no.

The ayes have it, and the bill is favorably reported.

Without objection, the motion to reconsider is laid on the table, and I ask unanimous consent that staff be authorized to make any necessary technical and conforming changes to the bill. Without objection, so ordered.

The Members will have two subsequent calendar days in which to submit supplementary minority or additional views on the measure.

I want to thank both gentlemen from Texas. I know the history of our State, and I appreciate your participation.

We will now consider H.R. 5374, the *Advanced Geothermal Research and Development Act of 2019*. The clerk will report the bill.

The CLERK. Committee print of H.R. 5374—

[The bill follows:]

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COMMITTEE PRINT

[Showing the text of H.R. 5374 as forwarded by the
Subcommittee on Energy on December 19, 2019]

1 SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

2 (a) SHORT TITLE.—This Act may be cited as the
3 “Advanced Geothermal Research and Development Act of
4 2019”.

5 (b) TABLE OF CONTENTS.—The table of contents for
6 this Act is as follows:

- Sec. 1. Short title; table of contents.
- Sec. 2. Definitions.
- Sec. 3. Hydrothermal research and development.
- Sec. 4. General geothermal systems research and development.
- Sec. 5. Enhanced geothermal systems research and development.
- Sec. 6. Geothermal heat pumps and direct use.
- Sec. 7. Cost sharing and proposal evaluation.
- Sec. 8. Advanced geothermal computing and data science research and develop-
ment.
- Sec. 9. Geothermal workforce development.
- Sec. 10. Reporting requirements.
- Sec. 11. Repeals.
- Sec. 12. Authorization of appropriations.
- Sec. 13. International geothermal energy development.
- Sec. 14. Reauthorization of High Cost Region Geothermal Energy Grant Pro-
gram.

7 SEC. 2. DEFINITIONS.

8 Section 612(1) of the Energy Independence and Se-
9 curity Act of 2007 (42 U.S.C. 17191(1)) is amended to
10 read as follows:

11 “(1) ENGINEERED.—When referring to en-
12 hanced geothermal systems, the term ‘engineered’
13 means designed to access subsurface heat, including

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2

1 stimulation and nonstimulation technologies to ad-
2 dress one or more of the following issues:

3 “(A) Lack of effective permeability, poros-
4 ity or open fracture connectivity within the heat
5 reservoir.

6 “(B) Insufficient contained geofluid in the
7 heat reservoir.

8 “(C) A low average geothermal gradient
9 which necessitates deeper drilling, or the use of
10 alternative heat sources or heat generation
11 processes.”.

12 **SEC. 3. HYDROTHERMAL RESEARCH AND DEVELOPMENT.**

13 Section 613 of the Energy Independence and Security
14 Act of 2007 (42 U.S.C. 17192) is amended to read as
15 follows:

16 **“SEC. 613. HYDROTHERMAL RESEARCH AND DEVELOP-
17 MENT.**

18 “(a) **IN GENERAL.**—The Secretary shall carry out a
19 program of research, development, demonstration, and
20 commercial application for geothermal energy production
21 from hydrothermal systems.

22 “(b) **PROGRAMS.**—The program authorized in sub-
23 section (a) shall include the following:

24 “(1) **ADVANCED HYDROTHERMAL RESOURCE
25 TOOLS.**—The research and development of advanced

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1 geologic tools to assist in locating hydrothermal re-
2 sources, and to increase the reliability of site charac-
3 terization, including the development of new imaging
4 and sensing technologies and techniques to assist in
5 prioritization of targets for characterization;

6 “(2) EXPLORATORY DRILLING FOR GEO-
7 THERMAL RESOURCES.—The demonstration of ad-
8 vanced technologies and techniques of siting and ex-
9 ploratory drilling for undiscovered resources in a va-
10 riety of geologic settings, carried out in collaboration
11 with industry partners that will assist in the acqui-
12 sition of high quality data sets relevant for hydro-
13 thermal subsurface characterization activities”.

14 **SEC. 4. GENERAL GEOTHERMAL SYSTEMS RESEARCH AND**
15 **DEVELOPMENT.**

16 Section 614 of the Energy Independence and Security
17 Act of 2007 (42 U.S.C. 17193) is amended to read as
18 follows:

19 **“SEC. 614. GENERAL GEOTHERMAL SYSTEMS RESEARCH**
20 **AND DEVELOPMENT.**

21 “(a) SUBSURFACE COMPONENTS AND SYSTEMS.—
22 The Secretary shall support a program of research, devel-
23 opment, demonstration, and commercial application of
24 components and systems capable of withstanding geo-
25 thermal environments and necessary to develop, produce,

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1 and monitor geothermal reservoirs and produce geo-
2 thermal energy.

3 “(b) ENVIRONMENTAL IMPACTS.—The Secretary
4 shall—

5 “(1) support a program of research, develop-
6 ment, demonstration, and commercial application of
7 technologies and practices designed to mitigate or
8 preclude potential adverse environmental impacts of
9 geothermal energy development, production or use;
10 and

11 “(2) support a research program to identify po-
12 tential environmental impacts and environmental
13 benefits of geothermal energy development, produc-
14 tion, and use, and ensure that the program de-
15 scribed in paragraph (1) addresses such impacts, in-
16 cluding effects on groundwater and local hydrology;

17 “(3) support a program of research to compare
18 the potential environmental impacts and environ-
19 mental benefits identified as part of the develop-
20 ment, production, and use of geothermal energy with
21 the potential emission reductions of greenhouse
22 gases gained by geothermal energy development,
23 production, and use; and

24 “(4) in carrying out this section, the Secretary
25 shall, to the maximum extent practicable, consult

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1 with relevant federal agencies, including the Envi-
2 ronmental Protection Agency.

