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Geothermal Education in the Philippines: The Bicol University Experience

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ABSTRACT

The indirect uses of geothermal energy partly depend upon the presence of specialists capable of conducting such research and development studies. The undergraduate degree in geothermal engineering offered by the Bicol University starting June, 2000 was in response to the need for the development of the geothermal resources in the Bicol Region, especially its indirect use. The course aimed to provide the students with comprehensive knowledge and skills essential for properly conducting geothermally - oriented activities. A major component of the program was an Industry Academe Linkage Program between the PNOC-Energy Development Corporation and Bicol University 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. The program was able to produce 85 graduates some of whom are employed in the energy and geothermal sector.

A re-evaluation of the program resulted to the freezing of the course and a recommendation to offer geothermal engineering as part of a post-baccalaureate course where specialized theoretical work and practical training is required. The Graduate Diploma in Energy Technology aims to provide the graduate students a more solid foundation of the engineering sciences as applied in the energy industry, to produce graduates with an increased capacity for understanding theoretical concepts and contemporary issues of various aspects of renewable energy, and to produce graduates who have in-depth knowledge and understanding of the scientific, technological, and socio-economic principles and techniques upon which energy technologies are founded.

1. INTRODUCTION

1.1 Geothermal Energy in Bicol

The Philippines is the second largest geothermal energy power producer in the world. In 2007, the installed gross capacity for electric power generation reached 2027 MWe with approximately total energy generation of 9676 GWH for the year, representing about 18‰ of the country's total energy generation mix (Bayrante et al, 2008). Anticipating an increase in energy demand, the Philippines has embarked on aggressive exploration activities to bring the total geothermal capacity to at least 3,131 MW under the Philippine Energy Plan by 2013, (DOE, 2004).

Bicol Region is situated at the southernmost tip of the Luzon landmass. It is straddled between 11 - 30’ to 14 - 20’ N and 122 - 20’ to 124 - 30’ East, (**Figure 1**). 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 with a total installed capacity of 495.5 MW. The Tiwi geothermal complex is located in the province of Albay of which the non-power application of the said area was offered for investment in the Philippine Energy Contracting Round 2005. The Bacon-Manito Geothermal Field, on the other hand, is located in the provinces of Albay and Sorsogon.

The Bacon-Manito Geothermal Production Field which was developed and operated by the Philippine National Oil Company (PNOC) -Energy Development Corporation , now the Energy Development Corporation (EDC), for electrical energy generation is divided into BacMan 1 (110 MWe) within Palayan Bayan and BacMan 2 (40 MWe) within the Cawayan and Botong sectors (Fajardo & Malate, 2005). On the other hand, the total installed capacity for the Tiwi Geothermal Field is 330 MW for the six - 55 MW plants, (Kitz and Toreja, 2002). In addition, three new areas being developed such as the Tanawon, Rangas, Kayabon geothermal resources, all in Manito, Albay can provide an additional 120 MWe.

The development of some promising geothermal areas has been temporarily set aside pending technological breakthroughs in handling acidic wells. An example is Mt. Labo which is located within the boundaries of Quezon, Camarines Sur, and Camarines Norte. Eight wells have been drilled in Mt. Labo from 1990 to 1997 but all intersected acidic geothermal fluids (Maturgo et al, 2000).

The Manito Geothermal Livelihood Project (MGLP), which comprise of a 1.5 MWe pilot power plant and a multi-crop drying plant, was put up in the Manito Lowlands. This brought the total installed electric power in Bicol to 481.5 MWe, (Padua et al, 2000).

Based from the surveys conducted, there are many identified surface thermal manifestations from the major thermal areas in the Bicol Region, which may be used for non-power use. These are located along Mt. Labo (Quezon-Camarines Norte-Camarines Sur Area), Mt. Isarog and Mt. Buhi (Camarines Sur), Mt. Bulusan (Sorsogon), Bac-Man Geothermal Production Field , Albay and Sorsogon and Tiwi Geothermal Production Field in Albay.

