GEOTHERMAL COLLEGIATE COMPETITION

Spring 2021 Rules

Release date: January 21, 2021

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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Acronyms and Abbreviations

ACH	Automated Clearing House
DOE	U.S. Department of Energy
FORGE	Frontier Observatory for Research in Geothermal Energy
GHP	geothermal heat pump
GTO	Geothermal Technologies Office
NREL	National Renewable Energy Laboratory

1. COMPETITION SUMMARY

Welcome to the U.S. Department of Energy (DOE) Geothermal Collegiate Competition!

The Geothermal Collegiate Competition engages student teams to develop—and analyze—forward-thinking concepts for district energy systems using geothermal resources for a community or campus to inspire students and professionals alike.

Through the Geothermal Collegiate Competition, the DOE Geothermal Technologies Office (GTO) encourages students to develop innovative solutions for geothermal energy application challenges and build career skills for the clean energy workforce. By engaging students not traditionally involved with geothermal research, GTO aims to raise awareness of geothermal resources among communities and the public, thereby broadening the geothermal stakeholder base.

The competition engages students across geosciences, engineering, finance, regional planning, sustainability, design, communications, and other disciplines to reimagine how energy is generated and used. Students assume the role of a geothermal developer leveraging a geothermal energy resource for a district-scale direct use application. Teams describe why the district (community or campus) was selected and then analyze information including the geothermal resource as well as energy consumption and cost data. Teams also provide a preliminary economic feasibility analysis and strategy for local stakeholder engagement.

The Geothermal Collegiate Competition is designed to inspire students to consider new career opportunities, learn geothermal industry-relevant skills, engage with the community, and prepare to lead the next generation of geothermal energy development. As competitors, students:

- Gain experience with innovative renewable energy applications
- Develop real-world concepts that shape the future of geothermal energy
- Collaborate with community leaders and property owners to develop real-life geothermal applications
- Compete to earn a cash prize and national recognition.

The Geothermal Collegiate Competition invites participation by teams of at least three students enrolled in accredited U.S.-based collegiate institutions or U.S. citizens enrolled at non-U.S. based collegiate institutions. In this case, “collegiate institution” refers to any school of post-secondary or higher education, including but not limited to community colleges, technical colleges, and traditional four-year and graduate-level universities. See “Who Can Enter” for more information on eligibility. There is no cost to register or participate.

The National Renewable Energy Laboratory (NREL) is the Geothermal Collegiate Competition administrator, and supports student team efforts through educational webinars and informational references. Learn more at https://www.energy.gov/eere/geothermal/geothermal-collegiate-competition. Questions on these rules or the program overall can be directed to Geo.Competition@nrel.gov.

Register to compete at https://www.herox.com/GeothermalCollegiateCompetitionSpring2021.

2. SUMMARY TIMELINE

The Geothermal Collegiate Competition is a semester-long project, starting in January 2021 and culminating in May 2021.

- January 21, 2021 – Spring 2021 competition opens
- February 10, 2021 – Informational webinar
- March 9, 2021, 5 p.m. ET – Progress submission deadline
- March 25, 2021 – Feedback on progress submission provided
- May 4, 2021, 5 p.m. ET – Final submission deadline
- Anticipated June 8, 2021 – Winners announced

Background

Geothermal energy is a renewable energy resource derived from the Earth's heat. It is used for a wide spectrum of applications including direct use and electricity generation, spanning temperature ranges from low (e.g., 38°C/100°F) to high (e.g., 300°C/572°F and above). DOE's recent *GeoVision* study determined that U.S. geothermal electricity generation has the potential to increase 26-fold by 2050. The study found that "taking action consistent with the associated *GeoVision* Roadmap could expand the domestic geothermal industry and potentially add job opportunities in both urban and rural communities. Development of a robust residential and commercial geothermal heat pump (GHP) industry could also expand the U.S. geothermal workforce." (*GeoVision: Harnessing the Heat Beneath Our Feet*, 2019, p. xiii.)

DOE has a history of supporting workforce development through competitions focused on project-based learning (e.g., Solar Decathlon, Collegiate Wind Competition, EcoCAR, Cleantech University Prize). Student competitors in the Geothermal Collegiate Competition gain experience solving relevant industry challenges that prepare them for careers in geothermal and related energy fields, while benefiting from mentorship, training, and collaboration. This competition supports DOE's ongoing work to help grow the domestic geothermal industry and address employment gaps through experiential learning that inspires innovation.

3. COMPETITION PROCESS

Introduction

The Geothermal Collegiate Competition engages collegiate student teams to analyze geothermal energy (direct-use or heat pump technologies) for a district energy application. For the purposes of this competition, "districts" are defined as communities or campuses. The strongest teams are multidisciplinary, including students from geosciences; mechanical, chemical, or civil engineering; business or finance; regional planning; construction management; resource management; communications; graphic design; sustainability; or other degree programs. The systems proposed by students integrate a geothermal energy resource to help meet the community's energy uses and needs.

For the purposes of this competition, teams identify a community or campus use case location and propose a direct-use or heat pump application of geothermal energy.

> Direct use, as the name implies, involves using the heat in the water for such things as heating of districts, buildings, industrial processes, greenhouses, aquaculture (fish farming), and resorts. Direct-use projects generally use resource temperatures between 38°C (100°F) and 149°C (300°F). Current U.S. installed capacity of direct-use systems totals 470 MW, or enough energy to heat 40,000 average-sized houses (Geothermal Rising, "What is Geothermal?")
>
> Direct, or non-electric, use of geothermal energy refers to the use of the energy for both heating and cooling applications. Fluids with temperatures adequate for direct use are available

throughout much of the United States. While accessing those fluids typically requires costly well drilling, the relatively low operations and maintenance costs (including zero fuel costs) of direct use systems means that direct use of geothermal energy in homes and commercial operations can be economically competitive under certain market conditions. Direct use of geothermal energy can help districts decarbonize their heating and cooling systems, which is of increasing value in today's energy market.