3 “(e) RESERVOIR THERMAL ENERGY STORAGE.—The
4 Secretary shall support a program of research, develop-
5 ment, and demonstration of reservoir thermal energy stor-
6 age, emphasizing cost-effective improvements through
7 deep direct use engineering, design, and systems research.

8 “(d) OIL AND GAS TECHNOLOGY TRANSFER INITIA-
9 TIVE.—

10 “(1) IN GENERAL.—The Secretary shall sup-
11 port an initiative among the Office of Fossil Energy,
12 the Office of Energy Efficiency and Renewable En-
13 ergy, and the private sector to research, develop, and
14 demonstrate relevant advanced technologies and op-
15 eration techniques used in the oil and gas sector for
16 use in geothermal energy development.

17 “(2) PRIORITIES.—In carrying out paragraph
18 (1), the Secretary shall prioritize technologies with
19 the greatest potential to significantly increase the
20 use and lower the cost of geothermal energy in the
21 United States, including the cost and speed of geo-
22 thermal drilling.

23 “(3) COPRODUCTION OF GEOTHERMAL ENERGY
24 AND MINERALS PRODUCTION RESEARCH AND DE-
25 VELOPMENT INITIATIVE.—

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1 “(A) IN GENERAL.—The Secretary shall
2 carry out a research and development initiative
3 under which the Secretary shall award grants
4 to demonstrate the coproduction of critical min-
5 erals from geothermal resources.

6 “(B) REQUIREMENTS.—An award made
7 under subparagraph (A) shall—

8 “(i) improve the cost effectiveness of
9 removing minerals from geothermal brines
10 as part of the coproduction process;

11 “(ii) increase recovery rates of the
12 targets mineral commodity;

13 “(iii) decrease water use and other en-
14 vironmental impacts, as determined by the
15 Secretary; and

16 “(iv) demonstrate a path to commer-
17 cial viability.”.

18 **SEC. 5. ENHANCED GEOTHERMAL SYSTEMS RESEARCH**
19 **AND DEVELOPMENT.**

20 Section 615 of the Energy Independence and Security
21 Act of 2007 (42 U.S.C. 17194) is amended to read as
22 follows:

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1 **“SEC. 615. ENHANCED GEOTHERMAL SYSTEMS RESEARCH**
2 **AND DEVELOPMENT.**

3 “(a) IN GENERAL.—The Secretary shall support a
4 program of research, development, demonstration, and
5 commercial application for enhanced geothermal systems,
6 including the programs described in subsection (b).

7 “(b) ENHANCED GEOTHERMAL SYSTEMS TECH-
8 NOLOGIES.—In collaboration with industry partners, the
9 Secretary shall support a program of research, develop-
10 ment, demonstration, and commercial application of the
11 technologies to achieve higher efficiency and lower cost en-
12 hanced geothermal systems, including—

13 “(1) reservoir stimulation;

14 “(2) reservoir characterization, monitoring, and
15 modeling;

16 “(3) stress and fracture mapping including real
17 time monitoring and modeling;

18 “(4) tracer development;

19 “(5) three and four-dimensional seismic imag-
20 ing and tomography;

21 “(6) well placement and orientation;

22 “(7) long-term reservoir management;

23 “(8) drilling technologies, methods, and tools;

24 “(9) improved exploration tools;

25 “(10) zonal isolation; and

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1 “(11) understanding induced seismicity risks
2 from reservoir engineering and stimulation.

3 “(e) FRONTIER OBSERVATORY FOR RESEARCH IN
4 GEOTHERMAL ENERGY.—The Secretary shall support the
5 establishment and construction of up to 3 field research
6 sites operated by public or academic entities, which shall
7 each be known as a ‘Frontier Observatory for Research
8 in Geothermal Energy’ or ‘FORGE’ site to develop, test,
9 and enhance techniques and tools for enhanced geothermal
10 energy.

11 “(1) DUTIES.—The Secretary shall—

12 “(A) award grants in support of research
13 and development projects focused on advanced
14 monitoring technologies, new technologies and
15 approaches for implementing multi-zone stimu-
16 lations, and dynamic reservoir modeling that in-
17 corporates all available high-fidelity character-
18 ization data; and

19 “(B) seek opportunities to coordinate ef-
20 forts and share information with domestic and
21 international partners engaged in research and
22 development of geothermal systems and related
23 technology.

24 “(2) SITE SELECTION.—Of the FORGE sites
25 referred to in paragraph (1), the Secretary shall—

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1 “(A) consider applications through a com-
2 petitive, merit-reviewed process, from National
3 Laboratories, multi-institutional collaborations,
4 institutes of higher education and other appro-
5 priate entities best suited to provide national
6 leadership on geothermal related issues and
7 perform the duties enumerated under this sub-
8 section; and

9 “(B) prioritize existing field sites and fa-
10 cilities with capabilities relevant to the duties
11 enumerated under this subsection.

