

## **GEOCAP: Geothermal Capacity Building Program (Indonesia-Netherlands)**

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### **ABSTRACT**

The dynamic growth and ambitious plans of the geothermal sector in Indonesia require a lot more skilled personnel and well-trained scientific specialists than currently exist hence a nation-wide capacity building program has been drafted by BAPPENAS. It is difficult to assess the capacity needed both in volume as well as in level of education. The Netherlands Embassy, through Agenschap.NL started to assist BAPPENAS in 2009, to accelerate investments in geothermal areas. In 2014 the Netherlands-Indonesian geothermal capacity building program GEOCAP was launched. The objective of the program is to increase the capacity of Indonesia's Ministries, Local Government Agencies, public and private companies and knowledge institutions in developing, exploring and utilization of geothermal energy sources, and to assess and monitor its impact on the economy and environment. A broad Indonesian-Netherlands consortium consisting of 11 universities, knowledge institutes and geothermal companies formed a Public-Private Partnership to draft GEOCAP. The GEOCAP program has a number of intimately linked components: (1) an Education and training program; focusing on developing capacity at university and technician level in support of the development of the geothermal sector, (2) a research program; addressing the real needs of the sector and solving real life problems related to exploration, exploitation of geothermal resources as well as environmental and legislation issues, (3) a data base program; to collect, standardize, digitize and store surface and subsurface information relevant to geothermal development, (4) a program targeted to explore the use of low & medium enthalpy resources in Indonesia and a (5) geothermal 2050 program aimed at out of the box thinking is necessary to explore potential unconventional geothermal resources that at present are undiscovered or technically not yet feasible. The GEOCAP program aims to engage with local governments and local population. This is unique and highly needed as all the permits are dealt with (contrary to oil and gas concessions that are dealt with by the state government) by local authorities who are only in part known with geothermal energy exploration. In this presentation we will report on the status of GEOCAP, discuss the challenges of geothermal exploration in the Indonesian context both from a geosciences perspective as from a policy perspective and we will discuss the advantages of collaborating in a public-private setting.

