

## International Geothermal Master's Program

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### ABSTRACT

Indonesia's geothermal energy potential is very large, scattered in 331 locations with a potential power source of 11.1 GW, with a large reserve of 17.6 GWe. Total current installed power plant capacity is 1.948,5 MW. With the plan to increase geothermal energy utilization, to be 7.241 MW by 2025, Indonesia has the potential to become the world's first largest country that utilizes geothermal energy. For supporting geothermal exploration, exploitation, and development activities in Indonesia, ITB has established a Master's Degree Program in Geothermal Engineering (hereafter will be called ITB Geothermal Master's Program) since 2008. To enable ITB graduates "to hit the ground running" as new hires for geothermal industries, it is important for ITB to establish an international standard education with an objective to bring together the students to study geothermal exploration or geothermal engineering program, not only from ITB's lecturers but also from industries and overseas geothermal experts. The main objective of the program is to expand students competence in the competitive global challenges in the application of geothermal exploration and engineering technology. The establishment of this program is projected in 2020, is in-line with the road map of ITB Geothermal Master's Program.

### 1. INTRODUCTION

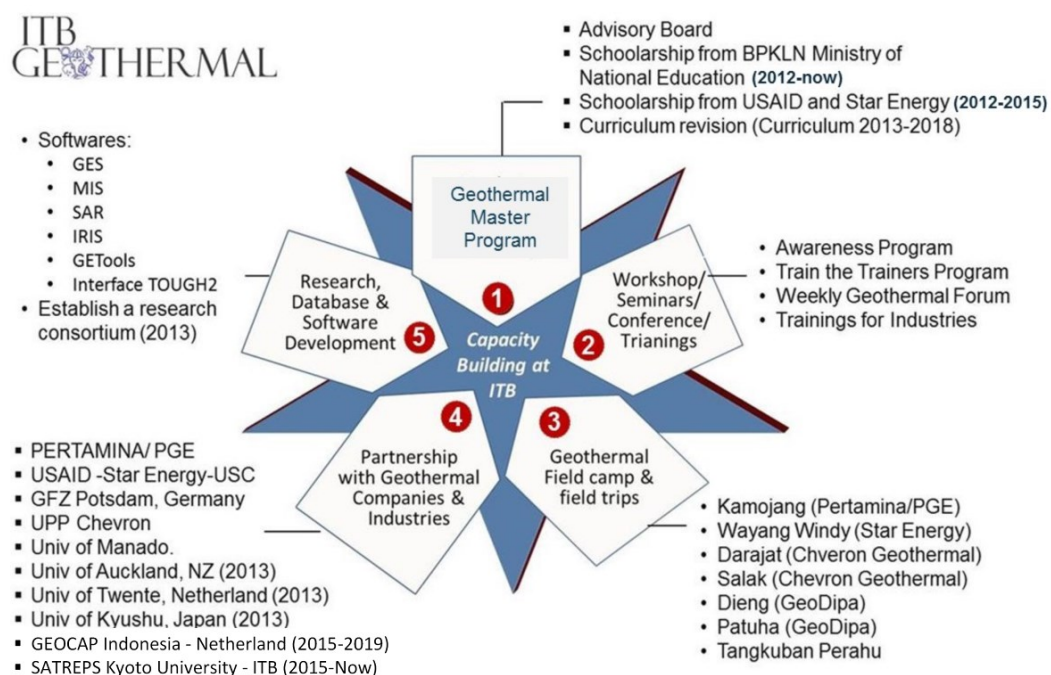
Since mid of 2018 Indonesia became the second-largest country in the world that has harnessed geothermal energy. Total current installed power plant capacity is 1948.5 MW (Geological Agency, 2018). With the plan to increase geothermal energy utilization, to be 7.241 MW by 2025, Indonesia has the potential to become the world's first largest country that utilizes geothermal energy. To achieve the target, exploration, and exploitation activities (development) in Indonesia needs to be improved. There has been 38 Geothermal Working Areas that already have Geothermal Operating Permit, of which 13 working areas are currently under development (exploitation), and 23 areas are being explored.