12 “(3) FUNDING.—Out of funds authorized to be
13 appropriated under section 11 of the ‘Advanced Geo-
14 thermal Research and Development Act of 2019’,
15 there shall be made available to the Secretary to
16 carry out the FORGE activities under this para-
17 graph—

18 “(A) \$45,000,000 for fiscal year 2020;

19 “(B) \$55,000,000 for fiscal year 2021;

20 “(C) \$65,000,000 for fiscal year 2022;

21 “(D) \$70,000,000 for fiscal year 2023;

22 and

23 “(E) \$70,000,000 for fiscal year 2024.

24 In carrying out this section, the Secretary shall con-
25 sider the balance between funds dedicated to con-

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1 construction and operations and research activities to
2 reflect the state of site development.

3 “(4) ENHANCED GEOTHERMAL SYSTEMS DEM-
4 ONSTRATIONS.—

5 “(A) IN GENERAL.—Beginning on the date
6 of enactment of the ‘Advanced Geothermal En-
7 ergy Research and Development Act of 2019’,
8 the Secretary, in collaboration with industry
9 partners and institutions of higher education,
10 shall support an initiative for demonstration of
11 enhanced geothermal systems for power produc-
12 tion or direct use.

13 “(B) PROJECTS.—

14 “(i) IN GENERAL.—Under the initia-
15 tive described in subparagraph (A), dem-
16 onstration projects shall be carried out in
17 locations that are commercially viable for
18 enhanced geothermal systems development,
19 while also considering environmental im-
20 pacts to the maximum extent practicable,
21 as determined by the Secretary.

22 “(ii) REQUIREMENTS.—Demonstra-
23 tion projects under clause (i) shall—

24 “(I) collectively demonstrate—

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1 “(aa) different geologic set-
2 tings, such as hot sedimentary
3 aquifers, layered geologic sys-
4 tems, supercritical systems, and
5 basement rock systems; and

6 “(bb) a variety of develop-
7 ment techniques, including open
8 hole and cased hole completions,
9 differing well orientations, and
10 stimulation mechanisms; and

11 “(II) to the extent practicable,
12 use existing sites where subsurface
13 characterization or geothermal energy
14 integration analysis has been con-
15 ducted.

16 “(iii) EASTERN DEMONSTRATION.—
17 Not less than 1 demonstration project car-
18 ried out under clause (i) shall be located in
19 an area east of the Mississippi River that
20 is suitable for enhanced geothermal dem-
21 onstration for power, heat, or a combina-
22 tion of power and heat.”

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1 **SEC. 6. GEOTHERMAL HEAT PUMPS AND DIRECT USE.**

2 (a) IN GENERAL.—Title VI of the Energy Independ-
3 ence and Security Act of 2007 is amended by inserting
4 after section 616 (42 U.S.C. 17195) the following:

5 **“SEC. 616A. GEOTHERMAL HEAT PUMPS AND DIRECT USE**
6 **RESEARCH AND DEVELOPMENT.**

7 “(a) PURPOSES.—The purposes of this section are—

8 “(1) to improve the components, processes, and
9 systems used for geothermal heat pumps and the di-
10 rect use of geothermal energy; and

11 “(2) to increase the energy efficiency, lower the
12 cost, increase the use, and improve and demonstrate
13 the effectiveness of geothermal heat pumps and the
14 direct use of geothermal energy.

15 “(b) DEFINITIONS.—In this section:

16 “(1) DIRECT USE OF GEOTHERMAL ENERGY.—
17 The term ‘direct use of geothermal energy’ means
18 geothermal systems that use water directly or
19 through a heat exchanger to provide—

20 “(A) heating to buildings, commercial dis-
21 tricts, residential communities, and large mu-
22 nicipal, or industrial projects; or

23 “(B) heat required for industrial processes,
24 agriculture, aquaculture, and other facilities.

25 “(2) ECONOMICALLY DISTRESSED AREA.—The
26 term ‘economically distressed area’ means an area

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1 described in section 301(a) of the Public Works and
2 Economic Development Act of 1965 (42 U.S.C.
3 3161(a)).

4 “(3) GEOTHERMAL HEAT PUMP.—The term
5 ‘geothermal heat pump’ means a system that pro-
6 vides heating and cooling by exchanging heat from
7 shallow ground or surface water using—

8 “(A) a closed loop system, which transfers
9 heat by way of buried or immersed pipes that
10 contain a mix of water and working fluid; or

11 “(B) an open loop system, which circulates
12 ground or surface water directly into the build-
13 ing and returns the water to the same aquifer
14 or surface water source.

15 “(c) PROGRAM.—

16 “(1) IN GENERAL.—The Secretary shall sup-
17 port within the Geothermal Technologies Office a
18 program of research, development, and demonstra-
19 tion for geothermal heat pumps and the direct use
20 of geothermal energy.

