

2011

Geothermal Education and Training Guide





209 Pennsylvania Avenue SE, Washington, D.C. 20003 U.S.A.
Phone: (202) 454-5261 Fax: (202) 454-5265 Web Site: www.geo-energy.org

Geothermal Education and Training Guide

By Alison Holm

Cover Photos:

Geothermal Students (*Top, left to right*): **Andres Ruzo** (Southern Methodist University), **Scott Bennet** (University of California-Davis), **Kelly Blake** (Temple University), **Mark McClure** (Stanford University), **Rob Klenner** (University of North Dakota), **Jared Peacock** (University of Adelaide, Australia); (*Bottom, left to right*): **Sam Scott** (Reykjavik Energy Graduate School of Sustainable Systems), **Andrew Fowler** (University of California-Davis), **Thomas Freeman** (Utah State University), **Sarah Pistone** (Stanford University), **Ryan Libbey** (McGill University, Canada), **Zach Frone** (Southern Methodist University)

For more information on these students and their studies, visit
<http://www.geothermalweb.org/studentfeatures.aspx>.

Geothermal drill rig photo courtesy **Gradient Resources**.

Acknowledgments:

The Geothermal Energy Association's (GEA) Geothermal Education and Training Guide benefits from the valuable contributions of many individuals. We would particularly like to thank John Pritchett and Marilyn Nemzer for their thoughtful comments and edits. Karl Gawell, Leslie Blodgett, and Dan Jennejohn of GEA also provided numerous edits and feedback at various stages of the research and writing process. Additional review by professors and faculty members at many of the schools listed in this document has helped to clarify and flesh out the information presented. Specific thanks to Maria Richards, Jefferson Tester, John Shervais, Lynn Stiles, Joseph Kozuch, Toni Boyd, Brandon Dugan, Glenn Rix, Nicholas Davatzes, Jeanne Knobbe, Derek Elsworth, Kerop Janoyan, Jim Nichols, Thomas Niesen, Jerry Fairley, Roland Horne, Peter Schiffman, Will Gosnold, Nafi Toksoz, Robert Bodnar, Wendy Calvin, Sarah Crippen, and Mark Person. This is the second incarnation of GEA's Geothermal Education and Training Guide and incorporates insight and edits provided on the first version from members of the GEA community, including Ann Robertson-Tait, Dan Fleischmann, and Rachel Bilyk among others already acknowledged.

Table of Contents:

Introduction 5

U.S. Schools and Universities with Geothermal Programs, Courses and/or Research Opportunities 7

 Boise State University 7

 Brown University..... 7

 Colorado School of Mines 7

 Cornell University..... 8

 Georgia Institute of Technology 8

 Massachusetts Institute of Technology 8

 Montana Tech University..... 9

 National Geothermal Academy..... 9

 New Mexico Institute of Mining and Technology..... 9

 New Mexico State University 10

 Northern Arizona University 10

 Oregon Institute of Technology 10

 The Pennsylvania State University..... 10

 Rice University 11

 San Diego State University..... 11

 Southern Methodist University..... 11

 Stanford University 12

 Temple University 12

 Texas A&M University..... 12

 University of Alaska, Fairbanks 13

 University of California, Berkley..... 13

 University of California, Davis 13

 University of Idaho..... 14

 University of Nevada, Reno 14

 University of North Dakota 15

 University of Utah 15

 Utah State University 15

 Virginia Polytechnic Institute and State University 16

Washington State University	16
West Virginia University.....	16
International Schools and Institutions with Established Geothermal Programs.....	17
Bicol University, Philippines	17
Negros Oriental State University, Philippines.....	17
RES The School for Renewable Energy Science, Iceland.....	17
Reykjavik Energy Graduate School of Sustainable Systems (REYST), Iceland.....	18
United Nations University Geothermal Training Program, Iceland.....	18
University of Adelaide, Australia.....	18
University of Auckland, New Zealand	18
Geothermal Technical Training Schools and Institutions	19
Baker Hughes	19
Gateway Technical College of Wisconsin.....	19
Geothermal Resource Group	20
Murchison Drilling Schools, Inc. (MDS).....	20
Richard Stockton College of New Jersey.....	20
Siemens.....	20
Southwest Mississippi Community College (SMCC).....	21
Truckee Meadows Community College (TMCC)	21
Schools and Institutions for Geothermal Heat Pump Education and Technical Training.....	22
International Ground Source Heat Pump Association.....	22
American Ground Water Trust	22
Clarkson University	22
Clean Edison.....	23
Geothermal Training Institute	23
Greenville Technical College	23
HeatSpring Learning Institute	23
National Ground Water Association (NGWA).....	23
Oklahoma State University	24
Other Geothermal Education Opportunities	25
NREL National Geothermal Student Competition	25
Additional Education and Training Resources and Links	25

Introduction

As geothermal energy production and use become more prominent in today's renewable energy landscape, academic institutions are taking note. A shortage of trained industry professionals – especially higher-level geothermal power plant managers, geologists, resource analysts, permitting staff, drillers, engineers, and geothermal heat pump installers – is often cited as an obstacle to the growth of the geothermal industry. As the industry grows, so too does the need for geothermal education and training. A number of colleges, universities and training institutions across the country are responding with undergraduate, graduate, and certification programs related to geothermal. The National Geothermal Academy (NGA), for example, is in its inaugural year offering an intensive 8-week summer program covering all aspects of geothermal energy development and utilization.

