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Evaluation of the BS Geothermal Engineering Program of the Bicol University College of Engineering, Legazpi City, Philippines

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ABSTRACT

Bicol University College of Engineering offered the BS Geothermal Engineering starting SY 2000-2001 with an initial enrolment of 35 students. From an original of 134 students, 86 finished the course. A summative assessment of the program showed its impact to the University, the region and the geothermal industry and determined the extent to which the BS Geothermal Engineering Program has achieved its objectives in terms of relevance and performance.

The study made use of documentary analysis of enrolment and scholastic records of the students enrolled in the program and employed a Graduate Tracer Study which was validated through interviews and the social networking media. The results showed an overall rating of 80.53 which is satisfactory using equivalent descriptive ratings. The program with a graduation rate of 64% was able to produce 86 graduates with a 96 % employment rate, 75% of which are involved in engineering and allied industries, thirty nine are connected with engineering and related services, while the rest are involved in environmental engineering, design engineering and safety engineering. The program enabled seven graduates to have post baccalaureate studies in Geothermal Technology Environmental Science, Geology and Mechanical Engineering and three graduates who had their Postgraduate Certificate in Geothermal Energy Technology at the Auckland University with specialization in Reservoir Engineering, Geo-Physics and Geo-Chemistry.

The study recommends that the re-opening of the BS Geothermal Engineering course had to be closely analyzed in consultation with the geothermal industry and the regional economic and power agenda to ensure that graduates will be employed along their fields of specialization. The on-going geothermal explorations and renewed activities at various geothermal areas in the Philippines offer opportunities for the available pool of engineers. Likewise, the development of technical capability especially on non-electrical applications and indirect use of geothermal resources is imperative now that the pace of geothermal activities and use of renewable energy has picked up in the light of the energy situation in the Philippines.

1. INTRODUCTION

The Philippines is the second largest geothermal energy power producer in the world with a total installed capacity as of 2014 of 1,867.690 MW and a potential capacity of additional 780 MW. However, the Department of Energy plans to double the installed capacity to 3,447 MW in 2030 (DOE, 2014).

Bicol Region is situated at the southernmost tip of the Luzon landmass. One of the most active volcanic arcs present in the Philippine Mobile Belt is the Bicol Arc, which stretches from Camarines Norte to Sorsogon in the Bicol Peninsula. The region is sandwiched between two major tectonic structures, namely, the Philippine Trench, located on the eastern side of the Bicol Arc, and the Philippine Fault Zone on the western side. Two of the country's major geothermal fields are located in the Bicol Region. Bicol University (BU) is strategically located between Bicol Region's two geothermal resources. The Tiwi geothermal complex is located in the province. The Bacon-Manito Geothermal Field, on the other hand, is located in the provinces of Albay and Sorsogon (Aligan 2010).

In response to this identified need by the Presidential Task Force on Science & Technology Development and to meet the future needs of the Bicol Region as it strives to be an agro-industrial center, Bicol University College of Engineering (BUCENG) proposed to offer a degree in Bachelor of Science in Geothermal Engineering. The Commission on Higher Education (CHED) identified this program as one of the priority areas in education. The BS Geothermal Engineering was offered by Bicol University College of Engineering starting SY 2000-2001 by virtue of Board of Regents Board Resolution No. 87 Series of 1999 as approved in December 20, 1999. With an initial enrolment of 35 students, the program was offered from SY 2000-2001 up to SY 2007-2008. From an original of 134 students, 86 finished the course. A summative assessment of the program shows its impact to the University, the region and the geothermal industry. The purpose of this summative evaluation is to determine the extent to which the BS Geothermal Engineering Program has achieved its objectives in terms of relevance and performance.

The study was intended to evaluate the Bachelor of Science in Geothermal Engineering offered by the College of Engineering from SY 2000-2008. The study is expected to (1) Analyze the effectiveness of the BS Geothermal Engineering program in achieving its goals and objectives in the discipline, and (2) Determine the relevance of the program to the manpower needs of the industry and the community.