21 “(2) AREAS.—The program under paragraph
22 (1) may include research, development, demonstra-
23 tion, and commercial application of—

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1 “(A) geothermal ground loop efficiency im-
2 provements, cost reductions, and improved in-
3 stallation and operations methods;

4 “(B) the use of geothermal energy for
5 building-scale energy storage;

6 “(C) the use of geothermal energy as a
7 grid management resource or seasonal energy
8 storage;

9 “(D) geothermal heat pump efficiency im-
10 provements;

11 “(E) the use of alternative fluids as a heat
12 exchange medium, such as hot water found in
13 mines and mine shafts, graywater, or other
14 fluids that may improve the economics of geo-
15 thermal heat pumps;

16 “(F) heating of districts, neighborhoods,
17 communities, large commercial or public build-
18 ings, and industrial and manufacturing facili-
19 ties;

20 “(G) the use of water sources at a tem-
21 perature of less than 150 degrees Celsius for di-
22 rect use; and

23 “(H) system integration of direct use with
24 geothermal electricity production.

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1 “(3) ENVIRONMENTAL IMPACTS.—In carrying
2 out the program, the Secretary shall identify and
3 mitigate potential environmental impacts in accord-
4 ance with section 614(e).

5 “(d) GRANTS.—

6 “(1) IN GENERAL.—The Secretary shall carry
7 out the program established in subsection (c) by
8 making grants available to State, local, and Tribal
9 governments, institutions of higher education, non-
10 profit entities, National Laboratories, utilities, and
11 for-profit companies.

12 “(2) PRIORITY.—In making grants under this
13 subsection, the Secretary may give priority to pro-
14 posals that apply to large buildings, commercial dis-
15 tricts, and residential communities that are located
16 in economically distressed areas.”.

17 (b) CONFORMING AMENDMENT.—Section 1(b) of the
18 Energy Independence and Security Act of 2007 (42
19 U.S.C. 17001 note) is amended in the table of contents
20 by inserting after the item relating to section 616 the fol-
21 lowing:

“616A. Geothermal heat pumps and direct use research and development.”.

22 **SEC. 7. COST SHARING AND PROPOSAL EVALUATION.**

23 Section 617(b) of the Energy Independence and Se-
24 curity Act of 2007 (42 U.S.C. 17196) is amended by strik-

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1 ing paragraph (2) and redesignating paragraphs (3) and
2 (4) as paragraphs (2) and (3), respectively.

3 **SEC. 8. ADVANCED GEOTHERMAL COMPUTING AND DATA**
4 **SCIENCE RESEARCH AND DEVELOPMENT.**

5 (a) IN GENERAL.—Section 618 of the Energy Inde-
6 pendence and Security Act of 2007 (42 U.S.C. 17197) is
7 amended to read as follows:

8 **“SEC. 618. ADVANCED GEOTHERMAL COMPUTING AND**
9 **DATA SCIENCE RESEARCH AND DEVELOP-**
10 **MENT.**

11 “(a) IN GENERAL.—The Secretary shall carry out a
12 program of research and development of advanced com-
13 puting and data science tools for geothermal energy.

14 “(b) PROGRAMS.—The program authorized in sub-
15 section (a) shall include the following:

16 “(1) ADVANCED COMPUTING FOR GEOTHERMAL
17 SYSTEMS TECHNOLOGIES.—Research, development,
18 and demonstration of technologies to develop ad-
19 vanced data, machine learning, artificial intelligence,
20 and related computing tools to assist in locating ge-
21 thermal resources, to increase the reliability of site
22 characterization, to increase the rate and efficiency
23 of drilling, to improve induced seismicity mitigation,
24 and to support enhanced geothermal systems tech-
25 nologies.

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1 **SEC. 9. GEOTHERMAL WORKFORCE DEVELOPMENT.**

2 (a) IN GENERAL.—Section 619 of the Energy Inde-
3 pendence and Security Act of 2007 (42 U.S.C. 17198) is
4 amended to read as follows:

5 **“SEC. 619. GEOTHERMAL WORKFORCE DEVELOPMENT.**

6 “The Secretary shall support the development of a
7 geothermal energy workforce through a program that—

8 “(1) facilitates collaboration between university
9 students and researchers at the national labora-
10 tories; and

11 “(2) prioritizes science in areas relevant to the
12 mission of the Department through the application
13 of geothermal energy tools and technologies.”.

14 (b) CONFORMING AMENDMENT.—Section 1(b) of the
15 Energy Independence and Security Act of 2007 (42
16 U.S.C. 17001 note) is amended in the table of contents
17 by amending the item related to section 619 to read as
18 follows:

“Sec. 619. Geothermal workforce development.”.

19 **SEC. 10. REPORTING REQUIREMENTS.**

20 Section 621 of the Energy Independence and Security
21 Act of 2007 (42 U.S.C. 17200) is amended to read as
22 follows:

23 **“SEC. 621. REPORTS.**

24 “(a) REPORT.—Every 5 years after the date of enact-
25 ment of Advanced Geothermal Research and Development

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1 Act of 2019 , the Secretary shall report to the Committee
2 on Science and Technology of the House of Representa-
3 tives and the Committee on Energy and Natural Re-
4 sources of the Senate on advanced concepts and tech-
5 nologies to maximize the geothermal resource potential of
6 the United States.