For supporting geothermal exploration, exploitation, and development activities in Indonesia, ITB has established a Master's Degree Program in Geothermal Engineering (hereafter will be called ITB Geothermal Master's Program) since 2008 (Saptadji, 2010). Until July 2019, the program has graduated 207 students, with the following program achievements:

1. ITB Geothermal Master's Program has become a pioneer (first and foremost) in geothermal education and training in Indonesia. Working closely with several industries, the ITB Geothermal program has conducted the "Geothermal Train the Trainers" program, approximately 7 times, facilitated by 15-20 lecturers from several college per-training, as well as industrial training for 3-4 times a year.
2. ITB Geothermal Master's Program has become a pioneer in community service activities. Six geothermal seminars were conducted in 2012 and 2013 in five cities in Indonesia, including Bandung (West Java), Padang (West Java), Manado (North Sulawesi), Aceh (North Sumatera) and Surabaya (East Java). The objective of a seminar is to disseminate the activities (especially a success story) of the geothermal exploration and exploitation activities in the development of a specific area. Each seminar was attended by average of 200 participants. The seminar is one of many ways to enhance communication among universities, developers/industries, local/central government, and local communities who have interests in geothermal energy development.
3. Collaborative researches of ITB Geothermal Master's Program with several industries has been strongly established, among others with Pertamina Geothermal Energy, Geodipa Energy, Star Energy, PLN, ELC-Electro consult, Industrial Engineering, Kinan Energy, Supreme Energy, Optima, KS-ORKA, Vale, G-Resources, Thermochem, Geological Agency and EBTKE
4. Collaborative researches of ITB Geothermal Master's Program with several overseas geothermal universities and industries has been established, among others with Auckland University (NZ); University of Southern California (USA), Kyushu University, Kyoto University (Japan); TU Delft, Utrecht University, ITC Twente (Netherlands); Iceland Geosurvey (ISOR); IF Technology, TNO, DNVGL (Netherlands); Leapfrog (NZ); Granite Power (Australia); Emerging Power (Philippine).
5. In 2012 – 2015, ITB Geothermal Master's Program has been conducting "US-Indonesian Geothermal Education Capacity Building Program". The program was funded by USAID (United States Agency for International Development) and Star Energy Ltd. The auditor of the USAID concluded that (1) the partnership objectives of this program are successfully achieved, (2) ITB demonstrated strong self-initiative and leadership in implementing the capacity building activities, (3) the overall ratings on the Partnership outcomes of achievement of objectives, sustainability, production /dissemination, and unanticipated outcomes were excellent (Smillie et al., 2015).

6. ITB has received recognition for its success in organizing the annual scientific meeting event, namely "ITB International Geothermal Workshop". ITB Geothermal Program has been performing this event 7 times (since 2012). The event was attended by 300-400 participants from many countries (Indonesia, Japan, Thailand, Philippines, New Zealand, Australia, Netherlands, Iceland, USA, Germany, Singapore, Ethiopia, Kenya and Nigeria). Since three years ago, it has become an international agenda. Since 2016, (IIGW 5th) a selected papers have been published through IOPEES online proceedings indexed in SCOPUS and several other indexes.
7. In 2014-2019, ITB Geothermal Master's Program has been conducting GEOCAP (Geothermal Capacity Building Indonesia – Netherlands), which is a public-private partnership with ITC's department of earth system sciences (University of Twente, The Netherlands) as the leader of the consortium, IF Technology, Well Engineering Partners (WEP), TNO, DNVKEMA (now DNVGL), Delft University of Technology, Utrecht University, and University of Twente with Indonesian partners include: Technical University Bandung (ITB), University of Indonesia (UI), Gadjah Mada University (UGM), INAGA, geothermal companies, (WWF Indonesia is an associate partner to GEOCAP). The overall objective of this program is to build education capacity in Indonesia in the field of geothermal prospecting and energy management (Van Der Meer et al., 2015)
8. In 2013-2017, the Project "School on the Move Program" under ASEAN-Japan Build Up Cooperative Education Program for Global Human Resource Development in Earth Resource Engineering.
9. Since 2014, ITB Geothermal Master's Program has received international students in regular classes. (2014-2017 Yohei Morifuji and Yudai Hirano double degree students from Kyushu University; 2019-2021, Nyora Donald from Tanzania regular students, 2019-2020 Elizabeth Oliphant from Fulbright Scholarship student.)

Overall the activities conducted by ITB Geothermal Master's Program is summarized in the following figure.



**Figure 1: Overall activity in 10 years of ITB Geothermal Master's Program**

For further geothermal capacity building program, ITB will establish International Geothermal Master's Program starting at the 1st semester of the 2020-2021's academic year, where the class will begin in mid-August 2020. This international program will be offered to both local and international students. It is important for ITB to establish an international standard education with an objective to bring together the students around the world to study geothermal exploration or geothermal engineering program. The curriculum of the International program will be identical with the current curriculum. However, in the classes of International program, will be delivered entirely in English and lectured not only by ITB lecturers but also by foreign lecturers from universities, geothermal industries and institutions and geothermal experts abroad.