2. Brief Description of Methodologies

Robertson (2004) explored the ways that multiple stakeholders' interests are represented in the program theory building process when conducting a theory-driven evaluation. Theory-driven evaluation is a process for evaluating programs in which a program theory, or logic model is created that represents program functioning. This program theory is then tested to see if the program is operating as conceptualized, and to understand if the program is creating the anticipated impact. This opens up the black box created by simple outcome focused evaluations, and explores the way the outcomes are created. The study shows that an outcome based evaluation for a program can be made using as basis the anticipated impacts.

Based on student and industry assessments surveys administered by Dessouky (2002) on the Environmental Health and Safety (EHS) Engineering program initiated at San Jose State University, the results indicated that the courses in the curriculum sufficiently address the EHS program objectives. The study is related since it provided insights into assessments that were based on the project objectives developed prior to implementation of the program.

Liong (2005) mentioned that there are potential threats in using a monitoring system such as (1) the possibility of restricting goals (of education or training) to a set of objectives defined centrally rather than locally, thus measuring the effects of training on a very broad perspectives without giving due credit on individual or group differences; (2) the use of inaccurate measurements leading to erroneous interpretation of results to justify maintenance or termination of certain intervention. This provided the study with a limitation on the scope of the assessment to be conducted.

This study was based on the systems-based approach using the Input Process Output Outcome (IPO) Model of Bushnell (1990) to determine whether the program had achieved its objectives using end stage evaluation methods. **Figure 1** shows the conceptual framework of the study.

Input consists of the elements that could be evaluated in terms of their potential contribution to the overall effectiveness of the academic program. Process refer to ways in which resources are used as expressed in the program design and implementation and other value adding factors such as the program objectives, program planning and development, curriculum development and the manner by which the academic program has been implemented and put together. Output deals with the short term benefits such as student performance and profile of graduates, the job effects of the program including employment data and contribution of the program to human resource development along science and technology. Outcomes refer to the long term effect of the program to the university's goals and organizational targets. These represent the consequences of the program beyond its direct and immediate interaction with the program stakeholders. Indicators include employment status of graduates, current status of the program and its impacts to the community especially on the development of science and technology manpower.