With the extensive exploitation of the economically viable, high-enthalpy geothermal resources and the fact that most of the remaining geothermal prospects of the country are of the intermediate to low-enthalpy types, the Government now gears for the development of small-scale geothermal resources for direct utilization. This is in line with the government policy, which is poverty alleviation in remote and off-grid areas, (Ulgado and Gular, 2005).

Figure 1: Location of the Bicol Region

1.2 Geothermal Manpower Development

Coupled with the government's aggressive energy development strategies is also an extensive manpower development program. On-the-job training with experts from New Zealand have been successfully implemented in major geothermal power companies. Special studies from short training missions, to masteral and doctoral studies for the local geothermal scientists and engineers have been given full support by the Philippine government and sponsoring countries and international agencies such as New Zealand, Iceland, Japan, Italy, USA and the United Nations Development Programme.

In-house personnel development programs have also been pursued by the government and private agencies involved in geothermal exploration and development in the country, all of which are geared towards the development of a highly capable, sufficient indigenous manpower base.

1.2.1 Foreign Geothermal training: Past and Present

There used to be several international geothermal schools which were established to cater to geothermal training: the Post-Graduate Course in Geothermics later to become the International School of Geothermics in Pisa, Italy (January 1970), the Group Training Course in Geothermal Energy in Kyushu, Japan (September 1970), the Geothermal Diploma Course in Auckland, New Zealand (January 1979). They were joined later by the United Nations University Geothermal Training Programme (UNU/GTP) in Reykjavik, Iceland (March 1979) , the Geothermal Diploma Programme in Mexicali, Mexico (1983), the International Summer School on Direct Application of Geothermal Energy at Skopje, Macedonia (1989) and the Geothermal Training Center- Los Azufres, Mexico (1995), (Dickson and Fanelli, 1998).

The last three are regional in character offering short courses and concentrating on topics of local interest. Unfortunately, the Pisa school has not held its annual course since 1993 due to drastic cuts in government financing; the International Group Training Course at Kyushu University was closed in 2001 but it started a new doctoral course (with Japanese Government Scholarships) on Environmental Systems Engineering in 2002.

The Graduate Diploma in Geothermal Technology course of the Geothermal Institute at the Auckland University has also been closed in 2003 for the same reason. However, it resumed teaching postgraduate geothermal courses in 2007. The Postgraduate Certificate in Geothermal Energy Technology (PGCertGeothermTech) is designed for students who wish to obtain a University qualification in geothermal geoscience or geothermal engineering (IESE , 2009).

The UNU/GTP is thus at present the only international graduate school offering specialized training in all the main fields of geothermal science. More recently, Master of Science degree courses have been introduced , (Fridleifsson 2003).

To enhance studies on geothermal exploitation, exploration and utilization, M.S. and Ph.D. programs oriented to geothermal have become available in few countries (e.g. Iceland, Germany, Greece, Turkey). Master of Science (M.S.) program including courses on Deep drilling technology, Borehole geophysics and Reservoir engineering are available at the Geothermal Centre of the University of

Applied Sciences (Fachhochschule) Bochum, Germany. M.S. and Ph.D. are likewise available at the Middle East Technical University in Ankara, Turkey. In Stanford University, the B.S. program in Petroleum Engineering was no longer very attractive and has been renamed to Energy Resources Engineering and oriented to renewable energy, mainly geothermal, followed by a M.S. program with the same name that also includes geothermal resources. A B.S. program in Thermal energy engineering oriented to renewable energy sources, including geothermal, M.S. program in Utilization of geothermal and solar energy, Ph.D. including geothermal energy utilization at the University of Oradea, Romania, (Rosca, 2008).

