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## **US Geothermal Education and Training Guide**

As geothermal energy production and use become more prominently recognized in today's renewable energy landscape, academic institutions are taking note. The recent dramatic increase in geothermal development in the United States has resulted in an inadequate number of trained industry professionals – especially higher-level geothermal power plant managers, geologists, resource analysts, permitting staff, drillers, engineers, and geothermal heat pump installers. As the industry grows, so too does the need for geothermal education and training. A number of colleges and universities across the country are emerging with undergraduate, graduate, and certification programs related to geothermal. The following institutions offer varying levels of geothermal educational and professional opportunities in the US.

### **Geothermal Education Opportunities**

**Undergraduate Studies:** Opportunities in the geothermal industry for undergraduate students encompass a broad range of fields. These 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) Earth Sciences department 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.

**Graduate Studies:** 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 both offer 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 Cornell University, OIT, UNR, University of North Dakota (UND), University of Utah,

Virginia Polytechnic Institute (Virginia Tech), and Washington State University (WSU). 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.

Geothermal-specific programs, coursework, or research opportunities have been identified at the institutions listed below. The National Geothermal Academy (NGA), which is currently under development, is highlighted at the top of the list; subsequent institutions are listed in alphabetical order with brief descriptions of their involvement in geothermal. Program information was gathered from the schools' Web sites. This list is not intended to be exhaustive, nor does GEA assure program quality.

### **National Geothermal Academy**

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

Born of the growing need to train and educate the next generation of geothermal experts, the Department of Energy granted \$995,000 to UNR to establish the NGA. UNR, SMU, West Virginia University, Cornell University, Stanford University, OIT, MIT, and the University of Utah – the country's top geothermal schools – are currently part of the consortium. Colorado School of Mines has joined since the NGA's inception and others are expected to follow. The NGA, which is expected to start operating in 2011, is a collaborative endeavor seeking to “develop the human resources necessary to grow the US energy infrastructure, and utilize America's vast geothermal resource base.” The NGA will offer eight one-week courses including: Introduction to Geothermal Energy Utilization; Geothermal Business Principles; Public Policy, Permitting and Environmental Issues; Exploration I; Exploration II; Reservoir Engineering and Management; Power Plant Design and Construction; and Direct Use. The NGA will be located on UNR's Redfield Campus.

### **Boise State University**

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

Boise State University offers courses in geotechnical engineering. Boise State was also awarded funding from the DOE to establish a National Geothermal Data System (NGDS). UNR, OIT, Stanford University, and SMU are also involved in the NGDS.

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

## **Brown University**

<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.

- Sustainable Energy Technologies: <https://wiki.brown.edu/confluence/display/SET/SET+Home>
- Pre-College Programs: <http://brown.edu/ce/pre-college/>

## **Colorado School of Mines**

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

Colorado School of Mines offers an undergraduate energy minor, as well as undergrad and graduate degree in various fields through its Geoscience and Resource Engineering Program. Colorado School of Mines was awarded DOE funding to establish a Geothermal Academy to develop data regarding geothermal heat pumps. The school is collaborating with the National Renewable Energy Laboratory (NREL) in researching geothermal heat pump technologies.

- Geosciences and Resource Engineering: <http://www.mines.edu/UgradGeoResources>

## **Cornell University**

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

Cornell University has adopted enhanced geothermal systems (EGS) as a focal area in the College of Engineering. The college also offers a minor in sustainable energy systems, which covers a variety “of energy resource types, with consideration of conversion, transmission and storage technologies” and focuses on “the interrelation and importance of environmental, policy, economic, business, political, ethical, risk and social consequences of pursuing potential energy options.” In addition, a new National Science Foundation (NSF) Integrative Graduate Education and Research Traineeship (IGERT) Center focused on earth energy systems is being developed. A key element in this program will be to bring together several disciplines in earth and environmental sciences and engineering and to establish curricula and research addressing geothermal technology. Undergraduate majors in science of earth systems, chemical engineering, and civil and environmental engineering address geothermal resources, geothermal power production, and geotechnical engineering, respectively.