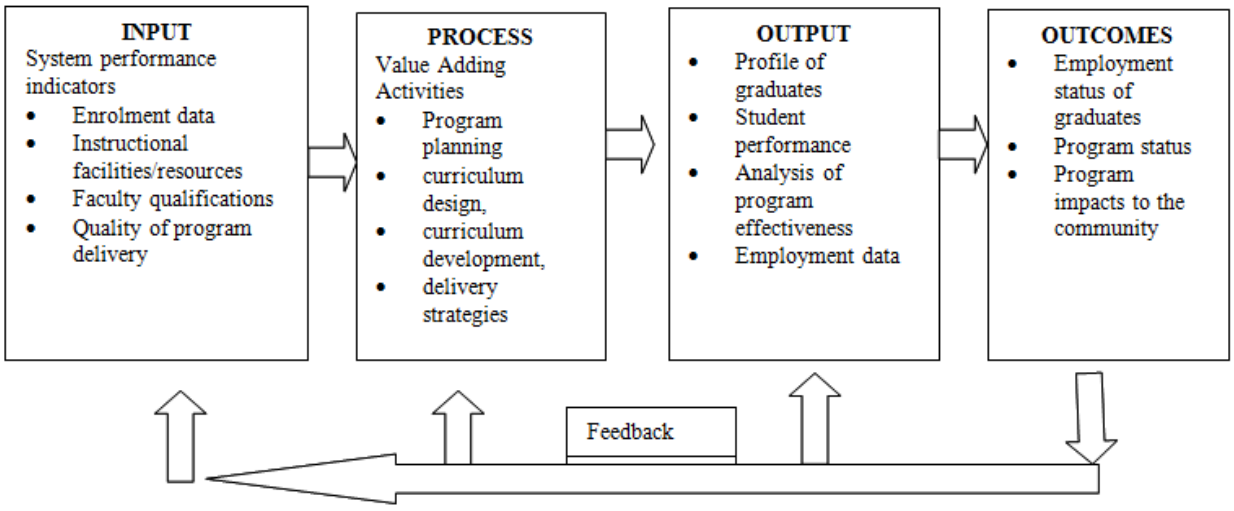

Figure 1: Conceptual Framework of the Study

The analysis of the effectiveness of the BS Geothermal Engineering program in achieving its goals and objectives in the discipline was measured considering the following: (1) the objectives of the program, (2) the priorities and strengths of the department, (3) the program's contributions to its field of specialization and to society, and (4) the program's performance in CHED-specified indicators. using the specific guidelines contained in Commission on Higher Education (CHED) Memorandum Order No. 20 Series of 2004, which spells the requirements of engineering programs to qualify as a CHED Center of Development for Engineering. A Center of Development for Engineering is an engineering unit of a Higher Education Institution with a good undergraduate program, extension capability, and potential for research and who shall act as a role model/leader in the local, regional and national community in its specific field (CHED, 2004).

The criteria include Instructional Quality along ten (10) areas, Research and Publication, Extension and Linkages and Institutional Qualifications. The extent of compliance of the program under evaluation with the CHED guidelines was used as a measure to indicate the effectiveness of the program in achieving its goals and objectives and to put together an accurate picture of the BS Geothermal Engineering program.

The relevance of the program to the manpower needs of the industry and the community was measured in terms of the impacts of various academic activities, research and extension projects undertaken by the program. This includes the profile of the graduates of

the program, the employment status of the graduates of the program, status and prospects of the program and the impacts of the program to the community and the industry. The outcomes and current status of the program were determined using the following methods: (a) Documentary analysis of enrolment and scholastic records of the students enrolled in the program, (b) A Graduate Tracer Study, (c) Interviews and survey questionnaires.

3. RESULTS / FINDINGS

3.1 Analysis of the Effectiveness of the BS Geothermal Engineering Program

The curriculum in BS Geothermal Engineering aimed to provide the students a solid foundation of chemistry, physics, mathematics and the engineering sciences and create a rich environment for teaching and learning the fundamentals of material and energy balance; heat and mass transfer, reaction kinetics, process instrumentation and control, process equipment and plant design, materials engineering, geothermal and environmental engineering, industrial management - which provided the basis for the design and production of new products or processes and the operation of geothermal plants.

The course consisted of training in the following subjects: Earth Science, Geology, Geochemistry, Geophysics and Engineering: Fluid Production and Transmission, Utilization and Reservoir Engineering. Other topics include the current state of technology, reservoir assessment, and characteristics of low, intermediate and high temperature resources. Introductory training in computer programming and numerical analysis was also provided. The curriculum was a 230-unit course, incorporating the minimum requirements of the Technical Panel for Engineering Education and the Commission on Higher Education (Aligan, 2010).

3.1.1 The objectives of the program

The broad objectives of the program are: (1) To develop a highly qualified and competent professional who shall take the lead in the maintenance, control and development of the geothermal resources of the region in particular, and of the country as a whole; (2) To propel the region's development and industrialization for a better quality of life through these professionals who shall be engaged in the wise utilization of geothermal resources into useful products; (3) To develop socially responsible professionals who shall promote the conservation and protection of environment and the keeping of ethical aspects of the profession with respect to the economic and industrial development of the country; and (4) To inculcate the spirit of patriotism among the students.

Out of the total number of graduates, the program produced thirty nine (39) who are currently employed in geothermal and related areas such as energy regulation, mining industry and support services, geo-sciences and environmental management. Of this, ten (10) graduates are directly involved in environmental management either in public or in government service. Sixty two (62) graduates or 75% are involved in engineering and related fields. A total of eighty three (83) or 96% of the total number of graduates were accounted for in the tracer study and this represents a pool of highly qualified and competent professionals.

