Proceedings World Geothermal Congress 2015
Melbourne, Australia, 19-25 April 2015

Development of Geothermal in Indonesia - PGE

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Keywords: Indonesia, Pertamina, Geothermal Energy, PGE, Emission Reductions, CDM.

ABSTRACT

PT Pertamina Geothermal Energy ("PGE"), a subsidiary of PT Pertamina (Persero) is one of the geothermal developer companies in Indonesia that have been developing 14 (fourteen) Geothermal Working Areas (GWA) in Indonesia. Indonesia, which is a country with enormous geothermal energy potential by approximately 40% of the world geothermal energy resources and about 4% has been installed, hence the rest of 96% need to be developed as one of the solutions to solve the power shortage in Indonesia due to the fast economic growing and its energy demands are growing rapidly. PGE is in agree with the government to develop the fourteen GWA where it has operated and developed simultaneously to accelerate and achieve the commercial target of the projects. Several GWA have already operated in scheme of Own Operation project for the area of Kamojang (Kamojang - Darajat), Sibayak (Gunung Sibayak – Gunung Sinabung), Lahendong (Lahendong) and Ulubelu (Gunung Waypanas) with a total installed capacity contribution of ~402 MW. PGE subsequent developments until year 2019 is ~655 MW, and it is expected to be raised by a total of ~2,300 MW in year 2025. Currently, PGE activities are divided into several sequence phases; the exploration phase has been conducted in projects of Iyang Argopuro (Gunung Iyang Argopuro), Kotamobagu (Kotamobagu) and Sungai Penuh (Sungai Penuh). The projects in the development phase are located in Hululais (Hululais), and the status of Engineering Procurement Construction (EPC) for Steamfield Above Ground System (SAGS) & Power Plant located in LumutBalai (Lumut Balai and Margabayur) and Karaha (Karaha Cakrabuana), while the extension phase is conducted on Kamojang Unit 5, Ulubelu Unit 3 & 4 and Lahendong Unit 5 & 6. A different PGE development scheme is Joint Operation Contract (JOC) that has been operating commercially in Gunung Salak (Cibeureum – Parabakti) for ~377 MW, Darajat (Kamojang - Darajat) for ~270 MW and Wayang Windu (Pangalengan) for ~227 MW.

1. INTRODUCTION

Geothermal resources represent a clean and renewable source of energy among various types of energy in the world. It can provide an alternative energy as a step towards achieving a sustainable development and to reduce the dependence on fossil fuel as primary energy for electricity generation. Indonesia is a country with enormous geothermal energy potential with approximately 40% of the world geothermal energy resources. With an impressive ~29,215 MW of potential (Ministry of Energy and Mineral Resource, 2012), and about ~1,341 MW already installed until 2014 from existing GWA, which is only less than 5% of ~29,215 MW.

With recent technology, geothermal energy sources could not be exported and hence their utilization is primarily intended to meet domestic energy needs that can provide added value in terms of optimizing the utilization of renewable energy sources in Indonesia. Geothermal resources potential spreads along the entire trajectory of volcanoes in Indonesia which is usually found only in remote locations, therefore requires adequate facilities as well as infrastructure development. Due to their specific locations, they help to bring about numerous benefits to Indonesia through developing and improving people's standard of living, as a result of and implementation of geothermal development which must be conducted in accordance with the prevail rules.

Geothermal development in Indonesia is unique and a comprehensive process from some aspects, i.e., scientific, engineering, administrative, economic, environment, law and regulation. Each aspect of those activities has its own procedure and regulation that has to be understood and implemented by geothermal developers. Many of those existing laws and regulations have to be followed and may become a big challenge for geothermal developments, which adds more time, costs and risk to the developer.

PGE, a subsidiary of PT Pertamina (Persero) ("Pertamina") is one of the geothermal companies in Indonesia, and it has been developing fourteen GWA (Figure 1) based on the government assertion through Ministerial Regulation of Energy and Mineral Resource (EMR) No.2067K/30/MEM/2012 which is the transfer of Pertamina's rights and obligations to PGE for granting authority to undertake exploration and exploitation of geothermal energy resources in fourteen existing GWA as well as to generate electricity from these resources and to sell such geothermal energy or electricity. The Government of Indonesia (GOI) through the Act No.27/2003 made a serie of reforms and a restructuring of geothermal energy management and utilization regulatory which allowed more companies, including the private sector, to participate in developing the geothermal sector.

GWA in Indonesia are basically divided into two regimes of law, those who are GWA formed prior Act No.27/2003 ("existing GWA") and GWA formed afterward Act No. 27/2003 ("new GWA"). Existing GWA are owned by PGE, and new GWA are owned by legal business entities that are the bidding winners from the bidding process of GWA, which is conducted by the government.