- Energy Studies: <http://www.geo.cornell.edu/eas/energy/>
- Research: [http://www.geo.cornell.edu/eas/energy/research\\_front\\_page/](http://www.geo.cornell.edu/eas/energy/research_front_page/)

### **Kansas University**

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

The Kansas University Department of Mechanical and Nuclear Engineering sponsors GeoCrack, a program focusing on “modeling flow in fractured rocks.”

- Geocrack: <http://www.mne.ksu.edu/~geocrack/>

### **Massachusetts Institute of Technology**

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

The MIT Energy Initiative (MITEI) established a spectrum of energy-related research areas, with geothermal as a specific focus. The school also features a minor in energy studies. MIT has been a leader in geothermal research and assessment. A 2006 MIT-led national study titled “The Future of Geothermal Energy: Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21<sup>st</sup> Century” has influenced national policy in projecting the important role geothermal could play in the nation’s energy future.

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

### **New Mexico Institute of Mining and Technology**

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

New Mexico Tech is developing a course on geothermal exploration and computational modeling of hydrothermal systems which will be offered for the first time in the fall of 2011. 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. The school received Recovery Act funding for a geothermal demonstration project and is developing its own geothermal resources to heat its campus.

- Department of Earth and Environmental Sciences: <http://www.ees.nmt.edu/>

## Oklahoma State University (OKSU)

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

Among the OKSU Building and Thermal Research Group's areas of interest are geothermal heat pump systems and ground loop heat exchanger technology. OKSU also serves as the headquarters for the International Ground Source Heat Pump Association (IGSHPA) and houses research and installation training facilities on its campus.

- OKSU Buildings and Thermal Systems Research Group: <http://www.hvac.okstate.edu/>

## Oregon Institute of Technology

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

OIT is a pioneer in both geothermal use and education. The school is home to the Geo-Heat Center, a source of extensive research on geothermal energy in all of its forms. The Geo-Heat Center serves as a research institution and "provides technical analysis for those actively involved in geothermal development." OIT also offers an undergraduate renewable energy degree, which includes a course in geothermal energy and ground-source heat pumps.

- Geo-Heat Center: <http://geoheat.oit.edu/>
- Oregon Renewable Energy Center (OREC): <http://www.oit.edu/renewable-energy/orec>

## Rice University

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

Rice University's Department of Earth Science offers a number of education and research opportunities related to geothermal, including the Rice GeoTechnical Lab specializing in "measurement of geomechanical properties ... on sediments and rocks." Various research opportunities are available through the lab for both undergraduate and graduate students interested in geofluids or geomechanics.

- Rice Geotechnical Lab: <http://earthscience.rice.edu/department/research/dugan/>
- Department of Earth Science: <http://www.earthscience.rice.edu/>

## **Southern Methodist University**

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

The SMU Geothermal Laboratory specializes in a variety of areas from resource assessment to mapping, to borehole temperature-depth logging and oil and gas coproduction. SMU offers a geothermal emphasis for undergraduates, a geothermal graduate degree and many opportunities for field research.

- SMU Geothermal Lab: <http://smu.edu/geothermal/>
- Earth Sciences Geothermal Program: <http://smu.edu/earthsciences/research/programs/geothermal.asp>

## **Stanford University Geothermal Program**

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

Stanford's Department of Energy Resources Engineering offers a graduate-level geothermal program, featuring "courses in Petroleum Engineering with specialization in geothermal reservoir technology." The program's primary focus is reservoir engineering techniques.

- Stanford Geothermal Program: <http://pangea.stanford.edu/ERE/research/geoht/>

## **Texas A&M University**

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

Texas A&M engages in geothermal energy research, specifically development of Enhanced Geothermal Systems (EGS) through its Petroleum Engineering Department.