Furthermore, direct-use applications such as aquaculture, greenhouses, microbreweries, fruit and vegetable drying, spas, pulp and paper processing, and lumber drying offer attractive, low-carbon opportunities for local businesses and entrepreneurs.

Geothermal heat pumps use the natural insulating properties of the Earth to heat and cool spaces, offering a unique and highly efficient renewable energy technology for heating and cooling. Geothermal heat pumps penetrate depths from just a few feet underground to as much as several hundred feet deep, offering a unique and highly efficient renewable energy technology for heating and cooling. Most work by circulating water in a closed system through a "loop field" installed horizontally or vertically in the ground adjacent to or even beneath a building. Heat is taken from the building or district and transferred to the ground in the summer. The system is reversible, and heat is taken from the ground and used in the building in the winter. The system only moves heat, which is much more efficient than using a fuel or electricity to create heat.

Geothermal heat pumps can support space heating and cooling needs in almost any part of the country.

The district use case must be located in the United States or a U.S. territory. The use case must consist of one or more commercial or multi-family buildings, or an industrial or agricultural process use with property access rights to the geothermal resources. Each team will develop a geothermal direct use concept for its identified use case. Students will work with real-world parameters including actual energy load, utility rates, and subsurface data while designing their district use project. Input from community stakeholders will serve as real-world project constraints and considerations. The concepts the teams develop will provide insights that could inform community stakeholders for future development of direct-use geothermal energy resources.

Goal

Each team will identify a community or campus site for a direct-use geothermal energy system and conduct an initial resource assessment, load and usage determination, and preliminary economic feasibility analysis. Teams will also develop a community engagement strategy for the local stakeholder audience at their chosen location.

Prizes to Win

Prizes for the Geothermal Collegiate Competition are as follows:

1st Place – $1,000 cash prize

2nd Place – $750 cash prize

3rd Place – $500 cash prize

Honorable Mention, Geosciences Component – $250 cash prize

Honorable Mention, Stakeholder Engagement Strategy – $250 cash prize

The collegiate institutions of the prize- and honorable mention-winning teams will be publicly recognized.

Cash prizes are paid to the team captain upon receipt of proof of school enrollment, Internal Revenue Service Form W-9, and Automated Clearing House (ACH) banking information.

How to Enter

1. Go to the Challenge page at https://www.herox.com/GeothermalCollegiateCompetitionSpring2021.
2. Create a HeroX account if you don't already have one, or sign in and then choose "Solve this Challenge." This indicates your interest in competing; it is not yet a commitment.
3. By the Progress Submission deadline, the Team Captain must click "Begin Entry" and then submit a "Progress Submission" entry on HeroX.
4. The competition administrator reviews all Progress Submission entries received by the deadline. All teams that meet the competition eligibility requirements and the Progress Submission evaluation statements are deemed eligible and may participate in the remainder of the competition.
5. Multiple teams from a single school may participate. Each student is only eligible to be a member on a single team.
6. Only the team captain may submit a Progress Submission entry. Other members join that captain's team via HeroX. Team members may be added or removed from a team at any time. Once you have created a team, you can invite additional members using HeroX. All participating student team members are expected to have HeroX accounts and be joined in a team.

How to Compete

The Geothermal Collegiate Competition consists of the following steps:

1. **Preparation** – Students identify their multidisciplinary team members and create their team on HeroX.
2. **Progress Submission** – Teams work toward their Progress Submission, identifying a site and conducting an initial resource assessment. Throughout the Progress Submission phase, the competition administrator hosts virtual educational opportunities and recommends resources to help teams complete their submission. These are announced through the HeroX platform. Teams must enter their Progress Submission in HeroX by the deadline.
3. **Progress Submission Feedback** – The competition administrator evaluates each Progress Submission for eligibility and relevance. Comments are provided to each team to help them continue their work toward the Final Submission deadline.
4. **Final Submission** – Teams complete all required sections for their Final Submission and entry in HeroX by the deadline.
5. **Assessment** – The competition administrator screens all entered Final Submissions and assigns expert reviewers to independently score the content of each submission.
6. **Winner Selection** – Taking into account the expert reviewer scores, DOE makes a determination of the first, second, and third-place teams and honorable mention winners.
7. **Winner Announcements** – The competition administrator publicly announces the competition results. After the public announcement, all teams are individually notified of their status and receive the expert reviewer comments on their respective Final Submissions.
8. **Prepare for the Next Competition** – Interested and eligible team members are encouraged to leverage lessons learned and skills developed in the next competition.

Each team designs its own solution to the challenge. A panel of expert reviewers individually scores each submission based on the evaluation statements given in this document. The reviewer scores play a key role in determining the winning teams, and a final selection is made by DOE GTO leadership.

What to Submit

Teams submit deliverables in two phases: a Progress Submission and a Final Submission. The Final Submission is comprised of five scored sections and one unscored section. The Progress Submission contains a subset of these sections. Teams must submit a Progress Submission in order for their Final Submission to be evaluated. The Progress Submission is evaluated by the competition administrator; the teams whose Progress Submissions meet the requirements become finalists and are eligible to enter a Final Submission.