7 “(b) PROGRESS REPORTS.—Not later than 1 year
8 after the date of enactment of the ‘Advanced Geothermal
9 Research and Development Act of 2019’, and every 2
10 years thereafter, the Secretary shall submit to the Com-
11 mittee on Science and Technology of the House of Rep-
12 resentatives and the Committee on Energy and Natural
13 Resources of the Senate a report on the results of projects
14 undertaken under this part and other such information
15 the Secretary considers appropriate.”.

16 **SEC. 11. REPEALS.**

17 (a) IN GENERAL.—Subtitle B of title VI of the En-
18 ergy Independence and Security Act of 2007 (42 U.S.C.
19 17191 et seq.) is amended by striking section 620.

20 (b) CONFORMING AMENDMENT.—Section 1(b) of the
21 Energy Independence and Security Act of 2007 (42
22 U.S.C. 17001 note) is amended in the table of contents
23 by striking the item related to section 620.

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1 SEC. 12. AUTHORIZATION OF APPROPRIATIONS.

2 Section 623 of the Energy Independence and Security
3 Act of 2007 (42 U.S.C. 17202) is amended to read as
4 follows:

5 "SEC. 623. AUTHORIZATION OF APPROPRIATIONS.

6 "There are authorized to be appropriated to the Sec-
7 retary to carry out the programs under the 'Advanced
8 Geothermal Research and Development Act of 2019'—

9 "(1) \$100,000,000 for fiscal year 2020;

10 "(2) \$111,125,000 for fiscal year 2021;

11 "(3) \$122,250,000 for fiscal year 2022;

12 "(4) \$128,375,000 for fiscal year 2023; and

13 "(5) \$129,500,000 for fiscal year 2024."

**14 SEC. 13. INTERNATIONAL GEOTHERMAL ENERGY DEVELOP-
15 MENT.**

16 Section 624 of the Energy Independence and Security
17 Act of 2007 (42 U.S.C. 17203) is amended—

18 (1) in subsection (a), to read as follows:

19 "(a) IN GENERAL.—The Secretary of Energy, in co-
20 ordination with other appropriate Federal and multilateral
21 agencies (including the United States Agency for Inter-
22 national Development) shall support collaborative efforts
23 with international partners to promote the research, devel-
24 opment, and demonstration of geothermal technologies
25 used to develop hydrothermal and enhanced geothermal
26 system resources."; and

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21

1 (2) by striking subsection (e).

2 **SEC. 14. REAUTHORIZATION OF HIGH COST REGION GEO-**
3 **THERMAL ENERGY GRANT PROGRAM.**

4 Section 625 of the Energy Independence and Security
5 Act of 2007 (42 U.S.C. 17204) is amended—

6 (1) in subsection (a)(2), by inserting “ or heat”
7 after “electrical power”; and

8 (2) in subsection (e), to read as follows:

9 “(e) AUTHORIZATION OF APPROPRIATIONS.—Out of
10 funds authorized under section 11 of the ‘Advanced Geo-
11 thermal Research and Development Act of 2019’, there
12 is authorized to be appropriated to carry out this section
13 \$5,000,000 for each of fiscal years 2020 through 2024.”.



Chairwoman JOHNSON. Without objection, the bill is considered as read and open to amendments at any point.

I will now recognize the sponsor of this bill, our Ranking Member, Mr. Lucas, to speak on the bill.

Mr. LUCAS. Thank you, Chairwoman Johnson.

This morning, I'm grateful to have another opportunity to discuss our bill, H.R. 5374, the *Advanced Geothermal Research and Development Act of 2019*, which authorizes research, development, and demonstration of innovative geothermal energy technologies at the Department of Energy.

Geothermal energy is a clean, renewable, and abundant domestic energy source. Our country has significant geothermal energy resources and leads the world in installed geothermal capacity. If harnessed correctly, these resources have the potential to provide reliable baseload power and adaptive energy storage for Americans across the country.

But today, geothermal energy technologies are behind the renewable market curve. While the renewable energy sources account for approximately 18 percent of total utility-scale U.S. energy electricity generation, geothermal contributes less than one percent. This is because today's geothermal energy technologies are often too expensive, time-consuming, and risky for widespread industrial adaptation. In order for U.S. industry to take advantage of geothermal energy, geothermal technologies, and techniques which must become much more efficient and substantially less expensive for American consumers.

The good news is that on the Science Committee we are uniquely positioned to help prioritize the kind of early stage research that leads to groundbreaking discoveries and energy technology. As we've heard so often in the Committee hearings this Congress, federally funded research programs have an established history of paving the way for industrial innovation. This is especially true at the Department of Energy.

H.R. 5374, the *Advanced Geothermal Research and Development Act*, will provide DOE with necessary funding and critical program direction to enable innovative research in advanced geothermal technologies, strengthening the U.S. geothermal workplace, leverage advanced computing practices for geothermal applications, support the construction of major advanced geothermal user facilities, and encourage international collaboration. By authorizing these programs, we can help U.S. industry improve the next generation of geothermal energy technologies using advanced designs to save time and money in planning and producing power more efficiently with less impact on the environment. I think these are goals we can all support.

If we want to ensure the responsible development of a diverse portfolio of clean and domestically sourced energy technologies, we in Congress should prioritize this important early stage research.

In a moment, I'll offer a manager's amendment to this bill, which I encourage my colleagues to support, that provides valuable technical and conforming changes suggested by stakeholders.