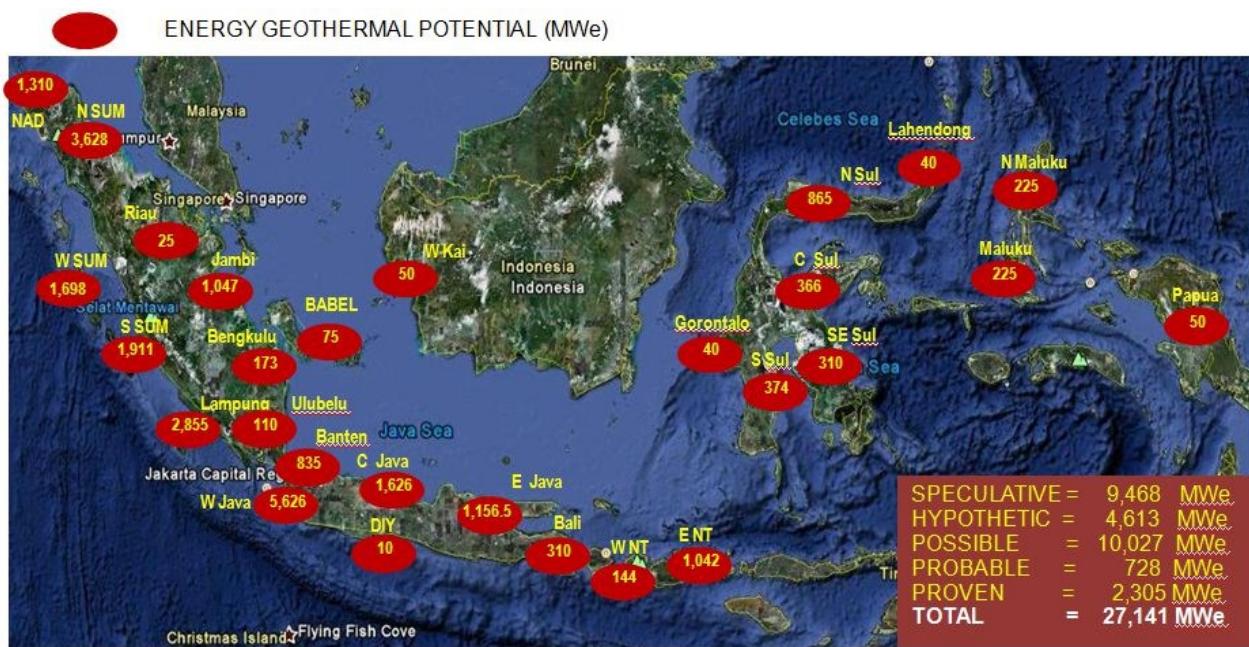
### **1. INTRODUCTION**

Indonesia is with 220 million people and a GDP estimated around US\$800 billion in 2010 one of the largest economies in Southeast Asia with a steady growth rate of 5 to 6 percent per year. The population growth rate along with the economic growth impacts on the countries need for infrastructure (e.g., schools, hospitals, housing, roads), resources (e.g., food, water, electricity), and jobs. In 2006, the Government of Indonesia adopted the Fast-Track Program designed to rapidly develop 10,000 MW of generation capacity utilizing the relatively inexpensive coal resources that are abundant in the country. This resource is cheap but the downside is that it results in massive CO<sub>2</sub> and dust emissions which are hazardous to the people and environment and negative contribute to climate change. Indonesia however is also committed to international agreements on greenhouse gas emission.

The government launched the INISIATIF ENERGI BERSIH (More Energy, less Carbon), the Indonesian effort to limit the impact of climate change caused by greenhouse gas emissions. This initiative proposes a 9,500 MW of Geothermal electricity generation to be commissioned by 2025 that will reduce 69.5 million ton CO<sub>2</sub> annually and over 2,085 million calculated over a 30 year. There are presently two main hurdles to overcome that limit the development of geothermal energy: lack of skilled and trained personnel to explore, produce and exploit the resource and the competition between exploration and protection of forest areas as most of the suitable locations for geothermal energy are located in protected forest areas.

Forty percent (40%) of world's proven geothermal resources can be found in Indonesia (Bertani, 2012), thus not only does Indonesia have enormous geothermal resources, and is Indonesia under-exploiting its potential, but there is substantial impact to be made in CO<sub>2</sub> reduction when investing in the geothermal energy sector in Indonesia (WWF, 2012). Figure 1 shows the geographic distribution of the geothermal potential indicating a concentration on the islands of Java and Sumatra.

The Government of Indonesia and the Government of the Netherlands are both committed to reduce the impact of climate change. The proposed 5,000 MW addition in geothermal capacity by 2015 will reduce more than 4 million ton of CO<sub>2</sub> annually. Indonesia has embarked on a geothermal power plant construction. The new plants commissioned since 2005 are 110 MW at Darajat, 117 MW at Wayang Windu, 2 x 20 MW at Lahendong, 60 MW at Kamojang, and 10 MW at Sibayak, reaching a total installed capacity of about 1.2 GW (including the upgrading of the six units of Salak, 60 MW and two in Darajat, 15 MW). However with these installations the production is still behind the Governments targets.



**Figure 1: The regional distribution of geothermal potential in Indonesia showing the largest potential in Java and Sumatera islands (source: Ministry of Energy and Mineral Resources of Indonesia 2010; courtesy: Antonari, BAPPENAS).**

The short term strategy of Indonesia is to keep up with economic development (> 6% growth rate) through the 10,000 MW crash programs 1 (based on coal) and 2 (based on an energy mix with 40% renewable energy). The medium term goal is to reach a share of 25% for renewable energy in 2025 (for reference the present share is <5% now). The long term energy mix in the vision of the National Energy Council is based for 40% on renewable energy in 2050. The share of geothermal energy now is 1,341 Mw (Kamojang 200 Mw, Darajat 270 Mw, Salak 377 Mw, Wayang Windu 227 Mw, Dieng 60 Mw, Ulubelu 110 Mw, Lahendong 80 Mw, Sibayak 12 Mw, Ulumbu Mw), whereas the Government goals are 3556 MW in 2014 and 12.332 MW in 2025. To achieve these goals the Government of Indonesia wants to develop a number of geothermal fields on different islands in the archipelago. The fields (Figure 2) that to be developed in Java are Karaha Bodas, Patuha, Tangkuban Perahu, Wilis/Ngebel, Baturaden, Guci, Rawa Dano, Tampomas, Iyang Argopuro, Arjuno Welirang and Guci while on Sumatera the following fields will be developed: Sungai Penuh, Lumut Balai, Hulu Lais, Rajabasa, Seulawah Agam, Gunung Talang, Muaralaboh, Bukit Kili, Rantau Dadap, Suoh Sekincau, Danau Ranau, Wai Ratai, Sipaholon, Sorik Merapi and Pusuk Bukit. A modest number of fields on the other islands will be developed such as at Jaboi (Sabang Island), Sembalun (Nusa Tenggara), Jailolo (Maluku) and Kotamubagu (Sulawesi).