Cultivating geothermal energy for all of its uses requires a wide range of experts in various fields. In an October 2010 report on geothermal industry jobs, the Geothermal Energy Association (GEA) discussed the numerous types of jobs created at different stages of geothermal project development. Development requires the expertise of “green collar” laborers (drill rig operators, welders, mechanics), degreed professionals (engineers, geologists, geophysicists) and a host of other professionals including environmental permitting consultants and lawyers, wildlife biologists and hydrologists, and plant managers and technicians.

Given the variety of jobs required for a productive geothermal workforce, there are a number of educational paths for students to consider. For undergraduate students, academic areas suited for a future career in the geothermal industry include civil and environmental engineering, chemical engineering, geology, geological engineering, geophysics, hydrology, mechanical engineering, and petroleum engineering. Undergraduate degree programs in these areas are available through most colleges and universities. A few institutions, such as the Southern Methodist University (SMU) have a geothermal focus within a major. Others, including the Oregon Institute of Technology (OIT), Massachusetts Institute of Technology (MIT), Cornell University, and University of Nevada, Reno (UNR) offer undergraduate renewable-energy-related minors which highlight geothermal. OIT also offers an undergraduate renewable energy major. Generally, a background in physical sciences or engineering will benefit students entering the geothermal industry or pursuing more advanced degrees suited for geothermal.

Due to the more specialized nature of graduate studies, many more opportunities in geothermal-specific education exist at the graduate level than at the undergraduate level. Stanford University and SMU offer both geothermal master's and doctorate degrees. In addition to the Stanford Geothermal Program and SMU's Geothermal Laboratory, research facilities and/or geothermal research opportunities exist at a growing number of institutions. More widely available graduate degrees including civil and environmental engineering, chemical engineering, geology, geological engineering, geophysics, hydrology, mechanical engineering, and petroleum engineering are useful for pursuing a geothermal career.

It is beyond the scope of this report to individually identify all of the academic programs – and institutions offering those programs – that could prepare students to enter the broad geothermal field. Instead, geothermal-specific programs, coursework, or research opportunities have been identified at the institutions listed below.

While this document focuses primarily on U.S. schools and institutions, a handful of prominent international geothermal education opportunities are noted as well. Institutions are divided into broad categories based on the nature of the education and training involved. The first section, “Schools and Universities with Geothermal Programs, Course Components and/or Research Opportunities,” identifies institutions of higher learning that are active in geothermal education or research in varying capacities. Within this section, U.S. and international schools and institutions are separately categorized. Subsequent sections are “Technical Training Schools and Institutions” and “Schools and Institutions for Geothermal Heat Pump Education and Technical Training.” Within each section, institutions are listed in alphabetical order with brief descriptions of their involvement in geothermal. Finally, other geothermal educational opportunities and resources are acknowledged. Program information was primarily gathered from the schools’ Web sites. This list is not intended to be exhaustive, nor does GEA offer assessment of program quality.

U.S. Schools and Universities with Geothermal Programs, Courses and/or Research Opportunities

Boise State University

Boise, ID

<http://www.boisestate.edu/>

Boise State University (BSU) is the lead institution for the Department of Energy (DOE)-funded National Geothermal Data System (NGDS). The school's Department of Geosciences also offers courses in geotechnical engineering.

Department of Geosciences: <http://earth.boisestate.edu/>

NGDS: <http://www.geothermaldata.org/>

Brown University

Providence, RI

<http://www.brown.edu/>

Brown University offers a course in Sustainable Energy Technologies. This technical course explores the scientific, political, and social aspects of many sustainable energy sources. Brown also offers a two-week pre-college program course, Alternative Energy Engineering – An Introduction, designed for high school students. The course broadly covers energy and global warming issues and includes a review of geothermal among other alternative energy sources.

Pre-College Programs: <http://brown.edu/ce/pre-college/>

Colorado School of Mines

Golden, CO

<http://mines.edu/>

Colorado School of Mines offers numerous courses and degree programs covering various aspects of geothermal, including Petroleum Engineering, Geophysics and an Energy Minor. The school also features a four-week field program conducted through the Department of Geophysics which has focused on geothermal system characterization and is designed to “give students hands-on experience at conducting geophysical field investigations.” Colorado School of Mines held a geothermal research symposium at its campus in May 2011 and has identified geothermal energy as a prominent research area. Colorado School of Mines is also among the consortium of schools that developed the National Geothermal Academy and participated in the NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled “Other Geothermal Education Opportunities.”)

Field Camp: <http://inside.mines.edu/GEO-Field-Camp>

Cornell University

Ithaca, New York

<http://www.cornell.edu/>

Cornell University is actively involved in geothermal research through the Cornell Energy Institute and the Atkinson Center for a Sustainable Future. Cornell has adopted enhanced geothermal systems (EGS) as a focal area in its College of Engineering. The College houses the Cornell Energy Institute and has established a new graduate program in Earth-Energy Systems which takes an interdisciplinary approach to studying subsurface energy sources, of which geothermal is a major component. The University also offers a wide variety of engineering degrees both at the undergraduate and graduate levels which include coursework on geothermal energy. Cornell recently started offering both undergraduate and graduate minors in Sustainable Energy Systems which combines instruction analysis of energy systems, energy sources and technologies, energy impacts on natural systems, and social impact as it relates to policy, economics, and ethics, among other categories. Cornell is also among the consortium of schools that developed the National Geothermal Academy.