Table 1: Submission Package Summary

Section	Included in Progress Submission	Included in Final Submission
Site Identification	✓	✓
Resource Assessment	✓	✓
Usage Assessment		✓
Preliminary Economic Feasibility Analysis		✓
Stakeholder Engagement Strategy	✓	✓
Team Information (unscored)	✓	✓

These packages are summarized in Table 2 and Table 3 and are described in greater detail in the appendices. These packages serve as the competition deliverables and are submitted via HeroX.

Only one entry is accepted from each team. Competition submissions are considered to be on-time if they are received by the respective due date and time as indicated on HeroX. Late submissions may be considered on a case-by-case basis but are marked as such with notice given accordingly to the competition administrator or expert reviewers.

How We Score

Progress Submission

Progress Submissions are reviewed by the competition administrator for eligibility and in accordance with the evaluation statements listed in Table 2. Teams advance as finalists if the competition administrator agrees (on average) with the evaluation statements more than they disagree with the statements. Teams do not compete against each other to become finalists, and there is no limit on the number of finalists. Feedback regarding the Progress Submission is provided to all teams who submit.

Final Submission

Final Submissions are screened by the competition administrator for compliance and completeness. Eligible submissions are reviewed, scored, and commented on by a panel of expert reviewers in accordance with the evaluation statements listed in Table 4. The individual reviewer scores for each submission are summed, and the summed scores from each of the reviewers are averaged to determine the final score for each submission.

The rank order of the final scores is the basis for DOE to determine the winners. An overall first, second, and third-place prize will be awarded. From the remaining submissions, an Honorable Mention – Geosciences Component and Honorable Mention – Stakeholder Engagement Strategy will also be awarded. Teams identified as first second, and third-place winners are not eligible to be considered for the honorable mentions. DOE makes the final determination of the winners.

Who Can Enter

The Geothermal Collegiate Competition invites teams consisting of at least three collegiate students that meet the following criteria:

- All participating students must be enrolled in an accredited collegiate institution. Students must be enrolled in at least one class and be pursuing a degree throughout the duration of the competition.
    - For the purposes of this competition, "collegiate institution" refers to a school of post-secondary or higher education, including but not limited to community colleges, colleges, and universities. Collegiate students of any level are eligible to compete. Teams with students from multiple universities are allowed, and multiple teams from the same university are allowed. Individual students may be members of only one team.
    - Due to the COVID-19 pandemic, students enrolled at a collegiate institution but taking a deferment or "gap year" may compete. Students not actively enrolled in at least one class must obtain documentation from their institution that corroborates their deferral or gap year status.
- The team captain and HeroX account holder for the team submission must be a U.S. citizen.
    - Teams may represent U.S.- or non-U.S.-based accredited collegiate institutions, provided the team captain is a U.S. citizen.
    - For teams representing non-U.S.-based accredited collegiate institutions, the team captain and all team members must be U.S. citizens.
- Members of the expert reviewer panels, competition administrator staff, and DOE and national laboratory employees are ineligible to compete.
- Teams are encouraged to have at least one faculty advisor, but this is not required for participation. The faculty advisor is not an official team member and does not count toward the minimum requirement of three participating students per team.
- By uploading a submission package, a team self-certifies that it is in compliance with the eligibility requirements. If the competition administrator becomes aware that a team or individual is not eligible, that team may be disqualified from competition.

4. PROGRESS SUBMISSION

Competing teams must enter a Progress Submission. Teams with successful Progress Submissions are considered finalists in the Geothermal Collegiate Competition and are eligible to enter a Final Submission. Progress Submissions must be entered in HeroX by the submission deadline in the form of a Progress Deliverable Package.

Table 2 contains the content requirements and corresponding evaluation statements for the Progress Submission. The required file format of each component of the Progress Deliverable Package is indicated in brackets.

Table 2. Progress Submission Content and Evaluation Statements

1. Site Identification	
Map showing identified site and 2-page written narrative [Single PDF document] *2-page limit does not include map of site.*	
Content: • Map clearly identifying location of proposed community or campus site, surface map of the area containing the geothermal resource, and end uses • Description of the community or campus site • Explanation of why the team selected this site • Explanation of why the site is appropriate for a geothermal direct use case.	Evaluation Statements: • The community or campus site is clearly identified. • The site is appropriate for a geothermal direct use case.
2. Resource Assessment	
5-page document [PDF] *5 pages is inclusive of all text and figures. References cited are not included in the 5-page total.*	
Content: • Geothermal resource characterization at the proposed location • Description of how this resource can be accessed • Description of why this resource is adequate for the selected site and end use.	Evaluation Statements: • Adequate geothermal resources are available at this site. • The team used relevant and reputable data to conduct their assessment.
3. Stakeholder Engagement Strategy	
10-slide PowerPoint presentation [saved as a PDF]	
Content: • Identify and interview relevant stakeholder(s) for the selected site • Present key findings from interviews • Develop preliminary messaging for materials to educate stakeholders around geothermal potential at the site.	Evaluation Statements: • The team identified appropriate stakeholders for the selected site. • The team's preliminary messaging educates stakeholders around the benefits of geothermal.
4. Team Information	
These questions are answered directly in the HeroX platform. They are used to determine eligibility and for the competition administrators to use for reference. They are not scored.	
Content: • Name, collegiate affiliation, and degree program of each team member • Feedback or questions for the competition administrator.	

Progress Submission Scoring

The competition administrator evaluates the Progress Submissions using the statements given in Table 2. Teams advance as finalists if the competition administrator agrees (on average) with the evaluation statements more than they disagree with the statements. Progress Submissions are scored on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree) as shown in Table 3.

Teams do not compete against each other to become finalists, and there is no limit on the number of finalists. Feedback regarding the Progress Submission is provided to all teams who submit.