And I want to thank Chairwoman Johnson and her staff for supporting me on this amendment and for her continued support of this legislation. I look forward to continuing to work with you all

to support this commonsense, productive, and bipartisan clean energy bill, and I yield back the balance of my time, Madam Chair.

Chairwoman JOHNSON. Thank you, Mr. Lucas. I would like now to speak on the bill, as I am a cosponsor.

Americans have used various forms of geothermal energy since the 1800s. Despite this long history, geothermal energy technologies have largely struggled to become or remain competitive in modern energy markets. Even though there are major opportunities for further advancement and commercialization, for example, in my home State of Texas there is great potential for geothermal energy production that remains untapped. With naturally occurring large wells of hot water and other promising heat reservoirs below the ground, energy produced by geothermal technologies do not emit greenhouse gases.

Just this Congress alone the Committee has passed several bills that would reduce the impact of climate change, and I'm hoping we can help have a few more along the way today.

Additionally, not only can geothermal technologies produce clean electricity, but they can also be used for industrial applications such as producing high levels of heat that are necessary for various manufacturing processes.

These are all reasons why I am pleased that these issues received serious attention during an Energy Subcommittee hearing in November. That hearing brought together esteemed experts, one of which from the great State of Texas I might add, who reinforced our understanding that geothermal energy production has huge potential as an essential resource in our clean energy technology portfolio.

I'm also happy to say that this bill was unanimously reported out of the Subcommittee markup held in December, so I'm glad that we're addressing this important issue today while considering the *Advanced Geothermal Research and Development Act* introduced by Mr. Lucas, my friend, the Ranking Member, which I'm again a proud cosponsor. And I want to thank you, Mr. Lucas, for working with us and introducing this great piece of legislation.

The bill includes research initiatives on oil and gas technology transfer to geothermal research, secondary-use research areas such as minerals recovery and storage and new areas of research in enhanced geothermal systems. It is—it also authorizes groundbreaking new research activities in advanced geothermal computing and data science, as well as research in heat pump technologies and direct-use applications. I look forward to continuing to work together with our—my colleagues on both sides of the aisle to pass legislation that helps advance geothermal energy, along with the broad range of other clean energy technologies.

Does anyone else wish to be recognized? Ms. Stevens.

Ms. STEVENS. Thank you, Madam Chair. I wanted to congratulate you and Mr. Lucas for being examples for all of us on how to get good legislation done.

I am excited about this bill. I am excited about geothermal. In my hometown neighborhood, we have a new development, a big house coming in, and they are using geothermal. And we have seen geothermal technologies create jobs, create supply chains, and help us to address some of our energy issues.

So often, the Science Committee is a best practice and a great example of how Congress should work collaboratively together with a focus on research and the next generation. I think that it is worth noting that the Department of Energy's Geothermal Technologies Office is going to be reawakened when we passed this legislation through Committee, pass it on the floor of the—the House floor of the Representatives, and continue to move our country forward. So thank you for your leadership.

Chairwoman JOHNSON. Well, thank you very much.

We will now proceed with the amendments in order of the roster, and the first amendment on the roster is an amendment offered by Ranking Member Lucas, and he's recognized to offer his amendment.

Mr. LUCAS. Madam Chair, I have an amendment at the desk.

Chairwoman JOHNSON. The clerk will read the amendment.

The CLERK. Amendment No. 1, amendment to Committee print of H.R.—

[The amendment of Mr. Lucas follows:]

**AMENDMENT TO
COMMITTEE PRINT OF H.R. 5374
OFFERED BY Mr. Lucas**

Page 1, in the Table of Contents, rename section 10 as “Organization and administration of programs”.

Page 1, line 8, strike “612(1)” and insert “612”.

Page 1, line 9, strike “17191(1)” and insert “17191”.

Page 1, line 9, insert “— (1) in paragraph (1),” after “amended”.

Page 2, after line 11, insert the following:

- 1 (2) by adding after paragraph (1) the following:
2 “(2) ELIGIBLE ENTITY.—The term ‘eligible en-
3 tity’ means any of the following entities:
4 “(A) An institution of higher education.
5 “(B) A National laboratory.
6 “(C) A Federal research agency.
7 “(D) A State research agency.
8 “(E) A nonprofit research organization.
9 “(F) An industrial entity.

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1 “(G) A consortium of 2 or more entities
 2 described in subparagraphs (A) through (F).”;
 3 and
 4 (3) by redesignating paragraphs (2) through
 5 (7) as paragraphs (3) through (8), respectively.

Page 4, line 12, add “, including induced seismicity,” after “environmental impacts”.

Page 4, line 16, add “water use and” after “including”.

Page 5, line 22, add “surface technologies, and well construction” after “drilling”.

Page 5, strike line 23 and all that follows through page 6, line 17 and insert the following new subsection:

6 “(e) COPRODUCTION OF GEOTHERMAL ENERGY AND
 7 MINERALS PRODUCTION RESEARCH AND DEVELOPMENT
 8 INITIATIVE.—

9 “(1) IN GENERAL.—The Secretary shall carry
 10 out a research and development initiative under
 11 which the Secretary shall award grants to demonstrate the coproduction of critical minerals from
 12 geothermal resources.