The energy policy direction for Indonesia is toward a CO<sub>2</sub> neutral energy mix with an equal share for coal, gas, oil and renewables (including geothermal) in 2025 (Figure 3). Whether at the current speed of development this is feasible remains questionable.

What is also striking in the Indonesian case is that despite the huge potential for geothermal energy and despite the fact the Indonesia features in the top 5 country lists for installed capacity, in terms of direct use of geothermal resources Indonesia is lagging behind despite great potential for various applications ranging from industrial through consumer market applications (Lund et al. 2005).

There are some modest attempts to directly use geothermal heat in the industry process. At the geothermal area of Lahendong (North Sulawesi), a foundation has built a crystal palm sugar manufacturing plant utilizing geothermal steam (URL.1).

Despite the potential, Indonesia also does not feature among the fourteen countries with the highest % share of geothermal energy in their national electricity production (URL.2). The above mentioned total potential of geothermal energy in Indonesia has been estimated by the National Geological Agency of Indonesia (NGAI) at about 27,000 MW (Darma et al. 2010). This is likely to be an underestimation because only 45 of the 256 identified geothermal locations have been extensively studied and only the more immediate prospective sites have been surveyed with geophysics.

The Government of the Netherlands and the Government of Indonesia have started a dialogue on strengthening the local capacity in geothermal in Indonesia which led to the development of a 6meuro program: GEOCAP Geothermal Capacity Building Program (Indonesia-Netherlands). In this paper we report on the status of the program and the components that will be developed to foster capacity building to accelerate the development of geothermal resources in Indonesia.

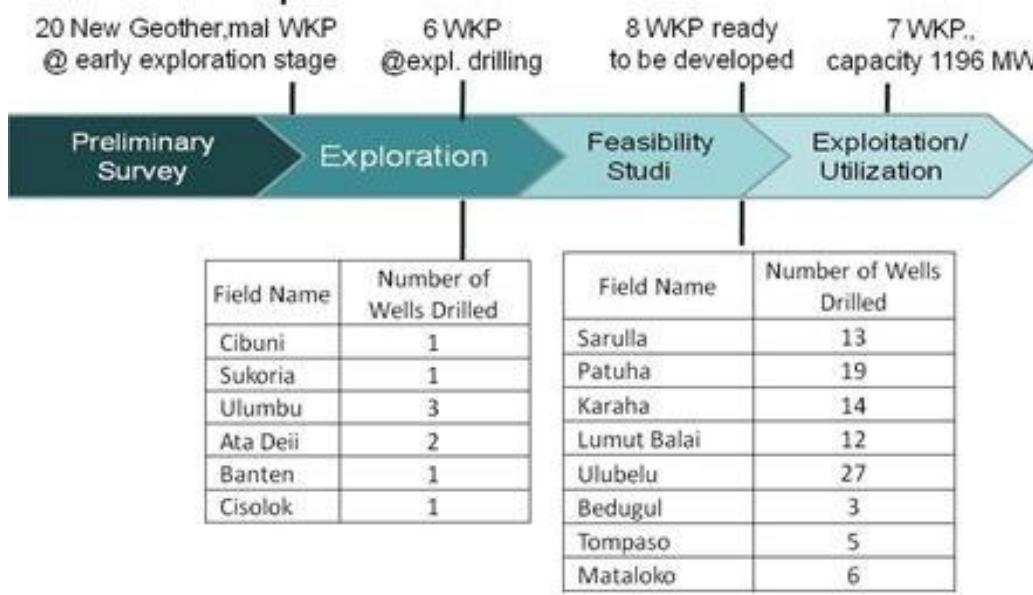
## 2. GEOTHERMAL MANPOWER DEMANDS IN INDONESIA

To achieve the ambition of the Government of Indonesia to increase energy production from geothermal resources to 3556 MW in 2014 and 12.332 MW and to support the 20 new geothermal working areas (WKP), geothermal companies will need earth scientists (geophysicist, geologists, geochemist) but also engineers, economists, land conservation experts and legal experts. In part university-level personnel will be required but also a range of technician-level personnel will be needed. At present there is not enough skilled personnel to fill the existing gaps hence a nation-wide capacity building program is needed.