The Reykjavik Energy Graduate School of Sustainable Systems was launched in 2007 at Reykjavik Energy headquarters in Reykjavik, in collaboration with Reykjavik University and the University of Iceland. The program is characterized by its focus on sustainable energy use, especially geothermal energy, practical experience in the field and ready access to on-site work with experts on various subjects (REYST, 2009).

In 2008, the Faculty of Mining and Petroleum Technology (FTTM) - ITB offered a Master Degree Program in Geothermal Technology that will put strong emphasis on technical and practical aspects of geothermal energy exploration, exploitation, utilization, economics, management and environmental, to meet man power needs for supporting geothermal exploration, development and utilization in Indonesia (ITB, 2009).

1.2.2 Local Initiatives

In the same way that these geothermal training institutions are contributing towards enhancing human resource development in the participating countries, and are helping them to be eventually self-reliant in terms of technical expertise in the different phases of geothermal development the Bicol University wanted to do its share in this endeavor.

Bicol University (BU) is strategically located between two geothermal resources, the Bacon-Manito Geothermal Production Field and the Tiwi Geothermal Field. It is centrally located within the Bicol Region's geothermal areas.

As early as 1985, Bicol University began studying the possibility of offering a BS Geothermal Engineering program. Initial studies revealed however that the existing geothermal manpower complement of NPC and PGI will not be able to absorb the graduates of the proposed course. There were not enough local experts yet who can handle the course on full time basis. Furthermore, the technology for the indirect uses of geothermal energy were not yet mature hence, was not made as a major justification for the opening of the course.

In 1995, Central Visayas Polytechnic College (CVPC) of Dumaguete City now the Negros Oriental State University (NORSU) pioneered the BS Geothermal Engineering course in the Philippines. A year later (1996), the Leyte Institute of Technology (now Eastern Visayas State University, EVSU) in Leyte, Philippines, offered the same course with 50 enrollees. To-date, enrolment in the course at EVSU is 83 students from 1st to 5th year.

It was also in the same year (1995) that Bicol University revived its plans of offering the BS Geothermal Engineering course. The move was an off-shoot of: (1) the Commission on Higher Education's (CHED) initiative classifying BS Geothermal Engineering as a priority course for the Bicol Region and, (2) Bicol University's plans of offering courses which could not be offered by private Higher Educational Institutions (HEIs).

A Local Study Mission was sent by the Bicol University to the Central Visayas Polytechnic College (CVPC) in Dumaguete, Negros Oriental to explore and evaluate the design of the geothermal engineering program. To come out with a BS Geothermal Engineering curriculum, Bicol University together with representatives from the PNOC Bacon-Manito Geothermal Project and Philippine Geothermal Inc. (PGI) –Tiwi Geothermal Project (now Chevron Holdings Geothermal, Phil, Inc) met several times to discuss the details. Following the approval of the proposal by its Academic and Administrative Councils and subsequently by the Board of Regents through Board Resolution No. 87 series of 1999 in December 20,1999 , the Bicol University College of Engineering started to offer Geothermal Engineering during the SY 2000-2001 with an initial enrolment of 35 students.

2. THE GEOTHERMAL ENGINEERING PROGRAM

2.1 Objectives

The broad objective of the program was to develop highly qualified and competent professionals 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.

They were also expected to propel the region's development and industrialization through these professionals who shall be engaged in the wise utilization of geothermal resources into useful products. At the same time the program aimed 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 to inculcate the spirit of patriotism among the students.

2.2 Rationale

As the Philippines moved on towards the Third Millennium, it was faced with the ever growing threat of worldwide competition, shrinking global market and internationalization. Hence, the significant contribution of the geothermal sector to the economy may be measured in terms of utilization of geothermal resources for both power and non-power applications, in post harvest processing of fishery and agricultural products, and value added products.