14 “(2) REQUIREMENTS.—An award made under
 15 paragraph (1) shall—

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- 1 “(A) improve the cost effectiveness of re-
2 moving minerals from geothermal brines as part
3 of the coproduction process;
4 “(B) increase recovery rates of the tar-
5 geted mineral commodity;
6 “(C) decrease water use and other environ-
7 mental impacts, as determined by the Sec-
8 retary; and
9 “(D) demonstrate a path to commercial vi-
10 ability.”.

Page 6, after line 17, insert the following new sub-
sections:

- 11 “(f) FLEXIBLE OPERATIONS.—The Secretary shall
12 support a research initiative on flexible operation of geo-
13 thermal power plants.
14 “(g) HYBRID ENERGY SYSTEMS.—The Secretary
15 shall identify opportunities for joint research, develop-
16 ment, and demonstration programs between geothermal
17 systems and other energy generation or storage systems.

Page 7, line 8, add “institutions of higher education,
and the national laboratories,” after “industry part-
ners,”.

Page 7, line 14, insert the following new paragraph
(and redesignate subsequent paragraphs accordingly):

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1 “(2) drilled, non-stimulated (e.g. closed-loop)
2 reservoir technologies;”.

Page 7, line 17, add “and understanding of the surface area and volume of fractures” after “modeling”.

Page 8, line 6, strike “operated by public or academic entities”.

Page 8, line 16, add “nonstimulation techniques,” after “stimulations,”.

Page 8, line 23, add “, including coordination between FORGE sites” after “technology”.

Page 9, after line 11, insert the following (and redesignate subsequent paragraphs accordingly):

3 “(3) EXISTING FORGE SITES.—A FORGE site
4 already in existence on the date of enactment of this
5 Act may continue to receive support.”.

Page 9, line 12, strike “3” and insert “4”.

Page 9, line 13, strike “11” and insert “12”.

Page 9, line 18, strike “2020” and insert “2021”.

Page 9, line 19, strike “2021” and insert “2022”.

Page 9, line 20, strike “2022” and insert “2023”.

Page 9, line 21, strike “2023” and insert “2024”.

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Page 9, line 23, strike “2024” and insert “2025”.

Page 10, strike lines 3 through page 11, line 15 and insert the following:

1 “(d) ENHANCED GEOTHERMAL SYSTEMS DEM-
2 ONSTRATIONS.—

3 “(1) IN GENERAL.—Beginning on the date of
4 enactment of the ‘Advanced Geothermal Research
5 and Development Act of 2019’, the Secretary, in col-
6 laboration with industry partners, institutions of
7 higher education, and the national laboratories, shall
8 support an initiative for demonstration of enhanced
9 geothermal systems for power production or direct
10 use.

11 “(2) PROJECTS.—

12 “(A) IN GENERAL.—Under the initiative
13 described in paragraph (1), demonstration
14 projects shall be carried out in locations that
15 are commercially viable for enhanced geo-
16 thermal systems development, while also consid-
17 ering environmental impacts to the maximum
18 extent practicable, as determined by the Sec-
19 retary.

20 “(B) REQUIREMENTS.—Demonstration
21 projects under subparagraph (A) shall—

22 “(i) collectively demonstrate—

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1 “(I) different geologic settings,
2 such as hot sedimentary aquifers, lay-
3 ered geologic systems, supercritical
4 systems, and basement rock systems;
5 and

6 “(II) a variety of development
7 techniques, including open hole and
8 cased hole completions, differing well
9 orientations, and stimulation and non-
10 stimulation mechanisms; and

11 “(ii) to the extent practicable, use ex-
12 isting sites where subsurface characteriza-
13 tion or geothermal energy integration anal-
14 ysis has been conducted.

15 “(C) EASTERN DEMONSTRATION.—Not
16 fewer than 1 of the demonstration projects car-
17 ried out under subparagraph (A) shall be lo-
18 cated an area east of the Mississippi that is
19 suitable for enhanced geothermal demonstration
20 for power, heat, or a combination of power and
21 heat.”.

Page 12, line 8, add “understanding of related earth
sciences,” before “components”.

Page 12, line 20, add “and cooling” after “heating”.

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Page 13, line 7, strike “ground” and insert “geology, groundwater,”.

Page 14, lines 20 through 22, strike “water sources at a temperature of less than 150 degrees Celsius” and insert “low temperature groundwater”.

Page 17, line 6, add “fluid and” before “heat flow”.

Page 17, line 7, add “geomechanics, geochemistry,” before “seismicity”.

Page 18, line 19, strike “**REPORTING REQUIREMENTS**” and insert “**ORGANIZATION AND ADMINISTRATION OF PROGRAMS**”.

Page 18, line 23, strike “**REPORTS**” and insert “**ORGANIZATION AND ADMINISTRATION OF PROGRAMS**”.

Page 18, line 24, insert the following (and redesignate subsequent subsections accordingly):

1 “(a) **EDUCATION AND OUTREACH**.—In carrying out
2 the activities described in this subtitle, the Secretary shall
3 support education and outreach activities to disseminate
4 information on geothermal energy technologies and the
5 geothermal energy workforce, including activities at the
6 Frontier Observatory for Research in Geothermal Energy
7 site(s).