Table 3. Scoring Scale

1	2	3	4	5	6
Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree

5. FINAL SUBMISSION

The Final Submission includes a proposed community or campus site, subsurface resource characterization, energy load or usage assessment, preliminary economic feasibility analysis, and stakeholder engagement strategy.

Final Submissions must be entered in HeroX by the submission deadline.

Table 4 contains the content requirements and corresponding evaluation statements for the Final Submission. The required file format of each component of the Final Submission is indicated in brackets. Additional details on the required content and formatting of the deliverable package sections are provided in Appendices A through E.

Table 4. Final Submission Content and Evaluation Statements

1. Site Identification	
Map showing identified site and 2-page written narrative [Single PDF] *2-page limit does not include map of site.*	
Content: • Map clearly identifying location of proposed community or campus site, surface map of the area containing the geothermal resource, and end uses • Description of the community or campus site • Description of why the team selected this site • Description of why the site is appropriate for a geothermal direct use case.	Evaluation Statements: • The community or campus site is clearly identified. • The site is appropriate for a geothermal direct use case.
2. Resource Assessment	
5-page document [PDF] *5 pages is inclusive of all text and figures. References cited are not included in 5-page total.*	
Content: • Geothermal resource characterization at the proposed location • Description of how this resource will be accessed • Description of why this resource is adequate for the selected site.	Evaluation Statements: • Adequate geothermal resources are available at the site. • The team used relevant and reputable data to conduct their assessment.

3. Usage Assessment	
Visual (graph or chart) and 4-page written narrative [PDF] *4-page limit does not include visual (graph or chart) or references cited.*	
Content: • Visual aid (chart or graph) showing annual energy end usage for the community or campus • Description of how the usage matches the available geothermal resources • Conclusions drawn from available data.	Evaluation Statements: • The chart or graph clearly demonstrates the community or campus energy usage. • The team clearly articulates accurate conclusions from the available data.
4. Preliminary Economic Feasibility Analysis	
3-page document [PDF] *References cited are not included in the 3-page total.*	
Content: • Identified life cycle cost and required payback period.	Evaluation Statements: • The team has used appropriate methodology and calculations to determine economic feasibility. • The payback period (return on investment) has been calculated, as well as potential future monetary savings.
5. Stakeholder Engagement Strategy	
Visual tool or link upload [PDF or URL] and 10-page PowerPoint presentation [Saved as a PDF]	
Content: • Identify and interview relevant stakeholder(s) for selected site • Presentation of key findings from interviews • Messaging for materials to educate stakeholders about geothermal potential at the site • A visual aid/tool (e.g., video, presentation, model, interactive website) to engage and educate local stakeholders about the geothermal potential of the community or campus geothermal direct use case • Description of how and with whom this tool was shared • A plan for sharing the tool more broadly.	Evaluation Statements: • The visual tool is innovative, with a unique and compelling story. • The visual tool is creative and clearly conveys a relevant message. • The visual tool is relevant and of high quality (increases public interest or assists decision makers). • The plan clearly defines how the team would engage appropriate stakeholders to inform them about this process, as well as possible objections and how those would be handled.
6. Team Information	
These questions are answered directly in the HeroX platform. They are used to determine eligibility and for the competition administrator to use for reference. They are not scored.	
Content: • Name, collegiate affiliation, and degree program of each team member • Feedback for the competition administrator • Favorite aspects of the competition experience.	

Final Submission Scoring

Final Submissions are screened by the competition administrator for compliance and completeness. Eligible submissions will be reviewed, scored, and commented on by a panel of expert reviewers in accordance with the evaluation statements listed in Table 4.

Submissions will be scored on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Each evaluation statement is equal weight and receives a score as shown in Table 5.

Table 5. Scoring Scale

1	2	3	4	5	6
Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree

The individual reviewer scores for each submission will be averaged for a total score for each submission. An additional score for the Geosciences Component (Site Identification, Resource Assessment, and Usage Assessment sections) and the Stakeholder Engagement Strategy will also be given for each submission.

The final scores for each submission will provide the basis for DOE to determine the winners. An overall first, second, and third-place prize will be awarded. From the remaining submissions, an Honorable Mention for the Geosciences Component and Stakeholder Engagement Strategy will also be awarded. Teams identified as first, second, and third-place winners are not eligible to be considered for honorable mentions. DOE makes the final determination of the winners.

6. ADDITIONAL TERMS AND CONDITIONS

Universal Contest Requirements

Your submission for the Geothermal Collegiate Competition is subject to the following terms and conditions:

- You agree to release your stakeholder engagement tool under a Creative Commons Attribution 4.0 International License (see https://creativecommons.org/licenses/by/4.0/).
- You must include all the required submission elements. The competition administrator may disqualify your submission after an initial screening if you fail to provide all required submission elements. Competitors may be given an opportunity to rectify submission errors due to technical challenges.
- Your submission must be in English and in a format readable by Adobe Acrobat Reader. Scanned hand-written submissions will be disqualified.
- Submissions and competitors will be disqualified if any engagement with the Geothermal Collegiate Competition—including but not limited to the submission, the HeroX forum, or e-mails to the competition administrator—contains any matter that, in the sole discretion of DOE or NREL, is indecent, obscene, defamatory, libelous, lacking in professionalism, or demonstrates a lack of respect for people or life on this planet.
- If you click “Accept” on the HeroX platform and proceed to register for the competition described in this document, these rules will form a valid and binding agreement between you and the U.S. Department of Energy and is in addition to the existing HeroX Terms of Use for all purposes relating to these contest. You should print and keep a copy of these rules. These provisions only apply to the contests described here and no other contests on the HeroX platform or anywhere else. To the extent that these rules conflict with the HeroX Terms of Use, these rules shall govern.