The rationale for study in ITB International Geothermal Master's Program are:

1. International Geothermal Master's Program offers curriculum that teach practical knowledge and address global issues of geothermal development as well as provide an in-depth understanding of geothermal fundamental science and technology.
2. International collaboration are required to obtain the best breakthroughs in research, technology, and international educators are utilized to share knowledge and develop new experts.
3. Geothermal energy in Indonesia has a promising future to as number one renewable energy in Indonesia.
4. International Geothermal Master's Program can significantly contribute to new methods of learning and a more diverse learning environment not only for domestic students and researchers but also for foreign nationals that study in Indonesia.

## 2. PROGRAM

ITB International Geothermal Master's Program will be offered starting at the 1st semester of the 2020-2021's academic year. The program will be implemented at ITB, Jalan Ganesa 10, Bandung 40132, Indonesia, in 2020. The program has the following purposes:

1. To promote stronger collaborative researches from national and international geothermal communities.
2. To enable foreign nationals to teach, study, conduct research, and or demonstrate special skills at the Geothermal Program of ITB.
3. To expose Indonesian students and researchers with international experience equally.
4. To be able to adopt a broader knowledge and technology in the geothermal sector.
5. To enhance geothermal laboratory qualification and its capacity (incl. tools and equipment) which favor the recent knowledge and technology.
6. To apply advanced information technology in the classroom that enables distant learning environment from throughout the world.

### 2.1 Objectives of the Program

The main objective of the program is to expand students competence in the competitive global challenges in the application of geothermal exploration and engineering technology. Courses are aimed to provide the students with sufficient understanding of the geothermal system and on technical and practical aspects of geological, geochemical and geophysical exploration, reservoir engineering, drilling, well testing, production engineering, utilization of geothermal energy, both for power generation and for direct uses, including reservoir management, project management and economics, and feasibility study.

### 2.2 Curriculum

The ITB International Geothermal Master's Program offers two options to the students, for them to choose based on their interest. The first option is a geothermal exploration program, and the second options are geothermal engineering program (Table 1). Core courses for the geothermal exploration program are geothermal system and technical and practical aspects of geological, geochemical, and geophysical exploration. Core courses for the geothermal engineering program are drilling, reservoir, production engineering, and utilization. There are four compulsory courses for all students (common courses). They are (1) Geothermal System & Technology, (2) Geothermal Management and Economics, (3) Research Methodology, and (4) Evaluation of Geothermal Prospects (Table 1).

At ITB, the course load is represented by a number of semester credit units (or in the Indonesian language is satuan kredit semester (SKS). For post-graduate program, 1 (one) SKS is equivalent to student effort of 5 hours a week in one semester, covering 1-hour face-to-face activities with the lecturer, 2 hour tutorial, and 2 hour independent activities.

**Table 1: The curriculum exploration and engineering program**

	Exploration Program				Engineering Program			
	No.	Code	Course Topics	Credit	No.	Code	Course Topics	Credit
Semester 1 (Aug - Dec)	1	PB5001	Geothermal System and Technology	3	1	PB5001	Geothermal System and Technology	3
	2	PB5002	Volcanology and Advanced Geothermal System	3	2	PB5005	Heat and Mass Transfer	3
	3	PB5003	Geology for Geothermal Exploration	3	3	PB5006	Geothermal Reservoir Engineering	3
	4	PB5009	Geothermal Management and Economics	2	4	PB5009	Geothermal Management and Economics	2
			Total	11			Total	11
Semester 2 (Jan - Apr)	1	PB5099	Leadership Development Program	1	1	PB5099	Leadership Development Program	1
	2	PB5013	Research Methodology	2	2	PB5013	Research Methodology	2
	3	PB5008	Geophysics for Geothermal Exploration	3	3	PB5011	Geothermal Production Engineering	3
	4	PB5007	Geochemistry for Geothermal Exploration	3	4	PB5012	Geothermal Utilization Engineering	3
	5	PB6025	Remote Sensing for Geothermal	2	5	PB5004	Environmental and Social Impact Assessment	2
			Total	11			Total	11
Semester 3 (Aug - Dec)	1	PB6098	Thesis Proposal	2	1	PB6098	Thesis Proposal	2
	2	PB6013	Feasibility Study of Geothermal Project	3	2	PB6013	Feasibility Study of Geothermal Project	3
	3	PB6021	Hydrothermal Alteration	2	3	PB6017	Geothermal Reservoir Simulation	2
	4	PB6014	Advanced Technology in Geothermal Geoscience	2	4	PB6019	Geothermal Power Plant Engineering	2
	5	PB6023	Production Geochemistry	2	5	PB6015	Geothermal Reservoir Management	2
			Total	11			Total	11
Semester 4 (Jan - Apr)	1	PB6099	Thesis	4	1	PB6099	Thesis	4
			Total	4			Total	4
			Total Credit of Exploration Program	37			Total Credit of Engineering Program	37

### 2.3 Program Scheme for the International Program

The curriculum of the International program will be identical with the current curriculum (Table 1), it is a four-semester program, but in the International program the classes will be delivered entirely in English and implemented not only by ITB lecturers but also by geothermal experts from universities, geothermal institutions and industries, such as from Geological Agency, Pertamina Geothermal Energy, Star Energy Geothermal, Geo Dipa Energy, Supreme Energy, PLN and many others; and also from geothermal experts abroad, such from New Zealand, USA, Iceland and Australia. The management of the program, however, is still held by the Geothermal Master's Program of ITB.