Energy Studies in the College of Engineering: <http://www.geo.cornell.edu/eas/energy/>

Geothermal: http://www.geo.cornell.edu/eas/energy/research_front_page/geothermal.html

Earth-Energy Systems Graduate Education: http://www.geo.cornell.edu/eas/earthenergy_grad_stud/

Atkinson Center for a Sustainable Energy Future: <http://www.sustainablefuture.cornell.edu/research/>

Georgia Institute of Technology

Atlanta, GA

<http://www.gatech.edu/>

The Geosystems Group within the School of Civil and Environmental Engineering (CEE) at Georgia Tech is active in both research and education related to geothermal energy. Various geotechnical courses are offered through CEE, which include instruction on Ground Source Heat Pumps (GSHP) for residential and commercial applications. Enhanced geothermal systems are also a key CEE research area.

School of Civil & Environmental Engineering: <http://www.ce.gatech.edu/>

Massachusetts Institute of Technology

Cambridge, MA

<http://web.mit.edu/>

The MIT Energy Initiative (MITEI), an interdisciplinary research program with a comprehensive focus on energy systems, includes geothermal among its key research areas. MIT also offers an Energy Minor and undergraduate research opportunities in energy systems, including geothermal. The Earth Resources Laboratory in the Department of Earth, Atmospheric and Planetary Sciences (EAPS) is also engaged in geothermal prospecting and resource characterization research.

MITEI: <http://web.mit.edu/mitei/index.html>

EAPS: <http://eapsweb.mit.edu/index.html>

Montana Tech University

Butte, MT

<http://www.mtech.edu/>

Montana Tech offers a Sustainable Energy Technology Certificate, a two-year program designed to produce entry level technicians in the first year and concentrate in geothermal, wind, and solar during the second year. The school offers a number of courses and degree programs through the School of Mines & Engineering related to geothermal, with some courses specifically covering geothermal systems. In addition, the School of Mines and Engineering hosts a Graduate Seminar Series, which this year included a section on Geothermal Resource Exploration Utilizing Ambient Seismic Noise.

School of Mines and Engineering: <http://www.mtech.edu/mines/>

National Geothermal Academy

Reno, Nevada

<http://www.unr.edu/geothermal/NGA.htm>

The NGA offers eight week-long modules covering all aspects of geothermal energy development and utilization. Currently in its inaugural year, the NGA offers the full eight-week summer course for undergraduate and graduate credit, with the option of enrolling in individual modules for professional development. Modules include: Introduction to Geothermal Energy Utilization; Public Policy, Permitting & Environmental Issues; Resource Assessment and Exploration; Drilling Engineering; Reservoir Engineering; Power Plant Design and Construction; Direct Use and Heat Pumps; and Geothermal Business Principles & Development. Born of the growing need to educate the next generation of geothermal experts, the DOE-funded NGA is administered through a consortium of top geothermal schools and hosted on the University of Nevada, Reno's Redfield campus.

New Mexico Institute of Mining and Technology

Socorro, NM

<http://www.nmt.edu/>

New Mexico Tech has developed a course on geothermal exploration and computational modeling of hydrothermal systems which will be offered for the first time this year. Graduate students and faculty are currently working on characterizing geothermal resources of Jemez Pueblo, the Socorro geothermal resource area, and are undertaking a statewide reassessment of New Mexico's geothermal resources. Undergraduate degrees in hydrology and petroleum geology and a master's degree in hydrology with an option in petroleum and geofluids are available through the Department of Earth and Environmental Sciences. New Mexico Tech is also developing local geothermal resources in order to heat its campus.

Hydrology - Earth and Environmental Science Department: <http://www.ees.nmt.edu/outside/Hydro/>

Geothermal Systems Research: <http://www.ees.nmt.edu/outside/person/research.html#geothermal>

New Mexico State University

Las Cruces, NM

<http://www.nmsu.edu/>

New Mexico State University houses the Southwest Technology Development Institute (SWTDI), based out of the College of Engineering which focuses on “the development, transfer, promotion, and commercialization of renewable energy technologies.” The Institute’s Environmental Systems program includes a geothermal-based aquaculture subdivision and operates the Southwest Geothermal Greenhouse Facility.

Southwest Technology Development Institute: <http://www.nmsu.edu/~tdi/about.html>

Northern Arizona University

Flagstaff, AZ

<http://home.nau.edu/>

The Northern Arizona University Sustainable Energy Solutions (SES) Group, housed in the colleges of Engineering, Forestry & Natural Sciences and Business Administration, focuses on new technology research and development, and education. Geothermal is among the SES Group’s areas of focus.

Sustainable Energy Solutions Group: <http://ses.cefn.s.nau.edu/>

Oregon Institute of Technology

Klamath Falls, Oregon

<http://www.oit.edu/>

Between a producing geothermal plant and the research-oriented Geo-Heat Center located on OIT’s Klamath Falls campus, OIT is a pioneer in both geothermal use and education. The Geo-Heat Center serves as a research institution and “provides technical analysis for those actively involved in geothermal development.” OIT also operates the Oregon Renewable Energy Center (OREC) and offers an undergraduate degree in Renewable Energy Engineering. OIT is among the consortium of schools that developed the National Geothermal Academy and participated in the NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled “Other Geothermal Education Opportunities.”)