Relative to the poor performance of the Bicol Region in domestic trade, indicative of very minimal activities in the region, the Regional Department of Trade and Industry pointed the following technology gaps which Bicol University might address, (BU ComDev, 2003) :

1. Product Development and Engineering;
2. Appropriate Technology on Drying, Processes and Post Harvest Handling and Storage;
3. Lack of Research Institutes to focus on appropriate technology, product diversification and modifications to adopt to world standards.

In response to this identified need and to meet the future needs of the Bicol Region as it strives to be an agri-industrial center, Bicol University College of Engineering offered a degree in BS Geothermal Engineering.

The Bicol University, through its College of Engineering, in cooperation with the Philippine National Oil Company, Philippine Geothermal Inc., National Power Corporation (NAPOCOR) and the BU Regional Science Teaching Center (BU RSTC) with its available facilities, were in the position to help solve the aforementioned problem and contribute to the national development effort.

2.3 Conceptual Framework

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.

2.4 Strategies for Implementation

Following the announcement of the launch of the new undergraduate degree in Geothermal Engineering, the Bicol University has received literally hundreds of inquiries. Understandably, many potentially interested students have shown hesitation due to the immaturity of the industry and uncertainty about its future. Nevertheless, the quota of 35 students to enroll in the first year of the program was met. Interestingly, it had attracted 23% females in 2000, increasing to 41% by 2004.

2.4.1 Methodology

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 PNOC-EDC and the PGI Geothermal Fields, and the NPOCOR 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. Similarly, on-the job trainings were provided by other government agencies such as Mines and Geo-sciences Bureau and the Department of environment and Natural Sciences Environmental Management Bureau especially on geological sciences.

Lecturers from the industry notably PNOC-EDC, PGI , NAPOCOR, Philippine Institute of Volcanology and Seismology (Phivolcs), DENR- Mines and Geo-Sciences Bureau (DENR-MGB), DENR-Environmental Management Bureau (DENR-EMB) served as affiliate faculty for the program.

The core training staff consisted of three permanent faculty members of the Bicol University College of Engineering who finished the Post Graduate Diploma in 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). Professional geothermal engineering courses were handled by the three faculty members who took up Steam Field Engineering, Utilization Engineering and Reservoir Engineering from 2000-2002 and by the Professorial Lecturers from other agencies. Basic engineering and the general education courses were handled by the faculty from within the Bicol University College of engineering.

2.4.2 Industry Academe Linkage Program

A major component of the program was the 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 and lectures, and scholarship program arrangements with BU. A number of geothermal engineering students became recipients of the cited scholarship.

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.

Attendance to the Annual NGAP General Assembly by senior students and faculty were facilitated by the PGI and PNOC-EDC through financial assistance for travel and accommodation. Similarly, PNOC-EDC provided discounted rates for faculty and student participants to the Annual PNOC-EDC Geothermal Conferences . Under its new management, the Energy Development Corporation (EDC) shouldered the travel and registration expenses of the faculty members and students from the three (3) universities

(BU, EVSU and NORSU) to the 2009 PNOC-EDC 30th Annual Geothermal Conference.

2.4.3 Lecture Series

Tie-ups with the NGAP, University of the Philippines-National Institute for Geological Sciences (UP-NIGS) and the Department of Science and Technology (DOST), the Department of Science and Technology- Philippine Council for Industry and Energy Research and Development (DOST-PCIERD) were made resulting to a series of lectures conducted for the students.

NGAP conducted a roadshow with a lecture on "Reservoir Engineering" by Anthony J. Menzies of PGI. Similarly, the UP-NIGS under Dr. Eddie Listanco conducted a series of lectures on Geology, Environment and Hydrogeology and the DOST-PCIERD on Renewable Energy and Information Technology.

2.5 Curricular Realignment

Recent developments in the power and energy sector, as a result of the Philippine Electric Power Industry Act, the resurging geothermal activities in the ASEAN region (Vietnam, Thailand, China and Indonesia), as well as advances in the geothermal industry, necessitated a realignment of the existing curriculum to provide more opportunities for employment and produce more competitive and competent graduates.