The course activities per-semester (16 weeks) consists of the following:

1. 12 (twelve) weeks lectures by ITB lecturers.
2. 12 (twelve) weeks tutorial by Indonesian junior lecturer and academic assistant.
3. 1 (One) week course by invited overseas geothermal experts.
4. 1 (One) week course by invited geothermal experts from industries or other institutions.
5. Mid-semester test (week 8) and final exam (week 16).

Other activities consist of:

1. Laboratory and studio work (use of software, laboratory equipment).
2. Excursion and Field Camp to green-field geothermal prospect (Figure 2) and existing plant.
3. Distance learning in multimedia rooms to enable students to have a discussion with foreign lecturers.
4. Annual seminar at ITB International Geothermal Workshop (Figure 3), where students and staff are presenting all their scientific works to the public. ITB Geothermal Program has been performing this event 8 times (since 2012). The event was attended by 300-400 participant from many countries annually.



**Figure 2: Field study in Tangkuban Parahu during the programs**



**Figure 3: ITB International Geothermal Workshop**

### 3. TEACHING TEAM

Teaching staffs are professors and researchers from the Faculty of Mining and Petroleum Technology (FTTM), from the Faculty of Earth Science and Technology (FITB) and from the Faculty of Mechanical and Aerospace Engineering (FTMD) in ITB. They hold PhD or Doctoral degrees, mostly from overseas such as United States of America, Japan, New Zealand, France and Germany. To provide practical knowledge, ITB invites guest lecturers from relevant and prominent institutions and from geothermal industries. Geothermal overseas experts also will be invited to give lectures for the students to get most recent knowledge from all around the world and each of them will deliver their lectures in one-week lecture program, based on the curriculum.

### 4. FACILITIES FOR SUPPORTING THE INTERNATIONAL PROGRAM

Academic activities of the ITB Geothermal Master's Program took place at the 2nd floor of Gedung Riset Energi & Mineral ITB, consists of 1 (one) classroom for maximum of 50 students, 2 (two) small classroom for maximum of 20 students, 1 (one) computer laboratory, and 3 (three) rooms for lecturer offices. For supporting education and research program at the Geothermal Master's Program of ITB, CHEVRON through its University Partnership Program (UPP), provides twenty computers, a microscope polarisation, and LCD (Figure 4). The computers have been used by the engineering students for conducting geothermal reservoir modeling, wellbore modeling, well test analysis and PTS data analysis and other things. By the geoscientists, the computers have been used among others to construct 3D geological, geochemical and geophysical models using Leapfrog, a geothermal software the ARANZ Geo Limited (is now Seequent) New Zealand. With the increasing number of students, more computers are needed.



For establishing an International Master's Program in Geothermal Engineering at Institut Teknologi Bandung (ITB) - Indonesia, it is important to upgrade the available facilities and to provide the unavailable facilities at ITB Geothermal Master's Program.

#### 4.1 Available facilities need to be upgraded:

- a. **Laboratory and Field Equipment**, include Fluid Inclusion equipment, set of heat loss equipment, computers and software, set of exploration geochemical sampling instruments, field HSE equipment, standard chemical laboratory analysis instrument, microscope polarization for thin section, equipment for MeB, etc.
- b. **Class Room** include AC, locker, projector, share printer, internet network, chairs, desk, electricity connection.
- c. **Working Room for overseas lecturers**
- d. **Library**, online and offline journal collection need to be added



Figure 4: Laboratory facility in ITB Geothermal Master's Program

## 5. SUMMARY

The ITB International Geothermal Master's Program will begin on August 2020 for 2020-2021's academic year. This program is going to be lectured by ITB lecturer's, geothermal industries and institutions and geothermal experts abroad. The curriculum is a combination of classroom studies and some field studies with total of 37 credits. Diverged into two options of programs, engineering, and exploration, which has dissimilarity in most of the learning subjects. Each program will give students focus and detail on theirs and some aspect related to other program. Because the courses are aimed to provide the students with sufficient understanding of the geothermal system and on technical and practical aspects of geological, geochemical and geophysical exploration, reservoir engineering, drilling, well testing, production engineering, utilization of geothermal energy, both for power generation and for direct uses, including reservoir management, project management and economics, and feasibility study.

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