

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

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

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 acquisi-
12 tion 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,

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

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

3 “(c) 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.—

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:

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

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

3 “(c) 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—

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-

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—

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.”.

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

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—

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.

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(c).

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-

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 geo-
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.

1 “(2) GEOTHERMAL SYSTEMS RESERVOIR MOD-
2 ELING.—Research, development, and demonstration
3 of models of geothermal reservoir performance and
4 enhanced geothermal systems reservoir stimulation
5 technologies and techniques, with an emphasis on
6 accurately modeling heat flow, permeability evo-
7 lution, seismicity, and operational performance over
8 time, including collaboration with industry and field
9 validation.

10 “(c) COORDINATION.—In carrying out these pro-
11 grams, the Secretary shall ensure coordination and con-
12 sultation with the Department of Energy’s Office of
13 Science. The Secretary shall ensure, to the maximum ex-
14 tent practicable, coordination of these activities with the
15 Department of Energy National Laboratories, institutes
16 of higher education, and the private sector.”.

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 amending the item related to section 618 to read as
21 follows:

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

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

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.

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

1 (2) by striking subsection (c).

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.”.

