Proceedings World Geothermal Congress 2020+1
Reykjavik, Iceland, April - October 2021

Enhancement of the Geothermal Engineering Curriculum of Negros Oriental State University in Response to the Philippine Geothermal Energy Agenda

Angel M. Honculada

Geothermal Engineering Department, Negros Oriental State University, Dumaguete City 6200 Philippines

norsu.cea.ge@gmail.com

Keywords: geothermal engineering, Negros Oriental State University

ABSTRACT

As the Philippines' Energy Department through its Geothermal Energy Bureau created a comprehensive road map for the geothermal energy development in the country, and the Higher Education Commission's restructuring of the engineering programs in order to be more responsive to the needs in the country and in the region as well, Negros Oriental State University takes this challenge, as it revises and enhances the Geothermal Engineering curriculum being a pioneering academic institution to offer such program. The new Geothermal Engineering curriculum aims to develop undergraduate students in field of power production technology, direct use technology, reservoir engineering, exploration, and drilling. Through a curriculum audit, the curriculum was reviewed and updated to come up with a four-year Bachelor of Science in Geothermal Engineering.

1. INTRODUCTION

Negros Oriental State University (NORSU) is the first and only state university in the Philippines that offers a bachelor's degree in Geothermal Engineering. The degree was first offered last June of 1994 by virtue of Resolution No. 7, Series of 1994, of the Board of Trustees of what was then Central Visayas Polytechnic College (CVPC).

Bachelor of Science in Geothermal Engineering was offered to respond the need for skilled manpower for the geothermal sector in the country. Moreover, NORSU is situated in the Negros Island, the home of the Palinpinon Geothermal Power Production Field. This program was conceived by the joint collaboration of the state university and the industry as represented by what was then Philippine National Oil Company – EDC, the company that operates the geothermal plant in the island.

In two decades from the time BSGE was offered, it produces around sixty graduates that were employed along different fields of engineering, mostly but not limited to the drilling companies and the oil industry.

With the passage of Republic Act 9513 known as the Renewable Energy Act, it is expected that the program would gain some popularity. This particular law enables the government, through the Department of Energy (DOE) to create a Road Map for the Exploration, Development and Utilization of geothermal resources in the country.

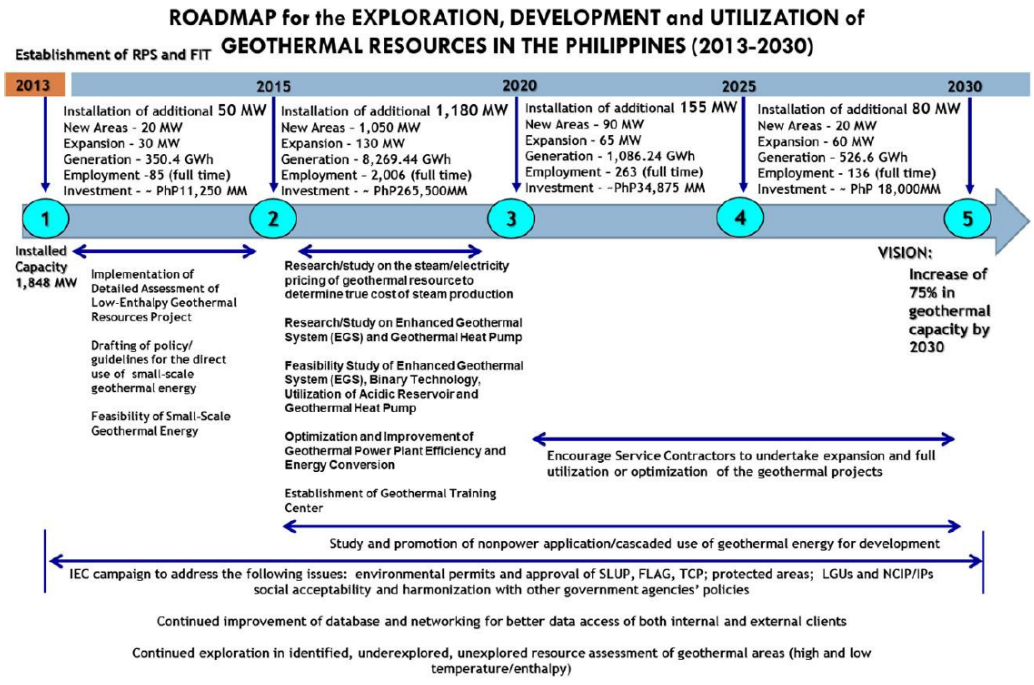

Figure 1: Geothermal Roadmap for the Exploration, Development and Utilization of Geothermal Resources in the Philippines (2013-2030)

2. CURRICULUM

The BSGE Curriculum was first developed through a research paper "Geothermal Engineering: CVPC's Contribution to the Philippine Energy Development Program" Henry A. Sojor, Eva M. Moncada, Gonzalo C. Bulaclac, Jr., and Mary Evangeline F. Gajunera published in 1995. It was conducted through DACUM approach led by Professor Steve Finnagan of Algonquin College, Canada. Then the same curriculum was revised last 2001 where some relevant courses were changed and added in order to suit the demands of the times.