Geo-Heat Center: <http://geoheat.oit.edu/>

Oregon Renewable Energy Center: <http://www.oit.edu/orec>

The Pennsylvania State University

University Park, PA

<http://www.psu.edu/>

Penn State offers undergraduate and graduate Energy and Geo-Environmental Engineering programs which cover some aspects of geothermal. Penn State is also among the schools that participated in the

NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled “Other Geothermal Education Opportunities.”)

Undergraduate Geo-Environmental Engineering:

http://bulletins.psu.edu/bulletins/bluebook/university_course_descriptions.cfm?letter=G&dept=GEOEE

Graduate Geo-Environmental Engineering:

http://bulletins.psu.edu/bulletins/whitebook/university_course_descriptions.cfm?letter=G&dept=GEOEE

Rice University

Houston, TX

<http://www.rice.edu/>

Rice University houses a Geotechnical Laboratory specializing in “measurement of geomechanical properties ... on sediments and rocks.” Various research opportunities in geofluids and geomechanics are available through the lab for both undergraduate and graduate students.

Rice Geotechnical Lab: <http://earthscience.rice.edu/departments/research/dugan/lab.html>

San Diego State University

San Diego, CA

<http://www.sdsu.edu/>

The Department of Geological Sciences at San Diego State University (SDSU) is engaged in geothermal exploration and assessment research. SDSU was also among the schools that participated this year in the NREL National Geothermal Student competition. Students who were enrolled in the undergraduate Summer of Applied Geophysical Experience (SAGE) program at SDSU helped conduct research for the competition. (For more information on the NREL Student Competition, see the section below titled “Other Geothermal Education Opportunities.”)

Department of Geological Sciences: <http://www.geology.sdsu.edu/>

SAGE: <http://www-rohan.sdsu.edu/~jiracek/EMGEO/introduction.html>

Southern Methodist University

Dallas, TX

<http://www.smu.edu/>

The SMU Geothermal Laboratory specializes in a variety of areas ranging from geothermal resource exploration to geophysical data mapping and oil and gas coproduction. SMU offers a geophysics degree with an emphasis on geothermal for undergraduates, a geothermal graduate degree and many opportunities for field research. SMU is also among the consortium of schools that developed the National Geothermal Academy and is one of the teams building the new National Geothermal Data System.

SMU Geothermal Laboratory: <http://smu.edu/geothermal/>

Geothermal Education: <http://smu.edu/geothermal/educatio/educate.htm>

Roy M. Huffington Department of Earth Sciences: <http://smu.edu/earthsciences/>

Stanford University

Stanford, CA

<http://www.stanford.edu/>

The Stanford Geothermal Program offers graduate degrees in Energy Resource Engineering and combines courses in geothermal with research tailored to geothermal reservoir engineering. The program's areas of research focus primarily on issues of concern to industry – specifically processes within fractured and low permeability rocks – and one of the stated objectives of the Stanford Geothermal Program is “graduating reservoir engineers.” Stanford works with industrial affiliates, which have been integral in hiring program graduates in recent years. Stanford is also among the consortium of schools that developed the National Geothermal Academy and participated in the NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled “Other Geothermal Education Opportunities.”)

Stanford Geothermal Program: <http://pangea.stanford.edu/ERE/research/geoth/index.html>

Temple University

Philadelphia, PA

<http://www.temple.edu/>

The Department of Earth and Environmental Sciences at Temple University is involved in geothermal research, particularly of fault zones in geothermal systems and investigating and enhancing geothermal systems in Nevada and California. Other research areas include the state of stress in geothermal systems and the mechanics of fault zones, as well as the materials comprising the faults.

Earth and Environmental Sciences: <https://ees.cst.temple.edu/>

Geothermal Opportunities at Temple: http://astro.temple.edu/~davatzes/Home_Page/Home.html

Texas A&M University

College Station, TX

<http://www.tamu.edu/>

Texas A&M offers a variety of avenues for students interested in pursuing geothermal energy. Through its Energy Certificate Programs, Texas A&M offers an Energy Sustainability Engineering Certificate with a Geothermal Energy Track, briefly described as “finding, appraising, and producing geothermal energy and designing direct thermal use or electric power generation facilities.” The school maintains the Energy Engineering Institute through the College of Geosciences which houses a number of research

centers currently pursuing geothermal energy research. Texas A&M is also among the schools that participated in the NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled “Other Geothermal Education Opportunities.”)

Energy Engineering Institute, Geothermal: <http://www.energyengineering.org/geothermal>

University of Alaska, Fairbanks

Fairbanks, AK

<http://www.uaf.edu/>

The Alaska Center for Energy and Power (ACEP), based out of the University of Alaska, is working to quantify geothermal resources in the state and assess potential areas for geothermal development. ACEP is working with the State of Alaska and the SMU Geothermal Lab to improve heat flow maps and study whether Alaska could develop EGS. ACEP is also involved in GSHP projects and research. The University of Alaska offers a number of geotechnical courses, as well.

Alaska Center for Energy and Power: <http://www.uaf.edu/acep/>

University of California, Berkley

Berkley, CA

<http://berkeley.edu/>

Courses including units on geothermal systems are offered through the Earth and Planetary Science and Mechanical Engineering Departments at the University of California, Berkeley.