In 2002, changes in the curriculum were made, consisting of realignment in the school terms that some subjects were offered, changes in subject content, deletion of some subjects, addition of much-needed subjects, merging of some subjects and/or enriching of other subjects.

The curricular enrichment was a result of the consultations conducted with PNOC-EDC's staff involved in the project, people who are involved in the geothermal industry and members of the Geothermal Engineering Department who had undergone fellowship at the Geothermal Institute, Auckland University.

The curricular enrichment was in consonance with the thrust of the College to set-up a Center for Geothermal Research and Studies in the region to undertake research projects aimed at developing alternative applications of geothermal energy. The proposed curricular enrichment was aimed to provide the students with the necessary skills and competencies to undertake geothermal studies and researches.

The changes in the curriculum were also made to realign the BS Geothermal Engineering curriculum to the revisions made to various engineering curricula in the College and changes in course coding and description suggested for university-wide adoption. The students currently enrolled in the course were duly apprised of the changes in the curriculum.

3. CURRENT STATUS OF THE PROGRAM

3.1 Enrollment

An analysis of the comparative data on enrolment from 2000-2008 (**Table 1**) revealed the following:

- Of the 35 initial enrollees to the program during SY 2000-2001, twenty four (24) students or 69% had finished the course.
- A significant 31 % of initial enrollees shifted to other engineering courses due to inability to cope up with the requirements of the program or lack of interest to pursue the program.
- For the 2nd batch of enrollees (SY 2001-2002), there was a slight increase in enrolment to 41; of this number 29 % were not able to reach the fifth year but shifted to other engineering courses.
- The 3rd batch (SY 2002-2003) had only 27 enrollees and of these, 20 were able to finish the course or a 26 % mortality rate.
- The 4th batch (SY 2003-2004) consisting of 31 enrollees had a 29% mortality rate due to shifters and transferees to other courses.
- Gender was not a factor in the choice of the program as a course of study as shown by the large number of female students in the program. During the SY 2003-2004, there were 48 female students enrolled in the program.
- The comparative enrolment data and the enrolment trend since the program was started in School Year (SY) 2000-2001 until SY 2008-2009 shows that at its maximum level of enrolment, there were 116 enrollees of which 48 were female or 42 % of the geothermal engineering enrollees and 8 % of the total female engineering population (**Figure 2**).
- Throughout the offering of the course, there was a consistent decrease in the number of enrollees in the program as they progressed into the course due to shifting of courses, transferring to other courses and inability to cope up with the requirements.

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. This resulted to a sharp drop in enrolment for the lower years for the 1st semester SY 2004-2005. There were a total of 17 students, 15% of the geothermal engineering population, who shifted to other engineering courses, 6 from those who are in the 2nd year and 11 from those who are in the 3rd year.

Table 1: Comparative Data on Enrolment, 2000 -2008

	Enrolment					Graduates
Term	1st yr	2nd yr	3rd yr	4th yr	5th yr	
1st sem 2000-2001	35					
2nd sem 2000-2001	35					
1st sem 2001-2002	41	29				
2nd sem 2001-2002	38	29				
1st sem 2002-2003	27	36	29			
2nd sem 2002-2003	27	34	28			
1st sem 2003-2004	31	29	32	24		
2nd sem 2003-2004	30	27	31	24		
Summer 2004	5	4	21	24		
1st sem 2004-2005		25	18	30	24	
2nd sem 2004-2005		24	17	28	24	12
summer 2005		6	15	16	24	8
1st sem 2005-2006			22	20	26	2
2nd sem 2005-2006			19	16	29	15
summer 2006			17	14	14	9
1st sem 2006-2007				20	19	5
2nd sem 2006-2007				19	16	12
Summer 2007					1	2
1st sem 2007-2008					31	
2nd sem 2007-2008					21	20
1st sem 2008-2009					1	
2nd sem 2008-2009					1	