3.1.2 The priorities and strengths of the department

The program was able to develop the competence of BUCENG faculty by sending them to a Post Graduate Diploma in Geothermal Energy Technology at the Geothermal Institute, Auckland University, New Zealand through a Fellowship provided by the New Zealand Ministry of Food, Agriculture and Trade (NZ-MFAT). Three (3) faculty members were sent from 2000-2002 and took up Steam Field Engineering, Utilization Engineering and Reservoir Engineering, inclusive of courses in geo-sciences and geo-physics.

The instruction was supported by field trips, fieldwork and laboratory work. In addition, all students carried out an individual terminal project. Extensive use of audio-visual facilities and handouts were made during the coursework. On-the-job trainings (OJT) under the traineeship program in the Philippine National Oil Company – Energy Development Corporation (PNOC-EDC) and the Philippine Geothermal Inc. (PGI) Geothermal Fields, and the National Power Corporation (NAPOCOR) Geothermal Power Plants for a period of twenty-six (26) days or 240 hours each during the Summer Terms of the 3rd and 4th curricular years, provided extensive laboratory work and hands-on training on Geosciences and Geothermal Field Operation, Maintenance & Management of various geothermal facilities. Similarly, on-the job trainings were provided by other government agencies such as the Mines and Geo-sciences Bureau on Geology and Exploration and the Environmental Management Bureau of the Department of Environment and Natural Resources on environmental issues.

A major component of the program was the Industry Academe Linkage Program between the industry and the Bicol University (BU). The PNOC-EDC and Bicol University signed a Memorandum of Agreement (MOA) last October 2001, to develop the manpower resources of the region, enhance and upgrade engineering education to make it relevant and responsive to the demands of national development. Under the agreement, PNOC-EDC identified and recommended, from among its employees, people who lectured in the program; assisted in designing the course curriculum including the on-the-job training of the students; shared the use of its facilities / equipment and basic printed manuals for instructional purposes; assisted in research involving geothermal engineering and provided free board and lodging, including daily allowance, to students undergoing OJT.

3.1.3 The program's contributions to its field of specialization and to society

The program with a graduation rate of 64% was able to produce 86 graduates from 2008-2011. With a 96 % employment rate, 75 % are involved in engineering and allied industries, 40 % of which are connected with engineering and related services, 31 % are involved in energy, geothermal and environmental engineering, 13% in the mining industry, 16% in the ICT and Business Processing Operations. The program enabled seven graduates (7) to have post baccalaureate studies in environmental science, geo-sciences and mechanical engineering.

Given the technical and scientific training of the geothermal graduates, the geothermal graduates were made part of the research, development, demonstration and promotional effort for the widespread and productive use of Renewable Energy systems for power and non-power applications. The government's energy regulatory (Department of Energy) and environmental agencies (DENR –

Environmental Management Bureau and DENR-Mines and Geo-Sciences Bureau) employ 14 % (12) of the graduates, performing various technical functions.

3.1.4 The program's performance in CHED-specified indicators

Using the CHED guidelines in evaluating Centers of Excellence, as a measure to indicate the effectiveness of the program in achieving its goals and objectives, the results showed an overall rating of 80.53 which is Satisfactory using equivalent descriptive ratings. **Figure 2** shows the breakdown of the overall rating into its various components.