Presently, with the introduction of K-12 education in the Basic education sector, the Commission on Higher Education through its Memorandum Orders, made the five year engineering degrees into four years but not compromising on the quality of courses it offers.

The Geothermal Engineering Department of Negros Oriental State University then responded to such changes by revising the BSGE Curriculum. In order to make it into a four year program, some courses were combined, like Geothermal Systems Resources with Energy Technology and Production Technology with FCRS Design. Other course offerings were also given emphasis like a separate course on Direct Utilization in order to respond to one of DOE's call to strengthen the geothermal direct utilization in the country.

3. PROGRAM POLICIES AND STANDARDS

3.1 Nature of the Field of Study

Geothermal Engineering is a profession that focus on earth sciences, geothermal energy utilization, renewable energy, thermodynamics, heat transfer, fluid dynamics, exploration technology, reservoir engineering and management, drilling, well testing and measurement, fluid collection and recovery system design, geothermal power plant operation and maintenance environmental management and advance technologies involving harnessing and use of geothermal energy. Geothermal Engineers work as earth scientist, design and develop technologies that enhances the utilization of geothermal energy for power production and other direct use. They may also involve in researches on the use of renewable energy, environmental protection and any ground-heat related studies that would help the society.

3.2 Program Educational Objectives

The Geothermal Engineering Program is to respond to a perceived need for a local training program that will answer the manpower needs of the companies involved in the growing geothermal industry in the Philippines.

3.3 Allied Fields

The following programs are considered allied to Geothermal Engineering:

a. Mechanical Engineering
b. Petroleum Engineering
c. Energy Engineering
d. Environmental Engineering
e. Mining Engineering
f. Geology

3.4 Institutional Outcomes

a.) Graduates of professional institutions must demonstrate a service orientation in one's profession,

b.) Graduates of colleges must participate in various types of employment, development activities, and public discourses, particularly in response to the needs of the communities one serves

c.) Graduates of universities must participate in the generation of the new knowledge or in research and development projects.

d.) Graduates of State Universities and Colleges must in addition, have the competencies to support "national, regional and local development plans." (RA7722).

e.) Graduates of higher educational institutions must preserve and promote the Filipino historical and cultural heritage.

3.5 Program Outcomes

By the time of graduation, the students of the program shall have the ability to:

a. apply knowledge of mathematics and science to solve complex geothermal engineering problems;
b. design and conduct experiments, as well as to analyze and interpret data;.
c. identify, formulate, and solve geothermal engineering problems;
d. understand professional and ethical responsibility;
e. communicate effectively;
f. recognize the need for, and engage in life-long learning;
g. use geothermal engineering knowledge in responding to community and environmental issues;
h. use techniques, skills, and modern engineering tools necessary for geothermal engineering practice;
i. know and understand engineering and management principles as a member and leader of a team, and to manage projects in a multidisciplinary environment.

3.6 Program Indicators

	PROGRAM OUTCOMES	PERFORMANCE INDICATORS
a	Apply knowledge of mathematics and science to solve complex geothermal engineering problems	- Apply concepts of advanced engineering mathematics to solve complex geothermal engineering problems. - Apply chemical and physical principles in solving problems involving fluids. -Apply the laws of thermodynamics in analyzing problems. -Apply geosciences principles in utilizing geothermal energy.
b	Design and conduct experiments, as well as to analyze and interpret data	- Conduct geothermal resource characterization. - Design drilling, well test programs and piping layout in geo-thermal utilization. - Analyze and interpet exploration data.
c	Identify, formulate, and solve geothermal engineering problems	- Identify geological and geochemical properties. - Solve drilling, reservoir engineering, & production problems.
d	Understand professional and ethical responsibility	- Understand ethical standards for geothermal engineers. - Understand existing professional and environmental laws related to geothermal engineering.
e	Communicate effectively	- Communicate effectively through written reports, research papers and oral presentations.
f	Recognize the need for, and engage in life-long learning	- Acknowledge the need to further enhance skills and knowl-edge and engage in a life-long learning.
g	Use geothermal engineering knowledge in responding to community and environmental issues	- Use geothermal engineering knowledge to introduce and up-grade existing community livelihood. - Use geothermal utilization principles as response to the call of environment friendly and sustainable source of energy.
h	Use techniques, skills, and modern engineering tools necessary for geothermal engineering practice	- Use scientific investigation to enhance geothermal technology. - Use data logging techniques and mathematical modeling in reservoir engineering and well testing programs.
i	Know and understand engineering and management principles as a member and leader of a team, and to manage projects in a multidisciplinary environment	- Know and understand management principles - Posses leadership skills in certain geothermal projects and activities.