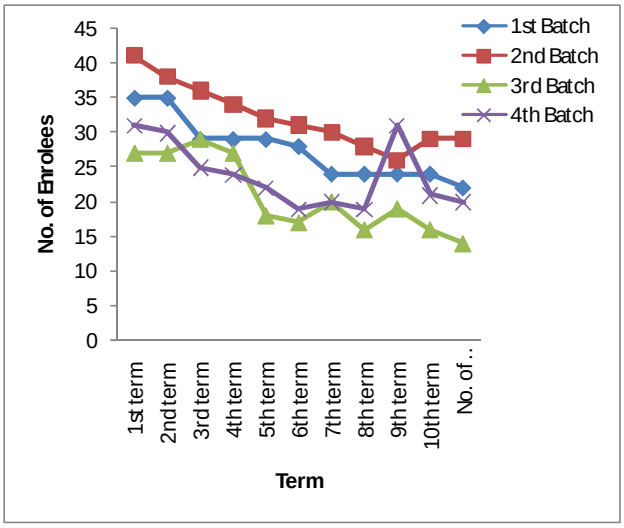

Figure 2: Enrollment Trend, 2000-2008

With the on-going changes at PNOC-EDC, the PGI, the National Power Corporation Tiwi Geothermal Plant during the period of evaluation, and an energy industry dependent on the proposed revisions of the Electric Power Industry Reform Act (**EPIRA**) of 2001 and favorable action on a proposed Renewable Energy Act, human resource availability and future employment of geothermal graduates will hinge on how these companies will treat its energy professionals as they resort to active downsizing, right sizing, early retirement programs in progress and corporate restructuring.

This was leading to a high availability of skilled and experienced personnel in all disciplines coming into the energy market place. These personnel represented an available and valuable source of capability for augmenting both the short and long term requirements of the energy industry but which competed directly with the prospective graduates of the program.

Faced with the prospects of uncertainty in the employment of its graduates, the Bicol University College of Engineering decided that effective 1st semester SY 2004-2005, the course will be frozen and no applicants for the entrance examination for the course were accepted. 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.

3.2 Graduates

Analysis of the Graduate Tracer data showed a 63 % percent graduation rate over the entire period that the course was offered, from 2004 - 2008. From an original of 134 students, 85 finished the course or a 63 % cohort survival rate.

The first batch had a 63 % graduation rate, while the 2nd batch had 29 graduates out of 41 original enrollees (70%). The 3rd and 4th batches had 52% and 65% graduation rates, (**Figure 3**).

Tracer studies for the geothermal engineering graduates likewise revealed a 78 % employment rate, with 22 % of the graduates unaccounted (**Table 2**).

Of the 85 graduates, 39 or 46 % were female. Forty two (42 %) percent or 28 of those accounted in the study were female and of these, 13 are in the energy , geothermal & environmental engineering and related services. Noteworthy, however, is the number of female graduates (6) who joined the Information Technology / Business Process Outsourcing sector either as software engineers or technical services engineers.

Out of the 24 % connected with the energy, geothermal and environmental sector, five (5) are directly employed by geothermal companies three of which are female, two (2) are with the Department of Energy which had 1 female, three (3) are with the drilling and geo-technical sector while the six (6) in environmentally related sector are all connected with the government environmental regulatory agencies (Table 2).

Of those in the engineering and related services, three (3) are in safety engineering while the rest are engaged in engineering design, technical and sales services. Three (3) graduates are working with the Mines and Geosciences Bureau while four are connected with mining companies as technical engineers and safety engineers.

It should be noted that geothermal skills can be redirected into other technologies and industries. The engineering expertise necessary to design or build a geothermal power station could equally be directed towards design and technical services engineering. The scientific expertise could be directed towards minerals exploration or into mining engineering. Proficiency in computing technologies are much valued skills in the business process outsourcing industry.