Some of the early studies conducted in 1993 by Freeston and Bolton (geothermal experts from New Zealand) estimated that 30–50 personnel per year were needed for supporting geothermal development of 1000 MW in Indonesia. The Indonesian Geothermal Association (API/INAGA, e.g., the Asosiasi Panas Bumi Indonesia) calculated that 70 earth scientists per year are required to reach that goal.

A survey in 2004 of geothermal employment in the USA predicted that each additional MWe of installed capacity creates 1.7 full-time jobs for technical personnel (URL.3).

Projecting this on the Indonesia situation under the assumption that 30–50 man power per year are required for supporting geothermal development of 1000 MW in Indonesia, hence for supporting development of 4733 MW in Indonesia until the year 2014, Indonesia will need at least 120 manpower per year, consisting of geothermal engineers and earth scientists. This number does not include the number of manpower needed for conducting exploration at 163 geothermal areas which at present are still at preliminary survey stage and for conducting further exploration at 78 areas which at present are still at exploration stage (URL.4).



**Figure 2: The current status of geothermal development in Indonesia: About 20 new geothermal WKP is currently being explored and proved geothermal WKP will be developed to meet the 2014's and 2016's target.**

In Indonesia a number of universities (and polytechnics) are delivering skilled personnel to the geothermal market. Since mid-1980's geothermal related courses have been built-in in the curriculum of undergraduate programs at a number of universities in Indonesia. The leading programs are:

- the Geothermal Magister Program at the Institut Teknologi Bandung (ITB) at Bandung (West Java)
- the Geothermal under graduate program at the Geothermal Research Center of the University of Gadjah Mada (UGM) at Yogyakarta (Central Java)
- University of Indonesia (UI) at Jakarta offering a Master Program in geothermal exploration

These programs form the academic basis for the Netherlands-Indonesian capacity building program GEOCAP that aims to contribute to the development of the geothermal sector in Indonesia.

### 3. GEOCAP

GEOCAP is a public-private partnership. ITC's department of earth system sciences (University of Twente, The Netherlands) is the leader of the consortium. The consortium consists of partners that have a broad range of expertise in all aspects of geothermal energy, ranging from exploration and exploitation to operational and management aspects, policy and governance, environment and planning. In the sections below the specific expertise of the partners is illustrated.

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).

Netherlands partners include: IF Technology, Well Engineering Partners (WEP), TNO, DNVKEMA (now DNVGL), Delft University of Technology, Utrecht University, and University of Twente.

The overall objective of this program is to build education capacity in Indonesia in the field of geothermal prospecting and energy management.

The program objective is to increase the capacity of Indonesian Ministries, Local Government, Agencies, Public and Private Companies, and Knowledge Institutions in developing, exploring and utilization of geothermal energy resources and to assess and monitor its impact on the economy and the environment.

The project goal for the program duration is:

To develop training and course materials on various aspects of geothermal energy exploitation, to conduct problem-solving research on key problem issues, to develop a comprehensive geothermal data base with the ultimate goal to assist the geothermal sector in Indonesia in universities and companies to increase the skilled personnel capacity in order to develop energy resources.

Furthermore we aim to raise the awareness among local people and local governments on the use of geothermal resources for generating energy in a safe and environmentally friendly manner.