- Geothermal Energy Research: <http://www.pe.tamu.edu/ghassemi/geothermal.html>

## **University of California, Berkeley**

<http://berkeley.edu/>

Courses including units on geothermal systems are offered through the Earth and Planetary Science and Mechanical Engineering Departments at UC Berkeley. The Mechanical Engineering Department received DOE funding to develop temperature and pressure sensing technology for geothermal well monitoring.

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

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

### **University of California, Davis**

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

The UC Davis Energy Institute “focuses and coordinates energy research and education” and administers the California Geothermal Energy Collaborative (CGEC). CGEC works with industry, government agencies and other stakeholders to promote and expand geothermal energy use and development in California. The Energy Institute has also proposed establishing an Energy Graduate Group (EGG) which would offer energy-related education and graduate degree programs in energy science and technology and energy policy and management. EGG is pending approval, but is expected to begin admitting students in 2011.

- UC Davis Energy Institute: <http://energy.ucdavis.edu/home.cfm?id=ENR,28>
- California Geothermal Energy Collaborative: <http://cgec.ucdavis.edu/pages/about.html>

### **University of California, Riverside**

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

UC Riverside’s Department of Earth Sciences offers research opportunities in petrology, geochemistry, and geothermics.

- Department of Earth Sciences: <http://earthscience.ucr.edu/>

### **University of Nevada, Reno, Great Basin Center for Geothermal Energy**

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

UNR’s Great Basin Center for Geothermal Energy (GBCGE) aims to promote geothermal energy 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. GBCGE is part of UNR Renewable Energy Center (REC), through which UNR established a renewable energy minor, featuring geothermal. A graduate certificate in renewable energy is under development.

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

- Renewable Energy Center: <http://www.unr.edu/energy/>

### **University of North Dakota, Energy and Environmental Research Center**

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

UND offers a number of engineering courses, such as Alternative Energy Systems, which highlight geothermal energy. UND's Geological Engineering graduate program is geared in part toward geothermal energy. UND was awarded Recovery Act funding under "Coproduced, Geopressed, and Low Temperature Projects" from DOE to develop geothermal resources in the state.

- Department of Geology and Geological Engineering: <http://www.geology.und.edu/>
- Energy and Environmental Research Center: <http://www.undeerc.org/sitemap.aspx>

### **University of Utah**

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

University of Utah's Energy and Geoscience Institute provides opportunities in geothermal education and research.

- Energy & Geoscience Institute: <http://www.egi.utah.edu/Home.aspx>
- Geothermal Energy Research Capabilities:  
<http://www.egi.utah.edu/GeothermalCapabilities.aspx>

### **Virginia Polytechnic Institute and State University**

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

The Geothermal Program at Virginia Tech emphasizes regional heat flow determination and low-temperature geothermal resources. Virginia Tech also maintains the Geothermal Database, which includes "temperature data from hundreds of temperature and other geophysical logs, rock thermal conductivity, and heat flow values from New Jersey to Georgia."

- Department of Geological Sciences: <http://www.geos.vt.edu/>
- Geothermal Database: <http://www.geothermal.geos.vt.edu/>

## **Washington State University, Cooperative Extension Energy Program**

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

The geothermal branch of the Renewables Project, part of the WSU Energy Program, is producing geothermal guidebooks and is aiding in “developing state-level geothermal action plans” with specialized knowledge of “cost, technologies, environmental impact, and reliability.”

- Extension Energy Program: <http://www.energy.wsu.edu/>
- Renewable Energy – Geothermal:  
<http://www.energy.wsu.edu/projects/renewables/geothermal.cfm>

## **Universities Receiving DOE American Recovery and Reinvestment Act (ARRA) Funding for Research and Development**

While not all of the following academic institutions have geothermal-specific coursework or degree programs, all of the schools listed below are involved in geothermal research or technology development. Colleges and universities with more robust geothermal education programs are discussed above. Geothermal R&D efforts may indicate research opportunities for students. For more information on DOE Geothermal R&D Awardees:

[http://apps1.eere.energy.gov/geothermal/projects/by\\_awardee.cfm](http://apps1.eere.energy.gov/geothermal/projects/by_awardee.cfm)

**Ball State University**, <http://cms.bsu.edu/>

**Boise State University**, <http://www.boisestate.edu/>

**California State University, Long Beach**, <http://csulb.edu/>

**Colorado Northwest Community College**, <http://www.cncc.edu/>

**Florida International University**, <http://www.fiu.edu/>

**Furman University**, <http://www2.furman.edu/Pages/default.aspx>

**Great Basin Center for Geothermal Energy, University of Nevada Reno**,  
<http://www.unr.edu/geothermal/>

**Indiana Institute of Technology**, <http://www.indianatech.edu/Pages/Default.aspx>

**Massachusetts Institute of Technology**, <http://web.mit.edu/>

**Montana Tech of the University of Montana**, <http://www.mtech.edu/>

**New Mexico Institute of Mining and Technology, <http://www.nmt.edu/>**

**Oakland University, <http://www.oakland.edu/>**

**Oklahoma State University, <http://osu.okstate.edu/welcome/>**

**Pennsylvania State University, <http://www.psu.edu/>**

**Southern Methodist University, <http://www.smu.edu/>**

**Stanford University, <http://www.stanford.edu/>**

**Texas A&M University, <http://www.tamu.edu/>**

**The University of Texas at Austin, <http://www.utexas.edu/>**

**University of Alaska, <http://www.alaska.edu/>**

**University of Albany, <http://www.albany.edu/>**

**University of Hartford, <http://admission.hartford.edu/>**

**University of Kansas, <http://www.ku.edu/>**

**University of Minnesota, <http://www1.umn.edu/twincities/index.php>**

**University of Missouri, <http://www.missouri.edu/>**

**University of Nevada, Reno, <http://www.unr.edu/>**

**University of North Dakota, <http://und.edu/>**

**University of Southern California, <http://www.usc.edu/>**

**University of Utah, <http://www.utah.edu/portal/site/uuhome/>**

**Utah State University, <http://usu.edu/>**

**West Virginia University, <http://www.wvu.edu/>**

**Wright State University, <http://www.wright.edu/>**

## **Geothermal Technical Training Opportunities**

The geothermal industry relies on a spectrum of professionals with varying technical backgrounds and experience. Power plant development, for example, depends on a skilled drilling crew and construction personnel with specific knowledge of geothermal operations. These trades require substantial on-the-job training.

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. 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.

### **Baker Hughes**

<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>

### **Geothermal Resource Group**

<http://www.geothermalresourcegroup.com/services.html>

Geothermal Resource Group provides wide-scale geothermal well control training for “contract and client personnel” and offers supervisor training in project-specific “safe and efficient drilling practices.”

## **HeatSpring Learning Institute**

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

HeatSpring Learning Institute specializes in Geothermal Heat Pump and Solar Electric Systems training and education for building professionals. Located in Cambridge, MA, courses are available online and in various locations on the East Coast. Advertised courses include: Accredited Geothermal Installer Training, Geothermal Designer Boot Camp, Geothermal Standing Column Well Training, and Online Entry Level Geothermal Certificate Training. HeatSpring Learning Institute also offers video recorded short courses in Geothermal Heat Pumps, Heat Pump Mechanics, and Climate Change & Geothermal Heat Pumps for people interested in learning more about these areas.

- Geothermal Training: [https://www.heatspring.com/?id=geothermal\\_training](https://www.heatspring.com/?id=geothermal_training)

## **International Ground Source Heat Pump Association (IGSHPA)**

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

Located on the OKSU campus, the IGSHPA provides a variety of training opportunities for the ground source heat pump (GSHP) industry. Training courses include: Accredited Drillers Training, Accredited Installer Workshops, a Certified GeoExchange Designer course, and a Train-the-Trainer course, in addition to other continuing education opportunities. Beyond GSHP system installation training, the IGSHPA also engages in geothermal research.