Currently, the on-going geothermal exploration at the Rangas, Tanawon and Kayabon Geothermal Areas in Manito, Albay, Philippines offer employment opportunities for the available pool of engineers.

The Philippine Renewable Energy Act of 2008 (R. A. 9513) 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 law encourages the development and utilization of renewable energy resources as tools to effectively prevent or reduce harmful emissions and thereby balance the goals of economic growth and development with the protection of health and the environment.

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.

3.3 Diploma in Energy Technology

During the academe-industry dialogue conducted in May 2006 at Baguio City, Philippines between the NGAP, the PNOC-EDC and its Project Managers, PGI now Chevron Geothermal Philippines Holdings, Inc. (CGPHI) , BU, EVSU and NORSU (academic institutions which offer the BS Geothermal Engineering courses), the geothermal companies expressed their preference for mechanical and electrical engineering graduates to man its current operations due to legal requirements. This was due to the legal implications provided by Republic Act 8495 on the practice of mechanical engineering.

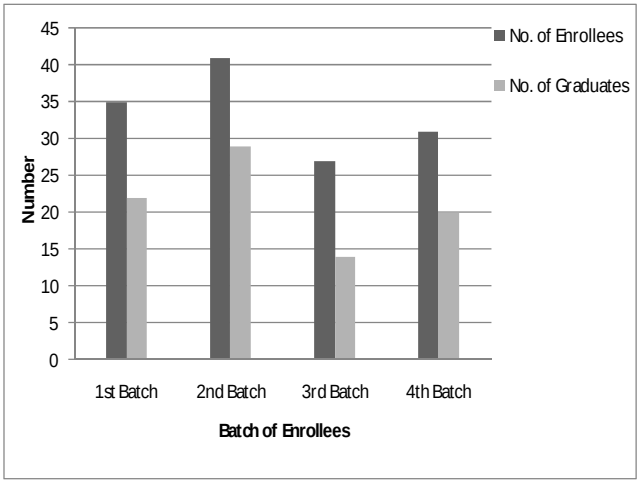

Figure 3: Comparative Enrolment-Graduate Data

Table 2: Graduate Employment Data

Industry	Female	Male	Total	%
Business, banking, sales	3	2	5	7
Engineering and related services	5	11	16	24
Energy, geothermal & environmental engineering	8	8	16	24
Mining		7	7	10
Information Technology related services	6	6	12	18
Others	4	3	7	10
Graduate studies	2	2	4	6
Total	28	39	67	

The Mechanical Engineering Law of the Philippines (Republic Act 8495) requires licensed Professional and / or Registered Mechanical Engineers to be in charge of the management or supervision of the erection, installation, alteration, testing and commissioning of mechanical equipment, machinery, or processes in mechanical works, projects or plants. Mechanical processes, works, projects or plants , as defined by RA 8495 include steam plants, geothermal plants and similar plants containing any mechanical equipment, machinery or process deriving power from steam, fossil fuels, wind, air, gas, water, solar heat, nuclear energy, ocean waves and tides, or other energy sources.

As a result, the NORSU continued with its B.S. Geothermal Engineering course offering, although it faced dwindling enrolment problems. Likewise, EVSU revised its BS Mechanical Engineering curriculum into a ladderized program where Geothermal Engineering became a specialization. Currently, the ladderized program is on its third year of operation with more or less 20 enrollees in the Geothermal Engineering specialization while there are 25 in the 4th and 5th year levels under the old BS Geothermal Engineering curriculum, (Pers com, 2009).

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. Under the BU Comprehensive Development Plan (2003-2013) 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.

The course offering was premised on the fact that PNOC-EDC and CGPHI and other industries in the province have many employees who are licensed engineers but do not have the time to pursue graduate studies along their fields of specialization except those who can pursue Graduate Diploma courses at the Geothermal Institute, University of Auckland, New Zealand or United Nations University, Iceland or in other universities. Hence, most of these engineers take up graduate programs that are not related to their specializations such as Master of Arts in Public Administration, Master in Management, Law, etc.