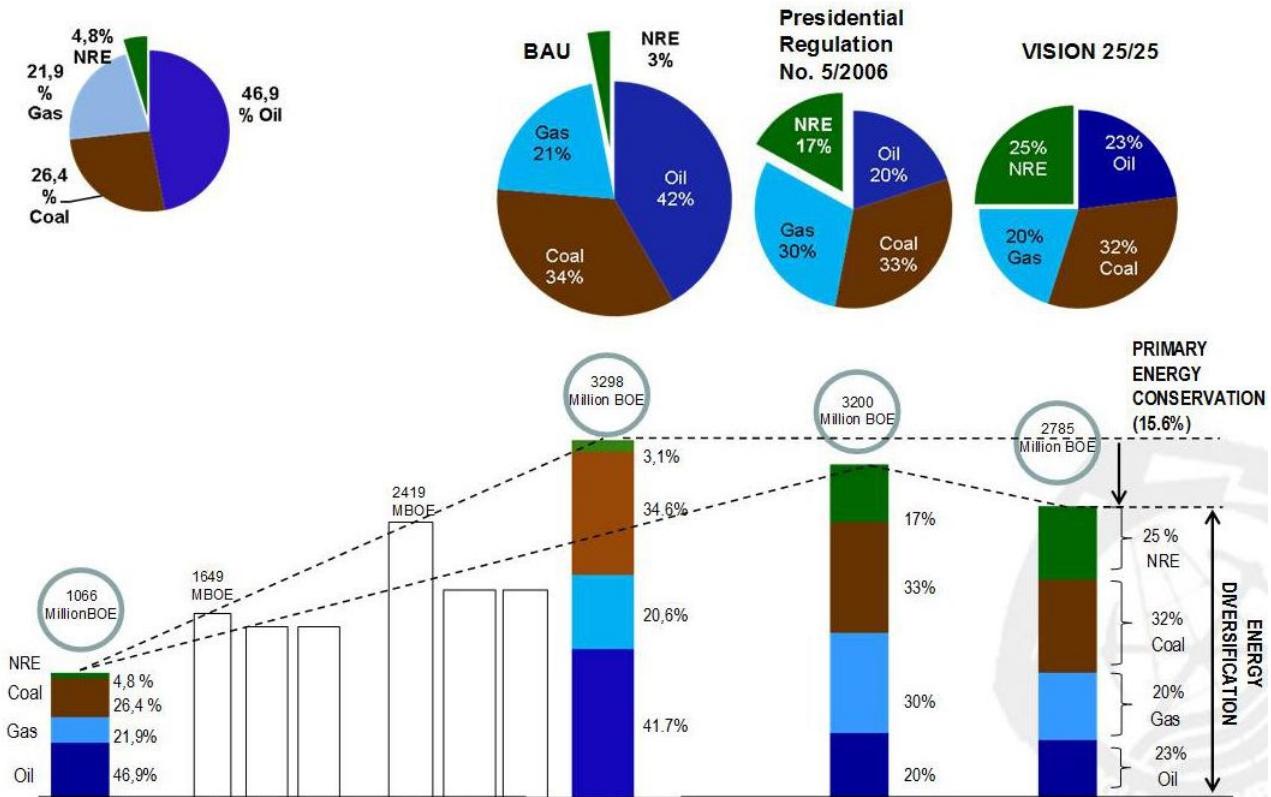


Figure 3: The present and future energy mix for Indonesia (Source: DGNREEC).

The goal beyond the lifetime of the program is to develop strategic and long-term collaboration in education and research through dual degree MSc programs and joint PhD research programs and to develop business to business cases for long-term cooperation between the Netherlands and Indonesian geothermal sectors.

The GEOCAP program has a number of intimately linked components:

1) An Education and training program

Besides engineers and scientists, a large number of personnel/staff will also be needed by geothermal companies to deal with legal, land, data management, forest and environmental management, economics, services, design, construction and project management. Geothermal human resources development may be conducted through various ways, among others through academic program at local universities or overseas or through trainings or short courses. The education and training program should be built on the existing university and short course programs of national universities of ITB, UGM and UI and develop a university network to develop curricula regional universities whereby the national universities adopt one or two regional universities and develop their capacity through train-the-trainer programs. Over 95 subject areas have been identified for which courses and case study materials have to be developed. Discussions with the various stakeholders has led to a prioritization of the various topics and a focus on 10 integrated work packages that form the backbone to the development of case materials.

2) A Research program

In support of geothermal development in Indonesia it is envisaged to develop a research road map until 2025. A number of research spearheads have been identified: Techno-Economic risk assessment, Geomechanics and Reservoir Modeling Studies, Detailed

Drilling Data Logging and Analysis, Improvement of exploration concepts, Hydraulic fracturing and acidizing, and Geothermal Power Plant Efficiency Systems.

### 3) A Data base program

Indonesia lacks a systemic data system or geoportal for data hosting and sharing. Hence a data base to support the Ministry of Energy, as the key keeper of geodata, in managing geothermal data (sub)surface data is required. In addition a data base supporting new geothermal companies in managing their data to enable earth-scientists and engineers to share the same information about geothermal systems through integrated reservoir analysis system is required. The Government is now looking to develop a publicly accessible web-based system, in support of geothermal education and support, similar to Dutch(TNO hosted) 'DINO Loket (URL.5)' and the European database which is developed under the guidance of the European Energy Research Alliance (EERA; URL.6).