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

## **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.

## **National Ground Water Association (NGWA)**

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

NGWA offers certification programs for well drilling, pump installation, and vertical closed loop drilling.

- Certifications: <http://www.ngwa.org/cert/index.aspx>

### **Richard Stockton College of New Jersey, Certification Program in Energy Studies**

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

Richard Stockton College initiated an interdisciplinary Certification Program in Energy Studies “to educate students in the multifaceted problems associated with energy usage in our society and to pose methods for possible solutions to problems.” The college’s Geothermal Project offers training courses in geothermal technology for design professionals.

- Energy Studies: <http://inraweb.stockton.edu/eyos/page.cfm?siteID=82&pageID=1>
- Geothermal Training: <http://inraweb.stockton.edu/eyos/page.cfm?siteID=82&pageID=30>

### **Southwest Mississippi Community College (SMCC)**

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

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](http://www.smcc.edu/index.php?option=com_content&task=view&id=147&Itemid=452)
- Welding and Cutting:  
[http://www.smcc.edu/index.php?option=com\\_content&task=view&id=146&Itemid=451](http://www.smcc.edu/index.php?option=com_content&task=view&id=146&Itemid=451)

### **Truckee Meadows Community College (TMCC)**

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

TMCC in Reno, NV offers an associate’s degree in applied science in renewable energy which is designed to broadly prepare students to enter renewable energy fields. Courses include introductions to geothermal, wind, solar, and biomass, in addition to industry safety, building codes, and energy efficiency. TMCC recently received a pending grant from DOE to establish a Geothermal Plant Operators Program (GPOP). The program is in its infancy, but as it develops the GPOP is expected to be geared toward field operators, plant operators, and maintenance activities with proposed courses covering such

topics as well design and construction, geothermal plant operations, fluid chemistry and cleansing processes, and control fundamentals, among others.

- Applied Science in Renewable Energy:  
[http://www.tmcc.edu/catalog/1011/pdf/worksheets/renew\\_energy\\_emp\\_aas.pdf](http://www.tmcc.edu/catalog/1011/pdf/worksheets/renew_energy_emp_aas.pdf)

### **Technical College of the Lowcountry (TCL)**

<http://www.tcl.edu/industrial/GreenTechnologyatTCL.asp>

TCL received a grant from the South Carolina Energy Office to establish Geothermal Training Center. The grant will go toward purchasing training equipment and training teachers in IGSHA standards. Once the program is fully implemented, the Geothermal Training Center will serve to train and certify geothermal heat pump installers.

### **Western Nevada College**

<http://www.wnc.edu/about/>

Western Nevada College's Fallon campus received ARRA funding to create a three-week entry-level geothermal class focusing on "geothermal safety, equipment and power plant management."<sup>1</sup> Students complete the program with OSHA certification and hands-on experience with geothermal machinery. An equipment yard at a Vulcan Power Company site provides a backdrop for students to gain experience in geothermal equipment maintenance and training for the drilling industry.

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<sup>1</sup> <http://www.energyempowers.gov/post/geothermal-energy-training-nevada.aspx>

## **Additional Resources**

Resources are also available for younger students – and the general public – interested in learning more about geothermal energy.

### **K-12 Geothermal Educational Materials and Teacher Resources**

- Geothermal Education Office: <http://geothermal.marin.org/>
- Energy Information Administration:  
[http://www.eia.doe.gov/kids/energy.cfm?page=geothermal\\_home](http://www.eia.doe.gov/kids/energy.cfm?page=geothermal_home)

### **US DOE Resources**

- DOE provides valuable information on energy-related education and career opportunities on their *Energy Education and Workforce Development* Web site:  
<http://www1.eere.energy.gov/education/index.html>.
- DOE also provides a list of academic institutions offering programs or coursework in energy efficiency and renewable energy:  
[http://www1.eere.energy.gov/education/colleges\\_universities.html](http://www1.eere.energy.gov/education/colleges_universities.html).