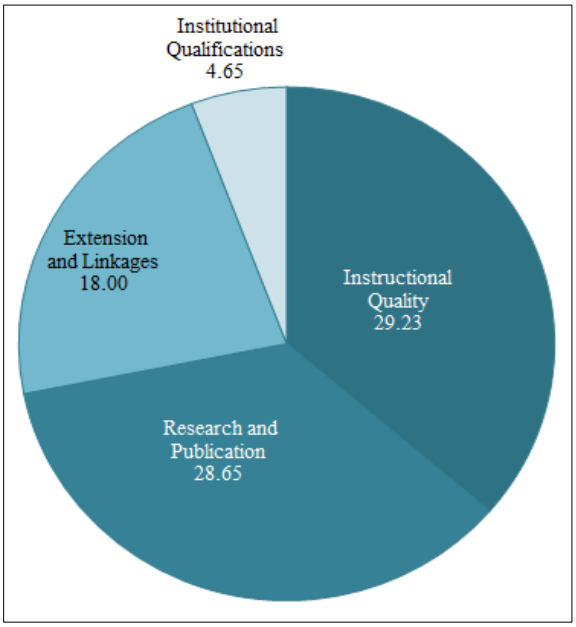

Figure 2: Effectiveness of the Program in Achieving its Goals and Objectives

Under Instructional Quality, the program obtained a rating of 29.23 with strengths along the curriculum, administration and faculty. Instructional materials, methods and support were provided by the administration and partner organizations notable PNOC-EDC, PGI and NGAP. Likewise, faculty development was enhanced thru the MFAT Fellowship at the Geothermal Institute, Auckland University. Unfortunately, efforts to have the BS program be professionalized ,so that a licensure examination can be given to the graduates, was not a success since it requires an enabling law from Congress of the Philippines. Engineering, inclusive of courses in geo-sciences. The instruction was supported by field trips, fieldwork and laboratory work. In addition, all students carried out an individual terminal project. Extensive use of audio-visual facilities and handouts were made during the coursework.

Along Research and Publication, the program had a rating of 28.65 strengthened by the presence of full time faculty conducting researches along geothermal studies. The BS Geothermal Engineering program produced innovative proposals on the agro-industrial use of geothermal heat, utilization of waste silica, and environmental studies. These include geothermal resource assessments, production of hollow blocks from silica sludge, heat exchanger designs for miscellaneous industries such as hand paper making, artificial incubation and brooding system, pool heating, prawn-tilapia aqua-culture, palay- drying, flour manufacturing, boiled water station, irrigation and drinking water supply, soil sterilization, environmental studies and plant optimization studies. The project studies conducted by the students were initial researches in the direct and in-direct uses of geothermal resources within the Albay-Sorsogon areas. These were done in close coordination with the local geothermal industry. Support in terms of technical expertise and access to information, technology and resources were given by the PNOC-EDC, CGPHI, the NAPOCOR / Transco, the DENR-MGB, Department of Public Works and Highways, DOST, the Philippine Coconut Authority and other agencies of the government.

Extension and linkage had a rating of 18 % primarily because of the presence of a strong extension office and an Industry Academe Linkage Program between the industry and the Bicol University. PNOC-EDC and Bicol University signed a Memorandum of Agreement (MOA) last October 21, 2001 to develop the manpower resources of the region, enhance and upgrade engineering education to make it relevant and responsive to the demands of national development. Under the agreement, PNOC-EDC identified and recommended, from among its employees, people who lectured in the program; assisted in designing the course curriculum including the on-the-job training of the students; shared the use of PNOC-EDC facilities / equipment and basic printed manuals for instructional purposes; assisted in research involving geothermal engineering which the Bicol University undertook and provided free board and lodging, including daily allowance, to students undergoing OJT;

Likewise, BU assisted PNOC-EDC in researches and extension activities for efficient and effective production and utilization of geothermal steam and in all other aspects pursuant to their plans beneficial to the public. A similar MOA between BU and the PGI was worked out but due to corporate changes in the latter, no formal agreements were made. PGI, however, had strongly supported the program in many ways such as OJT opportunities, plant visit accommodations, lectures on Reservoir Engineering, and scholarship program arrangements with BU. A number of geothermal engineering students became recipients of the cited scholarship.