Presently, no academic institution offers Graduate Diploma in Energy Technology in the Philippines. Leading universities like the De La Salle University, Technological University of the Philippines and Mapua Institute of Technology offer either MS Mechanical Engineering or Master in Mechanical Engineering with specializations. The University of the Philippines offers Master of Science in Energy Engineering and Ph. D. Energy.

The Diploma in Energy Technology offered by BU aims to:

- Provide the graduate students a more solid foundation of the engineering sciences as applied in the energy industry;
- To produce graduates with an increased capacity for understanding theoretical concepts and contemporary issues of various aspects of renewable energy.
- To produce graduates who have in-depth knowledge and understanding of the scientific, technological, and socio-economic principles and techniques upon which energy technologies are founded.
- To produce graduates with an extended capability to apply knowledge and skills in identifying, developing, analyzing and appraising solutions to a range of renewable energy problems.

The future required capability of the geothermal industry is dependent on the extent that the current level of geothermal power generation is maintained and more importantly to the extent that additional generation might be installed over the next decade. For the next generation it is expected to see the implementation of the Enhanced Geothermal System (EGS) production and an intensive increasing of the low-to-medium temperature applications through binary cycle and cascade utilizations, (GHC, 2007).

There is a very large geothermal power industry in South East Asia with some 40% of the worlds installed geothermal power plant capacity contained within the Philippines and Indonesia, (Chou, 2008). The geothermal industry in South East Asia is now quite mature with 30 years experience in geothermal power plant and steam field operations and there is considerable rationalization currently in progress within both the private sector and government agencies.

Given these scenario, growing importance should therefore be placed on the development and implementation of new programs and technologies to help provide the industry with an appropriately trained workforce and the necessary technology. Philippine and Indonesian experiences show that there is a need for continued specialization even after successful geothermal projects are undertaken, for sustained expertise in the local geothermal industry, (Benito and Reyes, 2003).

Similarly, the personnel involved in the industry are ageing and it is expected that the current personnel availability will decline sharply over the next decade (GHC, 2007).

It is foreseen that the development of technical capability on non-electrical applications is imperative now that the pace of geothermal activities and use of renewable energy in the Philippines has picked up in the light of the Approval of the Philippines Renewable Act of 2008. As such, there are opportunities where the Bicol University can play a major role in bridging this gap. The University can position itself as a strategic service provider to the 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.

3.4 Project Studies

Among the studies conducted by the geothermal engineering graduates were innovative proposals on the agro-industrial use of geothermal heat, utilization of waste silica, and environmental studies. Noteworthy among the projects were the 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 / Transcoc, the DENR-MGB, Department of Public Works and Highways, DOST, the Philippine Coconut Authority and other agencies of the government.

The preliminary researches and studies that have been conducted were aimed at generating and disseminating new knowledge and technologies towards Poverty Reduction & Sustainable Development. They 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 funding support from the cooperating agencies.

4. CONCLUSIONS

A BS Geothermal Engineering course was offered by the Bicol University starting SY 2000-2001.

The new engineering degree has been formulated in close consultation with industry, end-users and other stake holders.

A re-evaluation of the course resulted to the freezing of the course and a recommendation to offer geothermal engineering as part of a post-baccalaureate course where specialized theoretical work and practical training is required.

From an original of 134 students, 85 finished the course or a 63 % cohort survival rate.

Industry Academe Linkage Programs were established 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.

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.

Given the availability of geothermal sources of energy in the Bicol Region which can be tapped for power and non-power applications, including the incentives that maybe provided by Renewable Energy Act of 2008, growing importance should be placed on the development and implementation of new programs and strategies to help provide the industry with an appropriately trained workforce and the necessary technology.

A Graduate Diploma in Energy Technology was offered by the Bicol University to answer the need for advanced education.

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