Figure 2: Performance Indicators Matrix

3.7 Summary of Courses

COURSE CLASSIFICATION	UNITS	PERCENTAGE
A. General Education	50	25%
B. Engineering Mathematics	15	8%
C. Natural/Physical Sciences	8	4%
D. Engineering Sciences	35	18%
E. Allied Courses	20	10%
F. Professional Courses	70	35%
TOTAL	***198***	***100%***

Figure 3: Summary of Courses Matrix

4. CURRICULUM MAPPING

COURSES	a	b	c	d	e	f	g	h	i
A. General Education									
Understanding the Self				I					
Readings in Philippine History				I					
The Contemporary World				I					
Purposive Communication					E				
Art Appreciation				I					
Science, Technology & Society	I			I					
Mathematics in the Modern World	I			I					
Ethics				I					
Life & Works of Rizal				I					
World Literature				I					
Filipino 1					I				
Filipino 2					E				
Physical Education 1				I	I				
Physical Education 2				I	I				
Physical Education 3				I	I				
Physical Education 4				I	I				
NSTP 1									I
NSTP 2									I
B. Engineering Mathematics									
Calculus 1	I								
Calculus 2	I								
Differential Equations	I								
Advance Engineering Mathematics	E								
Engineering Data Analysis	I	E							
C. Natural & Physical Sciences									
Chemistry for Engineers	I	I						I	
Physics for Engineers	I	I						I	
D. Engineering Sciences									
Engineering Drawing	I				I			I	
Computer -Aided Design	I							I	
Computer Fund. and Programming	I							I	
Statics of Rigid Bodies	E								
Dynamic of Rigid Bodies	E								
Mechanics of Deformable Bodies	E								
Engineering Economics			E					E	
Environmental Science and Eng'g	I			I					
Engineering Orientation	I			I	I	I			I
Technopreneurship		I							I
Occupational Safety and Health				D					E

Materials Science & Engineering	E		E					I	
Research Methods for Engineering		E			E				
E. Allied Courses									
Basic Electrical Engineering	E		I						I
Basic Electronics	E		I						I
DC and AC Machinery	E		I						I
Control Engineering & Lab	E		E				E	E	
Thermodynamics 1	I		I						
Fundamentals in Surveying	I	E							
F. Professional Courses									
Engineering Management						I			E
Fluid Mechanics		E	E						
Thermodynamics 2	I		I						
Heat Transfer	E	E	E						
Power Plant Design w/ Renewable Energy	D			D			D		D
Geothermal Systems, Resources & Tech.	E	E						E	
Corrosion Engineering	D	D	D					D	
Geothermal Geology	E	D						D	
Geothermal Geochemistry	E	D						D	
Geothermal Geophysics	E	D						D	
Geothermal Exploration Tech	D	D					E	D	
Drilling	D	D	D					D	
Geothermal Prod.n Tech & FCRS Design	D	D	D					D	
Well Testing and Measurement	D	D	D					D	
Reservoir Engineering	D	D	D					D	
GE Project Proposal	E	D			D			D	
GE Power Plant Utilization	D	D	D				D	D	
GE Power Plant Oprtn & Maintenance	D	D						D	D
GE Direct Utilization	D	D					D	D	
GE Project Study	D	D	D		D	D	D	D	
Seminars and Field Trips	D	D			D	D	D	D	D
GE Laws, Contracts & Ethics				E	E				E
On-the-Job Training	D	D	D	D	D	D	D	D	D
Sub-Total									

Legend: ***I*** ***-introductory course***
E ***-enabling course***
D ***-demonstrating outcome***

Figure 3: Curriculum Mapping based on the program outcomes

5. CONCLUSION

After a series of workshops, benchmarking and consultation to concerned stakeholders, a new 4-year BS Geothermal Engineering Curriculum was presented to the university academic office for review. Finally the new curriculum was approved by the Board of Regents of NORSU to be implemented beginning this school year 2019-2020.

The new BSGE Curriculum will not only assures the sustainability of the program but also expected to be NORSU's contribution to the growing manpower demand due to the geothermal development agenda not only in the Philippines but throughout the world.

REFERENCES

Fronda, A.D., Marasigan, M.C., Lazaro, V.S.: Geothermal Development in the Philippines: The Country Update, Proceedings World Geothermal Congress 2015, Melbourne, Australia, 19-25 April (2015).

Sojor, H.A., Toralde, J.S.S.: Ahead of Its Time: 15 Years of Undergraduate Geothermal Engineering Degree Program of Negros Oriental State University, Philippines, Proceedings World Geothermal Congress 2010, Bali, Indonesia, 25-29 April (2010)..

Sojor, H.A., Moncada, E.M., Bulaclac, G. C. Jr., and Gajunera, M. E. F.: Geothermal Engineering: CVPC's Contribution to the Philippine Energy Development Program, Prism, Official Research Journal of Central Visayas Polytechnic College. Volume 1, January – December (1995).