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1 “(b) TECHNICAL ASSISTANCE.—In carrying out this
2 subtitle, the Secretary shall also conduct technical assist-
3 ance and analysis activities with eligible entities for the
4 purpose of supporting the commercial application of ad-
5 vances in geothermal energy systems development and op-
6 erations, which may include activities that support ex-
7 panding access to advanced geothermal energy tech-
8 nologies for rural, Tribal, and low-income communities.”.

Page 20, strike lines 9 through 13, and insert the following:

9 “(1) \$121,375,000 for fiscal year 2021;
10 “(2) \$132,750,000 for fiscal year 2022;
11 “(3) \$144,125,000 for fiscal year 2023;
12 “(4) \$150,500,000 for fiscal year 2024; and
13 “(5) \$151,875,000 for fiscal year 2025.”.

Page 21, line 10, strike “11” and insert “12”.

Page 21, line 13, strike “2020 through 2024” and insert “2021 through 2025”.



Chairwoman JOHNSON. I ask unanimous consent to dispense with the reading, and without objection, so ordered.

I recognize the gentleman for five minutes to explain his amendment.

Mr. LUCAS. In the spirit of the efficient use of time, Chair, I would simply note to the Committee that these are conforming and technical changes, and I ask their adoption and yield back.

Chairwoman JOHNSON. Thank you. Any further discussion?

The vote occurs on the amendment.

All those in favor, say aye.

Those opposed, no.

The ayes have it, and the amendment is agreed to.

Now, Mr. Tonko. OK. The next amendment on the roster is an amendment offered by the gentleman from New York, Mr. Tonko. And he's recognized to offer his amendment.

Mr. TONKO. Thank you, Madam Chair. I have an amendment at the desk.

Chairwoman JOHNSON. The clerk will read the amendment.

The CLERK. Amendment No. 2, amendment to Committee print of H.R.—

[The amendment of Mr. Tonko follows:]

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**AMENDMENT TO
COMMITTEE PRINT OF H.R. 5374
OFFERED BY Mr. Tonko**

Page 15, line 16, insert “ and areas that the Secretary determines to have high economic potential for geothermal district heating based on the report, “Geovision: Harnessing the Heat Beneath our Feet” published by the Department in 2019, or a successor report” after “economically distressed areas”.



Chairwoman JOHNSON. I ask unanimous consent to dispense with the reading. Without objection, so ordered.

I recognize the gentleman for five minutes to explain his amendment.

Mr. TONKO. Thank you, Madam Chair. And thank you and Ranking Member Lucas for introducing this bipartisan, forward-thinking bill.

It will be necessary for us to harness the energy in the earth right beneath our feet to achieve our goal of a clean-energy future. The research funded in this bill will develop technologies that convert naturally occurring geothermal heat into usable zero-carbon energy. In doing so, this bill will also help create thousands of good-paying technical jobs in the energy, environmental, and drilling sectors.

My amendment to this bill simply encourages that geothermal R&D occurs where it would be most useful. Geothermal plants require enormous initial capital investment. And like most clean-energy solutions, their success hinges on their viability as a commercially competitive solution.

Up until now, most American geothermal R&D has focused on a relatively specific application in a relatively specific area, electricity generation in the Mountain West. However, according to DOE's GeoVision report, deployment of geothermal technology can be most profitable when used to directly heat buildings rather than provide electric power in communities with relatively high population density.

This amendment provides that DOE consider these factors when choosing sites to demonstrate geothermal technology. The type of geothermal development that I am referring to is known as direct use, and I thank Mr. Lipinski for introducing an amendment at the Subcommittee markup to prioritize direct-use R&D. Direct-use heat doesn't need the extremely hot ground temperatures that electricity generation needs. And because of that, the technology is available nationwide. Direct use also provides an economic decarbonization solution for a very difficult problem.

Direct emissions from residential and commercial buildings primarily used for heating account for some nine percent of total U.S. carbon emissions. And that percentage is higher in densely populated cold communities in the Northeast and Midwest. For example, in New York State buildings represent over 30 percent statewide emissions. The GeoVision report itself states that the regions have high economic potential for direct-use development. The sites that DOE chooses to test direct-use technology should consider this potential.

With that, I thank the Committee for working with me on this simple amendment, and I urge Members to support it. And with that, Madam Chair, yield back.

Chairwoman JOHNSON. Thank you very much. Any further discussion on the amendment?

If there is no further discussion, the vote occurs on the amendment.

All in favor, say aye.

Those opposed, say no.

The ayes have it, and the amendment is agreed to.

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Are there any other amendments?

If no, then a reporting quorum being present, I move that the Committee on Science, Space, and Technology report H.R. 5374, as amendment—as amended to the House with the recommendation that the bill be approved.

Those in favor of the motion will signify by saying aye.

Those opposed, nay.

The ayes have it, and the bill is favorably reported.

Without objection, the motion to reconsider is laid on the table, and I ask unanimous consent that the staff be authorized to make any necessary technical and conforming changes to the bill. Without objection, so ordered.

And Members will have two subsequent calendar days in which to submit supplemental minority or additional views on this measure.

Next, we have before us 5428 for consideration. The Chair will now consider the *Grid Modernization Research and Development Act of 2019*. And the clerk will report the bill.

The CLERK. Committee print to H.R. 5428—

[The bill follows:]