Department of Earth and Planetary Science: <http://eps.berkeley.edu/>

Department of Mechanical Engineering: <http://me.berkeley.edu/>

University of California, Davis

Davis, CA

<http://www.ucdavis.edu/index.html>

The University of California, Davis recently offered a seminar on geothermal resources through its geology department. The seminar, titled “Geology of Geothermal Resources” was open to both undergraduate and graduate students to study the Long Valley, California geothermal system. The Geology Department is in the process of developing a Geothermal Energy course for Geology majors to be offered as an elective every year or every other year. Additionally, the UC Davis Energy Institute will begin offering graduate degrees in Energy Science and Technology and Energy Policy and Management through the Energy Graduate Group (EGG). The school administers the California Geothermal Energy Collaborative (CGEC), tasked with coordinating activities to expand the use of geothermal energy, and also offers a wide range of energy and sustainability related programs and coursework through the Energy Institute. UC Davis is also among the schools that participated in the NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled “Other Geothermal Education Opportunities.”)

Geology Department: <https://www.geology.ucdavis.edu/>

Seminar-Geology of Geothermal Resources:

https://www.geology.ucdavis.edu/classes/geothermalresources_F2010/index.html

UC Davis Energy Institute: <http://energy.ucdavis.edu/>

California Geothermal Energy Collaborative: <http://cgec.ucdavis.edu/>

University of Idaho

Moscow, ID

<http://www.uidaho.edu/>

The University of Idaho Computational Hydrology Group (CHG) is engaged in interdisciplinary investigations in geothermal systems with applications to microbiology, geological carbon sequestration, geothermal system characterization and modeling, and thermo-hydro-chemical coupled processes. The program is currently expanding and is expected to continue growing over the next few years. The group is affiliated with the Center for Advanced Energy Studies (CAES), a public-private collaboration based in Idaho Falls which is focused on energy research, education, and policy. The University of Idaho is also among the schools that participated in the NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled “Other Geothermal Education Opportunities.”)

Computational Hydrology Group: <http://www.sci.uidaho.edu/querrilla-hydrology/index.html>

Center for Advanced Energy Studies: <http://www.uidaho.edu/idahofalls/caes>

University of Nevada, Reno

Reno, NV

<http://www.unr.edu/>

The UNR’s Great Basin Center for Geothermal Energy (GBCGE) aims to promote geothermal development as “a sustainable, environmentally sound, economically competitive contributor to energy supply in the western United States” and does so through research, outreach, and scientific and technological innovation. Geothermal research fellowship opportunities are available to geosciences and engineering students through the GBCGE. UNR also offers Interdisciplinary Renewable Energy Minors, tracked either for engineering majors or non-engineers, which cover the economic, technical, and social realms of renewable energy. Geothermal-specific courses are also offered through the Renewable Energy Minor. UNR led the consortium of schools that developed the National Geothermal Academy, which operates out of UNR’s Redfield campus.

Great Basin Center for Geothermal Energy: <http://www.unr.edu/geothermal/index.html>

University of North Dakota

Grand Forks, ND

<http://und.edu/>

The University of North Dakota has established a Geothermal Laboratory which allows students to engage in geothermal research on a variety of topics, ranging from EGS resources and oil and gas co-production to the effect of climate change on heat flow. The school's Department of Geology and Geological Engineering offers education and research opportunities to students interested in geothermal. UND is also among the schools that participated in the NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled "Other Geothermal Education Opportunities.")

Department of Geology and Geological Engineering: <http://www.geology.und.edu/>

University of Utah

Salt Lake City, UT

<http://www.utah.edu/portal/site/uuhome/>

University of Utah's Energy and Geoscience Institute (EGI) conducts research on a variety of geothermal applications, ranging from tracer compounds to be used in geothermal reservoirs to geologic mapping. EGI, along with University of Utah's engineering departments provide geothermal research and education opportunities. The University of Utah is also among the consortium of schools that developed the National Geothermal Academy and participated in the NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled "Other Geothermal Education Opportunities.")

Energy and Geoscience Institute: <http://www.egi.utah.edu/Home.aspx>

Utah State University

Logan, UT

<http://www.usu.edu/>

Utah State University (USU) is heading up a DOE-funded Snake River Geothermal Drilling research project and involving both graduate and undergraduate students in the research efforts. The USU Department of Geology hosts a Petrology, Geochemistry & Volcanology program which incorporates elements of geothermal with its focus on "igneous and metamorphic petrology, high-temperature geochemistry, and volcanology."

Petrology, Geochemistry & Volcanology: <http://www.usu.edu/geo/shervais/Shervais-USU-Geology/Petrology.html>

Snake River Geothermal Drilling Project: http://www.usu.edu/geo/shervais/Shervais-USU-Geology/Project_Hotspot.html

Virginia Polytechnic Institute and State University

Blacksburg, VA

<http://www.vt.edu/>

Virginia Tech maintains a Geothermal Database which includes data on temperature, rock thermal conductivity, and heat flow from the southeastern and eastern United States. Additionally, the Department of Geosciences offers research opportunities in related areas, including exploration geophysics and well hydraulics. Virginia Tech is also among the schools that participated in the NREL National Geothermal Student Competition. (For more information on the NREL Student Competition, see the section below titled “Other Geothermal Education Opportunities.”)

Department of Geosciences: <http://www.geos.vt.edu/>

Geothermal Database: <http://www.geothermal.geos.vt.edu/>

Washington State University

Pullman, WA

<http://www.wsu.edu/>

Washington State University’s Extension Energy Program is responsible for energy-related education, information, technical assistance, and training programs. Geothermal energy is a specific area of focus within the Renewable Energy program and WSU produces various reports, guides, and other publications that deal with the energy source.