The need for ordaining policies to support geothermal energy is often recognized as a way out of a variety of barriers that prevent investments to expand. Barriers are situation-specific in any given region or country. Regulatory of Indonesia is comprehensive and interrelated of each other, for this reason there will be a need to identify the laws or regulations of the government to unity levels of authority. The investor must be aware of any regulations issued by the government as a whole from the existing regulations, particularly in the geothermal business development. It is very important to be understood and implemented for all regulations to minimize any non - technical barriers in order to avoid the risks.

Beside the big challenge, Indonesia as the country that has ratified the Kyoto Protocol and part of non-Annex 1 countries, it is an opportunity for geothermal projects in Indonesia to be classified as part of Clean Development Mechanism (CDM) project activities and gain benefit from the Certified Emission Reductions (CERs).

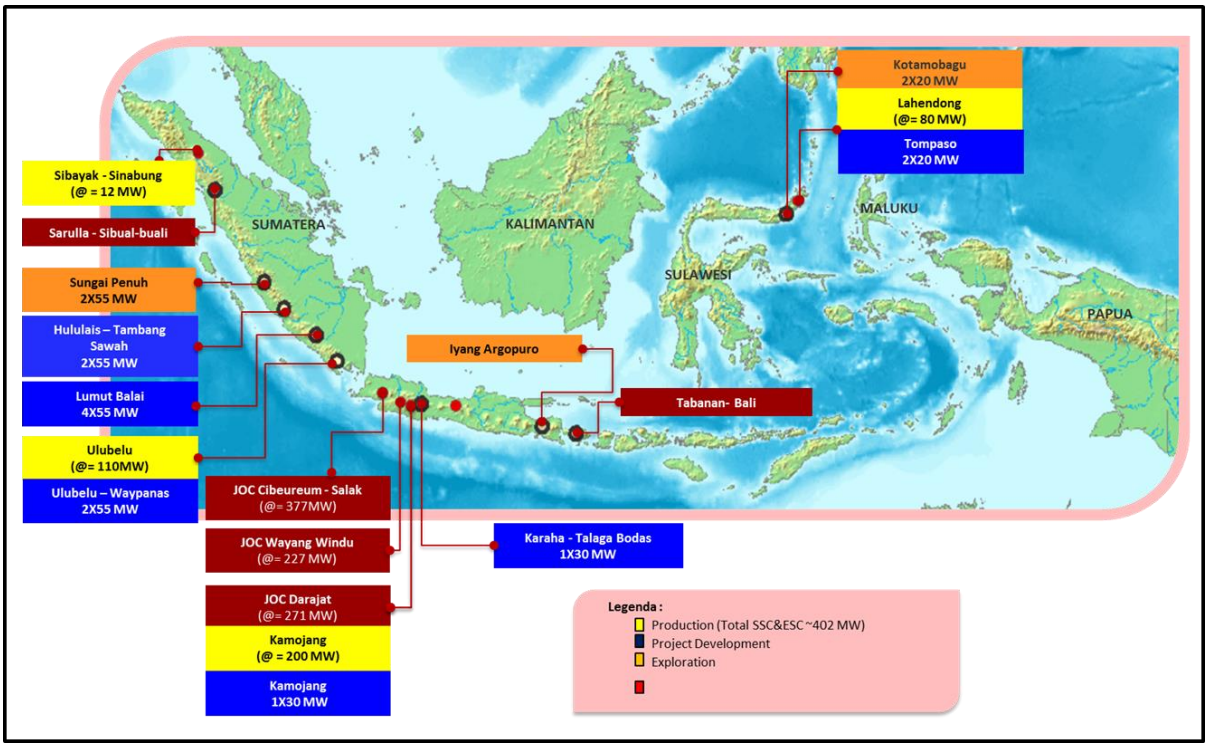

Figure 1: Geothermal Working Areas of PGE

2. GLOBAL GEOTHERMAL DEVELOPMENT

The generation of electricity is the largest producer of CO_2 emissions and responsible for 41% (Figure 2) of the world CO_2 emissions in 2009 (International Energy Agency, 2011). Worldwide, this sector relies heavily on coal, the most carbon-intensive of fossil fuels, amplifying its share in global emissions. In 2009, CO_2 emissions from fuel combustion were dominantly produced from coal, oil and gas.

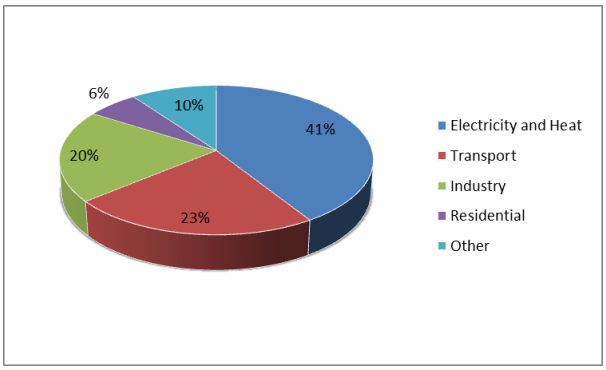

Figure 2: World CO_2emission by sector in 2009 (International Energy Agency, 2011).