3.1.5 Linkages with Professional organizations

Sponsorship and financial assistance by the partner industry notably the PNOC-EDC, CGPHI (Chevron Geothermal Philippines Holdings, Inc., formerly the Philippine Geothermal Inc.) and NGAP enabled faculty and students to participate in various geothermal technical conferences and events. Attendance by the faculty to the EDC Annual Geothermal Conferences and other similar conferences provided opportunities for paper presentation and update of technical knowledge and skills. The geothermal engineering students and faculty were active members of the National Geothermal Association of the Philippines (NGAP). Currently, there are 90 members from the Bicol University. Membership to the association entitled some students to sponsored membership to the Geothermal Resources Council (GRC) and access to the GRC Library's digital collection.

3.1.6 Institutional Qualifications

The program had a high rating of 4.65 in Institutional Qualifications which is primarily as a result of a better curricular planning along the Vision, Mission and Objectives of the University, institutional planning and development initiatives in coordination with the partners, good governance and well established linkages. **Table 1** shows the summary of rating for the different areas under evaluation.

Criteria	Weight %	Section %	Tentative score	
1. Instructional Quality	45			29.23
1.1 Administration		5	4.50	
1.2 Faculty		30	27.00	
1.3 Curriculum		10	10.00	
1.4 Laboratories		7	5.11	
1.5 Engineering Library		7	4.41	
1.6 Instructional Facilities		6	3.60	
1.7 Instructional Materials, Methods, and Support		5	5.00	
1.8 Students		5	4.75	
1.9 Licensure Examination	11.25	25	0.58	
2. Research and Publication	30			28.65
2.1 Personnel		30	30.00	
2.2 Organization and Funding		15	13.50	
2.3 Facilities and Equipment		15	12.00	
2.4 Output		40	40.00	
3. Extension and Linkages	20			18.00
3.1 Personnel		30	30.00	
3.2 Organization and Budget		15	12.00	
3.4 Output		40	36.00	
4. Institutional Qualifications	5			4.65
4.1 Vision/Mission/Objectives		20	20	
4.2 Institutional Planning and Development		20	20	
4.3 Governance		25	25	
4.4 Linkages		15	15	
4.5 Site and Buildings		20	13	
Total				80.53

Table 1: Summary of Rating for Effectiveness of the Program in Achieving its Goals and Objectives

3.2 Analysis Of The Relevance Of The Program To The Needs Of The Industry And The Community

3.2.1 Profile of the graduates of the program

The BS Geothermal Engineering program was offered during the SY 2000 – 2008. Analysis of the Graduate Tracer data showed a 64 % percent graduation rate. From an original of 134 students, 86 finished the course as shown in **Table 2**. Of the 86 graduates, 40 or 47 % were female. Tracer studies for the geothermal engineering graduates likewise revealed a 96 % employment rate.

3.2.2 Employment status of the graduates of the program

Of those employed, 75% are involved in engineering and allied industries, with 10 % in business, banking and sales and 16 % in Information Technology / Business Process Outsourcing. Forty five (45 %) percent or 37 of those accounted in the study were female and of these, 7 are in business, banking and sales, 8 along engineering services, 14 are in the energy, geothermal &

environmental engineering, 8 in Information Technology / Business Process Outsourcing sector and 5 in the mining industry. Of those employed, 19 % are with the government while 81 % are with the private sector (**Table 3**).

Out of the 16 connected with the energy and geothermal sector, eight (8)) are directly employed by geothermal companies, three (3) are with the energy regulation sector and three (3) with the petroleum industry with 2 in design engineering (**Table 4**). Seven graduates (7) had post baccalaureate studies of which two (2) had finished MS Environmental Science, five took up Geology courses where two (2) passed the Geology licensure examination one of whom placed 4th in the Licensure Examination while two (2) finished and passed the Mechanical Engineering licensure examination.