Extension Energy Program: <http://www.energy.wsu.edu/Home.aspx>

West Virginia University

Morgantown, WV

<http://www.wvu.edu/>

West Virginia University’s Advanced Energy initiative provides a platform for University-wide energy research in a range of areas, including a current project focusing on exploring West Virginia’s geothermal resources and expanding the use of geothermal through EGS. West Virginia University is also among the consortium of schools that developed the National Geothermal Academy.

Advanced Energy Initiative: <http://energyresearch.wvu.edu/>

International Schools and Institutions with Established Geothermal Programs

A number of geothermal education programs are available internationally. The following list is limited to prominent geothermal programs which are conducted in English. However, many additional programs are offered around the world, for example in Germany, Italy, Japan, and Hungary, and are taught in their native languages.

Bicol University, Philippines

Legazpi City, Philippines

<http://www.bicol-u.edu.ph/>

Bicol University offers an undergraduate Bachelor of Science degree in Geothermal Engineering through the College of Engineering located on the East Campus in Legazpi City.

College of Engineering: <http://www.bicol-u.edu.ph/index.php?option=3&taskid=18&subcat=4>

Negros Oriental State University, Philippines

Dumaguete City, Philippines

<http://www.norsu.edu.ph/home>

Negros Oriental State University offers an undergraduate degree in Geothermal Engineering through the College of Engineering and Architecture.

College of Engineering and Architecture: <http://www.norsu.edu.ph/courses>

RES The School for Renewable Energy Science, Iceland

<http://www.res.is/res/>

RES, an international graduate school operating in cooperation with the University of Iceland and the University of Akureyri, and other technical universities and institutions worldwide, offers an M.Sc. Program in Geothermal Energy. Students first complete courses in Renewable Energy Science and then enter specialized geothermal courses before embarking on a Master's Thesis. This is a relatively new program, having graduated three classes through affiliation with the University of Akureyri and the University of Iceland since the program began in 2008.

Geothermal Energy Graduate Program: <http://www.res.is/graduateschool/page/geothermal>

Reykjavik Energy Graduate School of Sustainable Systems (REYST), Iceland

Reykjavik, Iceland

<http://www.reyst.is/>

REYST is a collaborative program between Reykjavik Energy and Reykjavik University designed to produce experts in sustainable energy from the fields of engineering, earth sciences, and business. The 18-month program is international in nature and primarily covers geothermal energy, though other sustainable energy systems are included.

Graduate Program: <http://www.reyst.is/AcademicProgrammes/GraduateProgramme/>

United Nations University Geothermal Training Program, Iceland

Reykjavik, Iceland

<http://unugtp.is/>

The United Nations University Geothermal Training Program, based in Iceland, is a postgraduate program “aiming at assisting developing countries in capacity building within geothermal exploration and development.” The program involves six months of training for practicing geothermal professionals and draws fellows from “developing and transitional countries with significant geothermal potential.”

University of Adelaide, Australia

Adelaide, South Australia

<http://www.adelaide.edu.au/>

The University of Adelaide instituted the South Australian Centre for Geothermal Energy Research (SACGER) in mid-2010. The project is funded through the State Government’s Renewable Energy Fund and intends to focus on EGS and geothermal power systems. Research is broadly categorized in terms of geothermal exploration, geothermal reservoir modeling, and geothermal reservoir stimulation. The University also offers a number of degree programs which include instruction on geothermal.

SACGER: <http://www.adelaide.edu.au/geothermal/>

University of Auckland, New Zealand

Auckland, New Zealand

<http://www.auckland.ac.nz/uoa/>

The Institute of Earth Science and Engineering at the University of Auckland, New Zealand, “specializes in geothermal exploration, microseismic monitoring, borehole instrumentation and geothermal short course training.” The University of Auckland offers education opportunities at both the undergraduate and graduate level through short courses (ranging from one day to several weeks in length), graduate degrees in Energy, Engineering, and Science, and a Postgraduate Certificate in Geothermal Energy Technology.

Institute of Earth Science and Engineering: <http://www.iese.co.nz/Home.aspx>

Geothermal Technical Training Schools and Institutions

Classroom instruction is often a minor aspect of learning technical skills. The coursework precedes hands-on training and expertise accumulates gradually in the field. Geothermal drilling, for example, requires geothermal hydrogen sulfide and air drilling training, and knowledge of hot pipe and tubular. These are areas specific to geothermal and in which a trained oil and gas driller would have little or no experience. In some instances, classroom training can be completed in a two or three day course, but years of on-the-job training are required to truly understand geothermal drilling. Mindful that the majority of technical training takes place after an individual is hired, the following institutions, companies, and training facilities offer courses in a range of fields applicable to geothermal. Some larger companies offer in-house classroom training; other institutions provide background training which is further developed by the hiring company to fit the specifics of its geothermal work. However, a couple of longer-term, degreed geothermal technical training programs, such as those offered through Gateway Technical College of Wisconsin and Truckee Meadows Community College in Nevada, are emerging as well.

Baker Hughes

Houston, TX

<http://www.bakerhughes.com/>

Baker Hughes' Western Hemisphere Education Center in Houston, TX is used to train new and current employees. The facility houses classrooms, a workshop and a training rig which provide students with both instruction and hands-on experience.