- The competition administrator, when feasible, may give competitors an opportunity to fix non-substantive mistakes or errors in their submission packages.

Verification for Payments

The competition administrator will verify the identity and the role of a participant potentially qualified to receive the prizes. Receiving a prize payment is contingent upon fulfilling all requirements contained herein. The competition administrator will notify winning competitors using provided email contact information after the date that results are announced. Each competitor (or parent/guardian if under 18 years of age), will be required to sign and return to the competition administrator, within 30 days of the date the notice is sent, a completed NREL Request for ACH Banking Information form, and a completed W-9 form (https://www.irs.gov/pub/irs-pdf/fw9.pdf). In the sole discretion of the competition administrator, a winning competitor will be disqualified from the competition and receive no prize funds if: (i) the person/entity cannot be contacted; (ii) the person/entity fails to sign and return the required documentation within the required time period; (iii) the notification is returned as undeliverable; (iv) the submission or person/entity is disqualified for any other reason.

Teams and Single-Entity Awards

The competition administrator will award a single dollar amount to the designated primary submitter, whether consisting of a single entity or multiple entities. The primary submitter is solely responsible for allocating any prize funds among its member competitors as they deem appropriate. The competition administrator will not arbitrate, intervene, advise on, or resolve any matters between team members or between teams.

Submission Rights

By making a submission, and thereby consenting to the rules of the contest as described in this document, a competitor is granting to DOE, the competition administrator, and any other third parties supporting DOE in the contest a license to display publicly and use all parts of any submission for any other government purpose. This license includes posting or linking to the portions of the submission on the competition administrator or HeroX applications, including the contest website, DOE websites, and partner websites, and the inclusion of the submission in any other media, worldwide. The submission may be viewed by the DOE, competition administrator, and reviewers for purposes of the contests, including but not limited to screening and evaluation purposes. The competition administrator and any third parties acting on their behalf will also have the right to publicize competitor's name and, as applicable, the names of competitor's team members and organization, which participated in the submission on the contest website indefinitely.

By entering, the competitor represents and warrants that:

1. Competitor's entire submission is an original work by competitor and competitor has not included third-party content (such as writing, text, graphics, artwork, logos, photographs, dialogue from plays, likeness of any third party, musical recordings, clips of videos, television programs or motion pictures) in or in connection with the submission, unless (i) otherwise requested by the competition administrator and/or disclosed by competitor in the submission, and (ii) competitor has either obtained the rights to use such third-party content or the content of the submission is considered in the public domain without any limitations on use;

2. Unless otherwise disclosed in the submission, the use thereof by competition administrator, or the exercise by competition administrator of any of the rights granted by competitor under these rules, does not and will not infringe or violate any rights of any third party or entity, including, without limitation patent, copyright, trademark, trade secret, defamation, privacy, publicity, false light, misappropriation, intentional or negligent infliction of emotional distress, confidentiality, or any contractual or other rights;

3. All persons who were engaged by the competitor to work on the submission or who appear in the submission in any manner have:

    a. Given competitor their express written consent to submit the submission for exhibition and other exploitation in any manner and in any and all media, whether now existing or hereafter discovered, throughout the world;

    b. Provided written permission to include their name, image, or pictures in or with the submission (or if a minor who is not competitor's child, competitor must have the permission of their parent or legal guardian) and competitor may be asked by competition administrator to provide permission in writing;

    c. Not been and are not currently under any union or guild agreement that results in any ongoing obligations resulting from the use, exhibition, or other exploitation of the submission.

Copyright

Each competitor represents and warrants that the competitor is the sole author and copyright owner of the submission; that the submission is an original work of the applicant or that the applicant has acquired sufficient rights to use and to authorize others, including DOE, to use the submission, as specified throughout the rules; that the submission does not infringe upon any copyright or upon any other third party rights of which the applicant is aware; and that the submission is free of malware.

Contest Subject to Applicable Law

All contests are subject to all applicable federal laws and regulations. Participation constitutes each participant's full and unconditional agreement to these contest rules and administrative decisions, which are final and binding in all matters related to the contest. This notice is not an obligation of funds; the final awards are contingent upon the availability of appropriations.

Resolution of Disputes

The U.S. Department of Energy is solely responsible for administrative decisions, which are final and binding in all matters related to the contest.

Neither the U.S. Department of Energy nor the prize administrator will arbitrate, intervene, advise on, or resolve any matters between team members or among competitors.

Publicity

The winners of these prizes (collectively, "winners") will be featured on the DOE and NREL websites.

Except where prohibited, participation in the contest constitutes each winner's consent to DOE's and its agents' use of each winner's name, likeness, photograph, voice, opinions, and/or hometown and state information for promotional purposes through any form of media, worldwide, without further permission, payment, or consideration.

Liability

Upon registration, all participants agree to assume and, thereby, have assumed any and all risks of injury or loss in connection with or in any way arising from participation in this contest, development of any submission. Upon registration, except in the case of willful misconduct, all participants agree to and, thereby, do waive and release any and all claims or causes of action against the federal government and its officers, employees and agents for any and all injury and damage of any nature whatsoever (whether existing or thereafter arising, whether direct, indirect, or consequential and whether foreseeable or not), arising from their participation in the contest, whether the claim or cause of action arises under contract or tort.

Records Retention and the Freedom of Information Act

All materials submitted to DOE as part of a submission become DOE records and are subject to the Freedom of Information Act. The following applies only to portions of the submission not designated as public information in the instructions for submission. If a submission includes trade secrets or information that is commercial or financial, or information that is confidential or privileged, it is furnished to the Government in confidence with the understanding that the information shall be used or disclosed only for evaluation of the application. Such information will be withheld from public disclosure to the extent permitted by law, including the Freedom of Information Act. Without assuming any liability for inadvertent disclosure, DOE will seek to limit disclosure of such information to its employees and to outside reviewers when necessary for review of the application or as otherwise authorized by law. This restriction does not limit the Government's right to use the information if it is obtained from another source.