3.2.3 Status and prospects of the program

A re-evaluation of the course in 2003 resulted to the freezing of the program at the Bicol University and a recommendation to offer geothermal engineering as part of a post-baccalaureate course where specialized theoretical work and practical training is required. Effective 1st semester SY 2004-2005, the course was frozen and no applicants for the entrance examination for the course were accepted. The shift in priorities in course offering was reflected in the Bicol University Comprehensive Development Plan for 2003-2013 (BU ComDev, 2003)

BS Geothermal Engineering										
	Enrolled						Graduates			Total
	1st yr	2nd yr	3rd yr	4th yr	5th yr	Total	2nd sem	Summer	1st sem	
1st sem 2000-2001	35					35				
2nd sem 2000-2001	35					35				
1st sem 2001-2002	41	29				70				
2nd sem 2001-2002	38	29				67				
1st sem 2002-2003	27	36	29			92				
2nd sem 2002-2003	27	34	28			89				
1st sem 2003-2004	31	29	32	24		116				
2nd sem 2003-2004	30	27	31	24		112				
1st sem 2004-2005		25	17	29	26	97				
2nd sem 2004-2005		24	17	28	24	93	12			12
Summer 2005						0		8		8
1st sem 2005-2006			22	20	27	69			2	2
2nd sem 2005-2006			19	16	29	64	15			15
Summer 2006						0		9		9
1st sem 2006-2007				20	19	39			5	5
2nd sem 2006-2007				19	16	35	12			12
Summer 2007						0		2		2
1st sem 2007-2008					31	31				0
2nd sem 2007-2008						0	20			20
1st sem 2011-12						0				0
Summer 2011					1	1			1	1
Total							59	19	8	86

Table 2: Summary of Enrolment and Graduates

Industry	Sex		Sector		Total	%
	M	F	Private	Gov't		
Engineering and related services	25	8	26	7	33	39.8%
Mining and geo-sciences	8	5	9	4	13	15.7%
Energy / geothermal services	7	9	13	3	16	19.3%
ICT / Business Process Outsourcing	5	8	13	0	13	15.7%
Other services	1	7	6	2	8	9.6%
Total	46	37	67	16	83	100.0%
Per centage	55%	45%	81%	19%		

Table 3: Employment by Sector

Industry	Number	Total
Engineering and related services		33
Health & Safety Engineering	5	
Quality Assurance	1	
Miscellaneous engineering services	11	
Environmental management	10	
Overseas eng'g services	6	
Mining and geo-sciences	13	13
Energy / geothermal services		16
Geothermal engineering services	8	
Energy engineering	2	
Energy regulation	3	
Petroleum industry	3	
ICT / Business Process Outsourcing	13	13
Other services		8
Health services	4	
Manpower services	2	
Financial management services	2	
Total		83

Table 4: Employment Breakdown by Industry Sector

The freezing of the BS Geothermal Engineering program resulted to a proposal for a Graduate Diploma in Energy Technology which was approved by the BU Board of Regents in February 2008. This was part of the BU Comprehensive Development Plan (2003-2013) wherein the Bicol University College of Engineering will strengthen its current academic programs and will vigorously pursue the offering of advanced degrees in engineering and architecture.

Currently, there are thirty three (33) awarded geothermal contracts as of November 2012. Of this, six (6) are in Bicol Region (1- Albay, 1- Camarines Sur, 1-Quezon / Camarines Sur & Norte, 1- Sorsogon, 2- Sorsogon/Albay with a potential capacity of 175 MW), 14 in Luzon, 7 in the Visayas and 6 in Mindanao, all of which can offer employment opportunities for the available pool of engineers. Of the 33 awarded projects, 6 are operational (1,902.69 MW installed capacity), 18 have confirmed potential capacities (785 MW) and 9 are on exploratory stages (DOE 2014).