Western Hemisphere Education Center: <http://www.bakerhughes.com/company/corporate-social-responsibility/people-and-society/talent-management/technology-and-education-centers/education-centers>

Gateway Technical College of Wisconsin

<http://www.gtc.edu/>

Gateway Technical College offers a two-year AAS Geothermal Technician degree, as well as an Advanced Technical Certificate for a Geothermal Specialist, a person responsible for commissioning a loopfield and associated equipment. The GeoExchange training and certification programs are geared toward installers and technicians and provide hands-on training in GeoExchange drilling, installation and maintenance.

GeoExchange Technology: <http://www.gtc.edu/page.asp?q=1073&pid=10-601-1B>

Geothermal Resource Group

<http://geothermalresourcegroup.com/>

Geothermal Resource Group offers online and classroom training services, including a course in Geothermal Well Design and Drilling, which “covers all aspects of designing, programming, drilling and completing high-temperature, utility-grade geothermal wells for power production, with emphasis on how it differs from typical oil and gas wells.” Geothermal Resource Group also offers more subject-specific training modules on any of the topics covered in the Geothermal Well Design and Drilling course. These include: Well and Casing Design for Production, Injection and Exploration Wells; Cementing of Casing Strings including Foam and Reverse Cementing; Program Planning and Rig Selection; Drilling Fluids and Lost Circulation Issues; Types of Formations Penetrated; Use of Special Downhole Tools; Fishing Tools and Techniques; BOPE and Well Control; Testing and Completion.

Training Services: <http://geothermalresourcegroup.com/geothermal-services/training/>

Murchison Drilling Schools, Inc. (MDS)

<http://www.murchisondrillingschools.com/>

MDS provides training in drilling practices, which includes classroom instruction and simulator work. Courses offered include Operations Drilling Technology & Advanced Well Control, IADC WellCAP Well Control, IWCF Well Control, Practical Drilling Technology, and Floater Operation Transitions.

Richard Stockton College of New Jersey

Galloway, NJ

<http://intraweb.stockton.edu/eyos/page.cfm?siteID=197&pageID=5&layout=hp>

Richard Stockton College offers an interdisciplinary Certification Program in Energy Studies with options for certificates in Physical Science Energy and Environmental Science Energy. The college’s Geothermal Project, part of the Energy Studies initiative, also offers training courses in geothermal technology for design professionals. The geothermal project includes 400 boreholes 425 feet deep and an Aquifer Thermal Energy Storage system which provides around 600 tons of cooling without the use of chillers. Examples of topics covered in the trainings include Test Bore & Thermal Conductivity Test, Borehole Layout, and Ventilation Issues.

Energy Studies: <http://intraweb.stockton.edu/eyos/page.cfm?siteID=82&pageID=1>

Siemens

<http://www.usa.siemens.com/entry/en/>

The Siemens Power Academy offers technical courses and certification related to transmission, smart grids, power distribution, and equipment, among others, and includes instruction on renewable technologies.

Siemens Power Academy TD: <http://www.energy.siemens.com/us/en/services/power-transmission-distribution/power-technologies-international/siemens-power-academy/>

Southwest Mississippi Community College (SMCC)

Summit, MS

<http://www.smcc.edu/index.php/home-mainmenu-73>

SMCC offers a Well Construction Technology Program, which includes classroom and laboratory components and familiarizes students with “the use of rotary drilling and related equipment used in drilling for water, petroleum, ecological, and geo-technical operations.” SMCC also offers a Welding and Cutting certification.

Well Construction Technology:

http://www.smcc.edu/index.php?option=com_content&task=view&id=147&Itemid=452

Welding and Cutting: <http://www.smcc.edu/index.php/welding-and-cutting-careertechmenu-451>

Truckee Meadows Community College (TMCC)

Reno, NV

<http://www.tmcc.edu/>

TMCC has established a Geothermal Plant Operators Program (GPOP) to train geothermal technicians – the only program of its kind in the United States. The program is designed as a two-year Associate of Applied Science degree or one-year certificate program. Geothermal-specific technical courses include: Well Design and Construction; Fluid Mechanics, Hydraulics and Hydrology; Fundamentals of Process Controls, and others. TMCC also offers an Associate of Applied Science Construction Technologies Degree with an emphasis on renewable energy, which includes instruction on geothermal and a course specifically dedicated to the geology of geothermal energy resources.

Construction Technologies:

<http://www.tmcc.edu/appliedtech/programs/construction/renewableenergy/>

Schools and Institutions for Geothermal Heat Pump Education and Technical Training

Individuals working with geothermal heat pump systems require a somewhat different knowledge and expertise base than do those pursuing geothermal systems for larger-scale power production. Education and training opportunities specific to geothermal heat pumps, or ground source heat pumps (GSHP), are identified below. The International Ground Source Heat Pump Association (IGSHPA) is listed first in this section because many of their accredited courses are offered at additional institutions listed in this guide. Subsequent schools and training institutions are listed in alphabetical order.

International Ground Source Heat Pump Association

<http://www.igshpa.okstate.edu/index.htm>

The IGSHPA, a non-profit organization promoting the use and advancement of ground source heat pump technology, is engaged in “GSHP system installation training and geothermal research” both on campus at its headquarters at Oklahoma State University in Stillwater, OK, and in other off-campus locations around the country. Trainings include Accredited Drillers Training, Accredited Installer Workshops, Certified GeoExchange Designer Courses, and a Train-The-Trainer Course. Trainings are also offered through IGSHPA accredited trainers, which can be searched by state on IGSHPA’s online directory.