Submissions containing confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

The submission must be marked as follows and identify the specific pages containing trade secrets, confidential, proprietary, or privileged information:

Notice of Restriction on Disclosure and Use of Data:

Pages [list applicable pages] of this document may contain trade secrets, confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes. [End of Notice]

The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Trade Secrets, Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure." In addition, each line or paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets.

Competitors will be notified of any Freedom of Information Act requests for their submissions in accordance with 29 C.F.R. § 70.26. Competitors may then have the opportunity to review materials and work with a FOIA representative prior to the release of materials.

Privacy

If you choose to provide HeroX with personal information by registering or completing the submission package through the contest website, you understand that such information will be transmitted to DOE and may be kept in a system of records. Such information will be used only to respond to you in matters regarding your submission and/or the contest unless you choose to receive updates or notifications about other contests or programs from DOE on an opt-in basis. DOE and NREL are not collecting any information for commercial marketing.

General Conditions

DOE reserves the right to cancel, suspend, and/or modify the contest, or any part of it, at any time. If any fraud, technical failures, or any other factor beyond DOE's reasonable control impairs the integrity or proper functioning of the contests, as determined by DOE in its sole discretion, DOE may cancel the contest.

Although DOE indicates that it will select up to several winners for each contest, DOE reserves the right to only select competitors that are likely to achieve the goals of the program. If, in DOE's determination, no competitors are likely to achieve the goals of the program, DOE will select no competitors to be winners and will award no prize money.

ALL DECISIONS BY DOE ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE CONTEST.

7. COMPETITION AUTHORITY AND ADMINISTRATION

The Geothermal Collegiate Competition is organized by DOE and NREL, which is managed and operated by the Alliance for Sustainable Energy, LLC, for DOE. Funding is provided by DOE GTO. The views expressed herein do not necessarily represent the views of DOE or the U.S. government.

The Spring 2021 Geothermal Collegiate Competition is governed and adjudicated by this rules document, which is intended to establish fair contest rules and requirements. The competition is designed and administered by a team consisting primarily of DOE and NREL staff. In the case of a discrepancy with other competition materials or communication, this document takes precedence. The latest release of these rules takes precedence over any prior release. The competition administrator reserves the right to change contest criteria, rules, and outcomes as needed. Additionally, competitors are encouraged to bring to the organizers' attention rules that are unclear, misguided, or in need of improvement. For the purposes of competition evaluation, a violation of the intent of a rule will be considered a violation of the rule itself. Questions on these rules or the program overall can be directed to Geo.Competition@nrel.gov.

Expert reviewers may not have personal or financial interests in; be an employee, officer, coordinator, or agent of any entity that is a registered participant in; or have a familial or financial relationship with an individual who is a registered competitor in this contest.

By making a submission and consenting to the rules of this competition, each team member grants to the Government permission to use and make publicly available any entry provided or disclosed to DOE in connection with the competition. In addition, each team grants to the Government, and others acting on its behalf, a paid-up nonexclusive, irrevocable, worldwide license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the U.S. Government, for any and all copyrighted works that are or make up any submission.

Geothermal Collegiate Competition and any associated nicknames and logos ("Competition Marks") are trademarks owned by DOE. The trademark license granted to contestants is below. Non-contestants can request individualized trademark licenses (for the purpose of engaging with contestants and/or expressing interest in the competition); the decision to grant such licenses is under the sole discretion of DOE.

1. Contestants are granted, for the duration of the competition, a revocable, non-exclusive, royalty-free license to use the Competition Marks for the purposes of producing materials for the competition and other approved competition-related activities as long as the use does not suggest or imply endorsement of the contestant by DOE, and the use of the Competition Marks by a contestant does not imply the endorsement, recommendation, or favoring of the contestant by DOE.
2. Contestants may not use the Competition Marks for any other purpose. Contestants may not sublicense the Competition Marks.
3. All contestants can request individualized trademark licenses; the decision to grant such requests is under the sole discretion of DOE.

Further, from the Competes Act:

(j) Intellectual property

(1) Prohibition on the government acquiring intellectual property rights

The Federal Government may not gain an interest in intellectual property developed by a participant in a prize competition without the written consent of the participant.

(2) Licenses

As appropriate and to further the goals of a prize competition, the Federal Government may negotiate a license for the use of intellectual property developed by a registered participant in a prize competition.

APPENDIX A. SITE IDENTIFICATION

Description of Task:

- Map clearly identifying location of proposed community or campus site, surface area containing the geothermal resource, and end uses
- Description of the community or campus site
- Description of why the team selected this site
- Description of why the site is appropriate for a geothermal direct use case.

Guidance: The selected site must be within the United States or within U.S. territories. The site must be clearly identified and appropriate for the selected use case. The use case must consist of one or more commercial or multi-family buildings, or industrial or agricultural process use, with property access rights to the geothermal resources. Possible use cases include community or campus heat pumps or direct use (e.g., space heating, district heating, industrial processes, greenhouses, aquaculture).

Deliverable Requirements: Single PDF document containing a map (clearly showing the identified site, surface area containing the geothermal resource, and location of end uses) and a 2-page written narrative. Narrative includes descriptions of the site, why the site was selected, and why the site is appropriate for the selected use case (see "Description of Task"). The 2-page limit **does not** include the map.