3.2.4 Impact of the BS Geothermal Engineering program to the community and the industry

The BS Geothermal Engineering program produced innovative proposals on the agro-industrial use of geothermal heat, utilization of waste silica, and environmental studies. The project studies conducted by the students were initial researches in the direct and in-direct uses of geothermal resources within the Albay-Sorsogon areas. These include geothermal resource assessments, production of hollow blocks from silica sludge, heat exchanger designs for miscellaneous industries such as hand paper making, artificial incubation and brooding system, pool heating, prawn-tilapia aqua-culture, palay-drying, flour manufacturing, boiled water station, irrigation and drinking water supply, soil sterilization, environmental studies and plant optimization studies. Some of these research outputs were presented to the local government for consideration.

These were done in close coordination with the local geothermal industry. Support in terms of technical expertise and access to information, technology and resources were given by the PNOC-EDC, CGPHI, the NAPOCOR / Transmission Corporation of the Philippines (TRANSCO), the DENR-MGB, Department of Public Works and Highways, Department of Science and Technology (DOST), the Philippine Coconut Authority and other agencies of the government. Some of these proposals were made as basis for community development planning by local governments and the private sector, notably the environmental studies.

4. IMPLICATIONS AND RECOMMENDATIONS

The re-opening of the BS Geothermal Engineering course had to be closely analyzed in consultation with the geothermal industry and the regional economic and power agenda to ensure that graduates will be employed along their fields of specialization. Currently, the on-going geothermal explorations and renewed activities at various geothermal areas in the Philippines offer employment opportunities for the available pool of engineers.

Given the technical and scientific training of the geothermal graduates, the geothermal graduates can be part of the research, development, demonstration and promotional effort for the widespread and productive use of Renewable Energy systems for power and non-power applications as envisioned under the Philippine Renewable Energy Act of 2008 (R. A. 9513) which aims to hasten the exploration and development of renewable energy resources, including geothermal resources, and promote their use by providing fiscal and non-fiscal incentives.

The preliminary researches and studies that have been conducted which were aimed at generating and disseminating new knowledge and technologies towards Poverty Reduction & Sustainable Development could be springboards for the development of technologies for utilizing the available geothermal resources of the Bicol Region. Technology verification can be carried out by the graduate students under the Diploma in Energy Technology and the Departments of Chemical Engineering and Mechanical Engineering in coordination with the different agencies / companies under an Industry – Academe Linkage Program and with

There are opportunities where the Bicol University can play a major role in bridging the gap in the development of technical capability on non-electrical applications. The University can position itself as a strategic service provider to the geothermal industry in terms of capacity building, training, information and knowledge sharing, resource and capability build-up and mobilization aside from its mandate of knowledge and technology generation, research and extension, capitalizing on its Diploma Program in Energy Technology.

5. CONCLUSIONS

A BS Geothermal Engineering course was offered by the Bicol University starting SY 2000-2001 until 2008 with a total of 134 enrollees and 86 graduates. The curriculum was a 230-unit course, incorporating the minimum requirements of the Technical Panel for Engineering Education and the Commission on Higher Education. A re-evaluation of the course in 2003 resulted to the freezing of the program at the Bicol University and a recommendation to offer geothermal engineering as part of a post-baccalaureate course where specialized theoretical work and practical training is required.

Using the Commission on Higher Education's (CHED) guidelines in evaluating Centers of Excellence, as a measure to indicate the effectiveness of the program in achieving its goals and objectives, results showed an overall rating of 80.53 which is Satisfactory using equivalent descriptive ratings. The priorities and strengths of the program lie along the development of the competence of the faculty, methods of instruction and strong linkages.

The objectives of the program have been met with 64 % cohort rate or 86 students who finished the course. Tracer studies for the geothermal engineering graduates likewise revealed a 96 % employment rate. Of those employed, 75% are involved in engineering and allied industries, with 25 % in Information Technology / Business Process Outsourcing and other services.

The BS Geothermal Engineering program produced innovative proposals on the agro-industrial use of geothermal heat, utilization of waste silica, and environmental studies. The project studies conducted by the students were initial researches in the direct and in-direct uses of geothermal resources within the Albay-Sorsogon areas. These were done in close coordination with the local geothermal industry

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