### 4) Use of low & medium enthalpy resources

In Indonesia, low & medium enthalpy (temperatures < 200°C) systems are abundant from which direct heat, among others for drying of vegetables and fruits, distillation, food processing (canning), greenhouses, fish farming, pasteurization and making high quality (drinking) water through distillation of other water sources (sea water) can be derived. Also electricity can be produced using binary cycles. To date, the potential of low & medium enthalpy geothermal resources in Indonesia is underutilized. Hence it is necessary to assess the approximate underground potential for low & medium enthalpy geothermal resources in Indonesia and the approximate potential market for these resources.

### 5) Geothermal 2050 program

The present geothermal exploration program is directed toward conventional exploration for hydrothermal system in support of the 2025 timeline. Out of the box thinking is necessary to explore potential unconventional geothermal resources that at present are undiscovered or technically not yet feasible to explore including: conventional high enthalpy resources, supercritical, and engineered geothermal systems (EGS).

GEOCAP addresses a unique set of technical issues building on the strengths of the Netherlands partners including addressing Indonesia's resource potential in low and medium enthalpy systems and risk reduction of failure in the drilling phase by transferring. The coordinating partner ITC (founded as UNESCO ITC) has 60 years of experience in capacity building aimed at economic development in developing countries and emerging economies being founded to fulfill the Netherlands contribution to the UN. The program will develop training and research beyond the traditional technical and geoscientific topics in geothermal exploration. In particular addressing issue related to environmental issues, legislation, and strategic environmental assessment are strongly desired by the Indonesian companies and universities. The program aims to engage with local governments and local population. This is unique and highly needed as all the permits are dealt with (contrary to oil and gas concessions that are dealt with by the state government) by local authorities who are only in part known with geothermal energy exploration. The program seeks, and has established, a liaison with parties like WWF, MER committee and other stakeholders. The program has made links to other donor organizations and has adjusted its ambitions accordingly to create synergy rather than to duplicate. The program is aiming to outlive its duration by establishing structural and strategic joint degree programs between partners.

Recently the Indonesian Parliament Plenary Passes Geothermal Law to substitute the previous law Nr. 27/2003 which relates to geothermal. With this new law, it is expected that it can support geothermal development to realise national energy security, to reduce dependency on fossil fuel and create economic growth centres that can increase the population's economy. The main goal and aim of the new law is to improve business development in geothermal for the benefit for people's welfare. The government and parliament have the same perception on this law. Some of the main changes in the legal setting related to geothermal energy are:

1. Geothermal does not fall in the category of mining activities;
2. Geothermal is seen as a natural resources that lays within Indonesian jurisdiction and is considered as national assets that is controlled by the country and used for the benefit of the population.
3. Government authority for exploration, exploitation and utilisation can be done by state owned company and public services agencies;
4. Supervision and monitoring on geothermal mining license that was previously the authority of local government has become the authority of the central government;

The new law was an initiative from the central government that is proposed by the president Susilo Bambang Yudhoyono to the parliament on August 13th 2013.

## 4. CONCLUSIONS

Forty percent (40%) of world's proven geothermal resources can be found in Indonesia, thus not only does Indonesia have enormous geothermal resources, and is Indonesia under-exploiting its potential, but there is substantial impact to be made in CO<sub>2</sub> reduction when investing in the geothermal energy sector in Indonesia. The Geothermal capacity Building Program Indonesia-Netherlands (GEOCAP) contributes to building individual and institutional capacity in the field of geothermal energy in Indonesia. A Education and training program forms the core of GEOCAP developing capacity at university and technician level along with a research program addressing the real needs of the sector and solving real life problems related to exploration, exploitation of geothermal resources as well as environmental and legislation issues. GEOCAP will also assist in collecting, standardizing, digitizing and storing surface and subsurface information relevant to geothermal development. A specialized component is the

exploration of the use of low & medium enthalpy resources in Indonesia. The GEOCAP program has a duration of 3.5 years and started early 2014. The program envisages outliving its duration as it strives to implement a number of joint degree MSc programs with NL and IND universities after the lifetime of the program. The program also serves as gateway for Netherlands companies to liaise with the Indonesia geothermal sector to develop business to business case studies and corporation. Further the alliance aims to foster south to south cooperation through trilateral collaboration. A new law for geothermal now placing its exploration outside the scope of mining will ensure a faster uptake.

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