APPENDIX B. RESOURCE ASSESSMENT

Description of Task:

- Geothermal resource characterization at the proposed location
- Description of how this resource can be accessed
- Description of why this resource is adequate for the selected site and end use (temperature, required flow rate, available/required infrastructure, etc.).

Guidance: This is intended to be a literature review and analysis of available data at the proposed location. Teams are not expected to conduct surveys or collect their own data. The resource assessment should demonstrate that the geothermal resources at the site are adequate for the selected use case. Teams must use relevant and reputable data to conduct the assessment.

Deliverable Requirements: 5-page PDF document containing characterization of the geothermal resource, a description of resource access, and a description explaining how the resource is adequate for the selected use case (see "Description of Task"). The 5-page limit is inclusive of all text and figures, but a list of references cited is not included in the 5-page total.

Possible Resource: GeoRePORT and protocol documents, available at https://openei.org/wiki/GeoRePORT/Protocol. While this tool is for power production rather than direct use, it may still be useful to guide your resource assessment for your direct use application.

APPENDIX C. USAGE ASSESSMENT

Description of Task:

- Visual aid (chart or graph) showing annual energy end usage for the community or campus
- Description of how the usage matches the available geothermal resources
- Conclusions drawn from available data.

Guidance: The visual aid should clearly demonstrate the community or campus energy usage. The written narrative should explain why the usage is appropriate for the available geothermal resources at the site, and should clearly articulate conclusions drawn from available data.

Deliverable Requirements: A single PDF document containing a visual aid (graph or chart) and a 4-page written narrative describing how the usage matches the geothermal resource and conclusions drawn from available data. The 4-page limit does not include the visual aid or references cited.

APPENDIX D. PRELIMINARY ECONOMIC FEASIBILITY ANALYSIS

Description of Task: Identify life cycle cost and required payback period (return on investment).

Guidance: Teams should use appropriate methodology and calculations to determine economic feasibility. This includes calculations of payback period (return on investment), as well as potential future monetary savings.

Teams are strongly encouraged to use GEOPHIRES (see "Educational References"), a freely available program that has built-in assumptions for direct-use geothermal cases. The program is Python-based, and relatively simple to use for even the novice coder. For comprehensible instructions on running both Python and the program, see the GEOPHIRES User Manual, provided in "Educational References."

GEOPHIRES can calculate many different cost components of a geothermal project, including but not limited to its overall lifetime costs, operation and maintenance costs, and the levelized cost of heat or electricity. Many different types of geothermal plants can be evaluated, including direct use, electric, and hybrid.

If the team has no familiarity with Python or certain project characteristics are unknown, they may still use relevant assumptions and default values in GEOPHIRES (listed below in Table D-1) for their economic assessment. Other resources for performing an economic assessment without the assistance of GEOPHIRES are listed in the Economics subsection of 'Educational References,' below.

Table D-1. GEOPHIRES Default Values and Assumptions

Input Parameter	Default Value	Description
Reservoir depth	3 km	Depth of the reservoir
Geothermal gradient	50°C/km	The change in temperature as depth in the reservoir increases. GEOPHIRES divides the reservoir into different rock "segments" of different thicknesses, each having its own geothermal gradient.
Number of production wells	2	
Number of injection wells	2	
Production well diameter	8 inches	Inner diameter of production wellbore
Injection well diameter	8 inches	Inner diameter of injection wellbore
Production wellbore temperature drop	5°C	Geofluid temperature drop between the reservoir and the surface
Injection wellbore temperature gain	0°C	Fluid temperature gain at the injection well
Production flow rate per well	50 kg/s	Rate at which well can produce fluid
Reservoir volume	125,000,000 m^3	Volume (Depth x surface area) of the geothermal reservoir

Input Parameter	Default Value	Description
Productivity index	10 kg/s/bar	Ratio of production well flow rate over production well inflow pressure drop
Injectivity index	10 kg/s/bar	Ratio of injection well flow rate over injection well outflow pressure drop
Production wellhead pressure	Water vapor pressure (at initial production temperature) + 344.7 kPa	
Plant outlet pressure	Production wellhead pressure – 68.95 kPa	Equals the injection wellpumps suction pressure
Injection temperature	70°C	Geofluid temperature at injection wellhead
Reservoir heat capacity	1000 J/kg/°K	Constant and uniform reservoir rock heat capacity
Reservoir density	2700 kg/m^3	
Reservoir thermal conductivity	3 W/m/°K	
Reservoir porosity	0.04	Fraction of reservoir comprising pore space
Reservoir permeability	$1x10^{-13}$ m^2	
Pump efficiency	0.75	The efficiency (out of 1) of production and injection well pumps
Utilization factor	0.9	Fraction of the year which the plant is running (can vary significantly with direct use projects)
End-use efficiency	0.9	Thermal efficiency (out of 1) of the direct use application
Surface temperature	15°C	
Plant lifetime	30 years	The amount of time the plant is up and running
Fixed charge rate	0.1	The percentage of the total plant cost that is required over the project life per year to cover the minimal annual revenue requirements. This concept can be compared to a home mortgage.
Discount rate	7% per year	Approximates the rate of interest earned on investments.
Fraction of investment in bonds	0.5	Fraction of the geothermal project that will be financed through bonds
Inflation rate	0.02	Approximates the rate of economic growth and inflation in value of the dollar.
Inflated bond interest rate	0.05	Defined in GEOPHIRES as: (1 + inflated bond interest rate) =

Input Parameter	Default Value	Description
		(1 + deflated bond interest rate) × (1 + interest rate). This parameter characterizes the cost of debt.
Inflated equity interest rate	0.1	Defined in GEOPHIRES as: (1 + inflated equity interest rate) = (1 + deflated equity interest rate) × (1 + interest rate). This parameter characterizes the cost of equity.
Combined income tax rate	0.3	Defined in GEOPHIRES as: using (combined income tax rate) × (revenue – deductible expenses) – investment tax credits.
Gross revenue tax rate	0	
Investment tax credit rate	0	
Property tax rate	0	
Inflation rate during construction	0	

Deliverable Requirements

- 3-page document [PDF document]
- List of references cited is not included in 3-page total.