IGSHPA Training: <http://www.igshpa.okstate.edu/training/training.htm>

IGSHPA Directory: <http://www.igshpa.okstate.edu/directory/directory.asp>

American Ground Water Trust

<http://www.agwt.org/index.htm>

The American Ground Water Trust, a non-profit dedicated to protecting, developing and managing ground water resources, offers short geothermal forums around the country geared toward architects, HVAC designers, and building owners and managers. The workshops incorporate broad overviews of a variety of topics ranging from environmental benefits to tax breaks and incentives to installation practices.

Workshops: <http://www.agwt.org/workshops.htm>

Clarkson University

Potsdam, NY

<http://www.clarkson.edu/index.html>

Geothermal energy is among the research programs at The Clarkson University Center for Sustainable Energy Solutions. Specifically, the research is geared toward GSHP systems. Clarkson University also offers an undergraduate Minor in Sustainable Energy Systems.

Center for Sustainable Energy Systems: <http://www.clarkson.edu/cses/index.html>

Clean Edison

<http://www.cleandison.com/>

Clean Edison offers an accredited geothermal installer certification, accredited driller workshop, and an entry-level geothermal course designed to instruct on the basics of GSHP systems. Both the installer and driller programs are IGSHPA accredited

Geothermal Training: <http://www.cleandison.com/geothermal.html>

Geothermal Training Institute

<http://www.geotrainers.com/index.htm>

The Geothermal Training Institute provides hands-on GSHP training through a variety of courses available online and around the country. Courses offered range from GSHP design and optimization to thermal conductivity testing. IGSHPA accredited installer and driller courses are available as well.

Greenville Technical College

Greenville, SC

<http://gvltec.edu/index.aspx>

Greenville Technical College houses a Geothermal Training Center, which trains and certifies GSHP installers along IGSHPA criteria. The training is part of the Construction Engineering Technology Department.

Geothermal Energy Training: http://gvltec.edu/technology_depts.aspx?id=7806&terms=geothermal

HeatSpring Learning Institute

<http://www.heatspring.com/>

The HeatSpring Learning Institute is an education and training company geared toward building professionals. The Institute offers geothermal energy training and certification courses around the country and online. Courses offered include Geothermal Designer Boot Camp + LoopLink Certification and IGSHPA Geothermal Installer Certification Training.

Geothermal Training Courses: <http://www.heatspring.com/geothermal-courses>

National Ground Water Association (NGWA)

<http://www.ngwa.org/>

The NGWA offers a Certified Vertical Closed Loop Driller designation for geothermal drillers and maintains a student resources section of its web site which includes a list of the leading hydrogeology programs in North America.

NGWA Student Membership: <http://www.ngwa.org/information-for/students/Pages/default.aspx>

Certified Vertical Closed Loop Driller: [http://www.ngwa.org/Professional-Resources/certifications-exams/Pages/Geothermal-driller-\(CVCLD\).aspx](http://www.ngwa.org/Professional-Resources/certifications-exams/Pages/Geothermal-driller-(CVCLD).aspx)

Oklahoma State University

Stillwater, OK

<http://osu.okstate.edu/welcome/>

Oklahoma State University (OSU) serves as the headquarters for the IGSHPA and houses research and installation training facilities on its campus (see IGSHPA paragraph above). OSU also houses a Building and Environmental Thermal Systems Research Group, of which geothermal heat pump systems are a major interest.

Building & Environmental Thermal Systems: <http://www.hvac.okstate.edu/index.htm>

Other Geothermal Education Opportunities

NREL National Geothermal Student Competition

<http://www.nrel.gov/geothermal/competition.html>

The National Renewable Energy Laboratory (NREL) this year held the first-ever DOE-funded National Geothermal Student Competition (NGSC), which provided a platform for student teams to advance their understanding of geothermal energy by engaging in comprehensive research projects – this year focused on the geothermal energy potential of the Rio Grande Rift. Eleven student teams participated in the NGSC this year, bringing in students from the following schools from across the country: Colorado School of Mines, Oregon Institute of Technology, The Pennsylvania State University, San Diego State University, Stanford University, Texas A&M University, University of California-Davis, University of Idaho, University of North Dakota, The Utah University, and Virginia Polytechnic Institute and State University. In addition to the objective of expanding the future qualified geothermal workforce, the NGSC also served to incorporate geothermal education into university curriculum. Three of the eleven participating schools developed a class and tailored curriculum to support the students' efforts in the competition.

Additional Education and Training Resources and Links

Geothermal Energy Association (GEA)

www.geo-energy.org

Reports: <http://geo-energy.org/reports.aspx>

Geothermal Energy Weekly: <http://geo-energy.org/updates.aspx>

GEA Geothermal Web, Student Resources

<http://geothermalweb.org/Students.aspx>

Geothermal Education Office (GEO)

<http://geothermal.marin.org/>

U.S. Department of Energy: Energy Education & Workforce Development

http://www1.eere.energy.gov/education/colleges_universities.html

U.S. Department of Energy: Scholarships and Internships

<http://www.energy.gov/scholarships&internships.htm>

International Geothermal Association: Information and Education Links

http://www.geothermal-energy.org/311,links_-_topic_order.html#edu

U.S. DOE Geothermal Technologies Program: Related Links

http://www1.eere.energy.gov/geothermal/related_links.html#education