APPENDIX E. STAKEHOLDER ENGAGEMENT STRATEGY

Description of Task:

- Identify and interview relevant stakeholder(s) for selected site
- Presentation of key findings from interviews
- Developed messaging for materials to educate stakeholders about geothermal potential at the site
- Create a visual aid/tool (e.g., video, presentation, model, interactive website) to engage and educate local stakeholders about the geothermal potential of the community or campus geothermal direct use case
- Description of how and with whom this tool was shared
- A plan for sharing the tool more broadly.

Guidance: Depending on your selected site, there will be a variety of local, relevant stakeholders. Through this task, you should work with and interview key stakeholders for your site. For example, this could be a governing board or leadership for your site, local government officials, and people who would be the end users of the geothermal energy. During the first part of the challenge, you should engage these decision makers in your site selection progress.

During the second part of the competition, you should develop a visual aid. This could be a short video, presentation, model, interactive website, or some other creative tool to engage these stakeholders and others about the geothermal potential of your direct use case.

Deliverable Requirements: For the Progress Submission, a 10-slide PowerPoint briefing deck saved as a PDF is required. For the Final Submission, update the briefing deck and include the visual aid/tool.

APPENDIX F. EDUCATIONAL REFERENCES

General

Better Buildings Solution Center Geothermal Case Studies
https://betterbuildingssolutioncenter.energy.gov/search?f%5B0%5D=field_technology%3A433

Bureau of Land Management, Geothermal Energy
https://www.blm.gov/programs/energy-and-minerals/renewable-energy/geothermal-energy

California Energy Commission, Geothermal Energy in California
https://www.energy.ca.gov/data-reports/california-power-generation-and-power-sources/geothermal-energy

DOE Geothermal Educational Resources
https://www.energy.gov/eere/geothermal/educational-resources

DOE Frontier Observatory for Research in Geothermal Energy (FORGE)
https://www.energy.gov/eere/forge/forge-home

Geothermal Rising, "What is Geothermal?"
https://geothermal.org/what.html

GeoVision: Harnessing the Heat Beneath Our Feet
https://www.energy.gov/eere/geothermal/geovision

Idaho National Laboratory, Environmental and Geological Engineering
https://inl.gov/research-program/sustainable-resource-recovery/

Lawrence Berkeley National Laboratory Geothermal Systems Program
https://eesa.lbl.gov/programs/geothermal-systems/

NREL Energy Basics: Geothermal
https://www.youtube.com/watch?v=rpgJWYp2OLA

NREL Advancing Geothermal Research with Impact Analysis
https://www.youtube.com/watch?v=l4oKi2spRPE

NREL Geothermal Research
https://www.nrel.gov/geothermal/

Pacific Northwest National Laboratory, Geothermal Energy: Harvesting the Earth's Natural Heat
https://www.pnnl.gov/geothermal-energy

U.S. Energy Information Administration, Geothermal Explained
https://www.eia.gov/energyexplained/geothermal/

U.S. Environmental Protection Agency, A Student's Guide to Global Climate Change: Geothermal Energy
https://archive.epa.gov/climatechange/kids/solutions/technologies/geothermal.html

U.S. Fish and Wildlife Service, Energy Development: Geothermal Energy
https://www.fws.gov/ecological-services/energy-development/geothermal.html

U.S. Geological Survey Geothermal Resources Investigations Project
https://www.usgs.gov/energy-and-minerals/energy-resources-program/science/geothermal?qt-science_center_objects=0%23qt-science_center_objects

Data

Geothermal Data Repository
https://gdr.openei.org/

NREL Geothermal Prospector
https://maps.nrel.gov/geothermal-prospector/

Southern Methodist University Geothermal Lab Data and Maps
https://www.smu.edu/Dedman/Academics/Departments/Earth-Sciences/Research/GeothermalLab/DataMaps

Economics

GEOPHIRES github contains its Python script, user manual, papers describing its use, and sample input and output files.
https://github.com/NREL/GEOPHIRES-v2

OpenEI Transparent Cost Database
https://openei.org/apps/TCDB/transparent_cost_database

Short W., Packey, D.J., and Holt T. 1995. A manual for the economic evaluation of energy efficiency and renewable energy technologies. Golden, CO: NREL. https://www.osti.gov/biblio/35391

A helpful reference for determining drilling costs:
Lukawski, M.Z., Anderson, B.J., Augustine, C., Capuano Jr, L.E., Beckers, K.F., Livesay, B., & Tester, J.W. 2014. Cost analysis of oil, gas, and geothermal well drilling. *Journal of Petroleum Science and Engineering* 118, 1-14.

Resource Assessment

GeoRePORT and protocol documents
https://openei.org/wiki/GeoRePORT/Protocol
While this tool is for power production rather than direct use, it may still be useful to guide your resource assessment for your direct use application.

Conference Papers

DOE Office of Scientific and Technical Information research database
https://www.osti.gov/

Geothermal Rising Library
https://www.geothermal-library.org/

International Geothermal Association Geothermal Paper Database
https://www.geothermal-energy.org/explore/our-databases/conference-paper-database/

Stanford Earth
https://pangea.stanford.edu/ERE/db/IGAstandard/search.php