The development of geothermal power plant appears to be increasingly supported by the global market with a total installed capacity of ~11,962 MW in 2014 (Geothermal Energy Association, 2014), with the top three countries producing geothermal electricity are United States (29%), Philippines (16%) and Indonesia (11%) as shown in Figure 3.

3. INDONESIA GEOTHERMAL DEVELOPMENT

Geothermal energy is one of the solutions to solve the power shortage in Indonesia, which is a fast growing economy and its energy demands are growing rapidly. Geothermal is a clean and renewable energy that could help Indonesia to reduce greenhouse gases (GHG) emissions by 16% by 2025 (Holm et al, 2010). Several areas have been developed in fourteen GWA where currently around ~1,341 MW (Directorate General of Renewable Energy and Energy Conservation, 2012) have been installed until 2014 and with West Java with a potential of ~1,075 MW (Table 1) installed capacity contribute more than 80% from the total installed capacity in Indonesia.

The implementation process of geothermal development activities in PGE projects at existing GWA through all phases with sequences are next: preliminary survey, exploration, feasibility study, exploitation and utilization as interpreted in Figure 4, where the fourteen GWA activities of PGE are spread in a variety of phases.

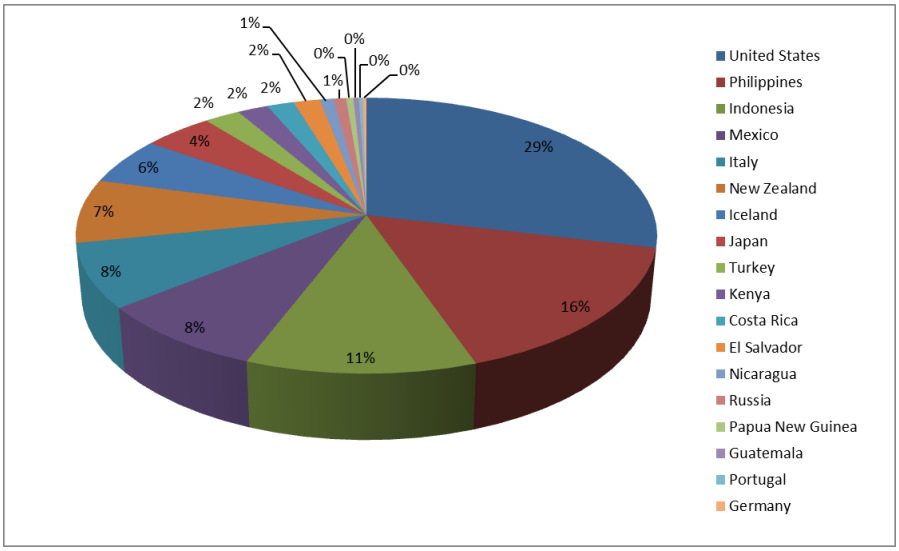

Figure 3: Developing geothermal power markets nameplate capacity in MW.

3.1 Geothermal 2025 Strategy

The Ministry of EMR has established a geothermal development road map for the period 2006-2025 as listed in Figure 5 (Ministry of Energy and Mineral Resource, 2012), its target is to develop 9,500 MW in total by 2025. As a stimulus for the development of geothermal energy, the government has issued Ministerial Regulation of EMR No.21/2013 which is dominated by geothermal power plant projects. Nevertheless the results have not appeared as expected for developing geothermal energy. Many factors that obstruct geothermal business investments in geothermal development are related with the regulation or policy that associated permit and economical electricity tariff. The geothermal resources are controlled by the state, to accommodate expansion of new GWA and regional autonomy in Indonesia, thus the provincial and local governments within their respective jurisdiction, have been given the authority to regulate, supervise and license all new geothermal energy developments.

No.	Geothermal Working Area/ Location	License Holder	Developer	Power Plant	Installed Capacity (MW)
1	Sibayak – Sinabung, NORTH SUMATERA	PT. Pertamina Geothermal Energy (PGE)	PT. Pertamina Geothermal Energy (PGE)	Sibayak	12
2	Cibeureum – Parabakti, WEST JAVA	PT. Pertamina Geothermal Energy (PGE)	KOB - Chevron Geothermal Salak, Ltd (CGS)	Salak	377
3	Pangalengan, WEST JAVA	PT. Pertamina Geothermal Energy (PGE)	KOB - Star Energy Geothermal Wayang Windu, Ltd (SEGWWL)	Wayang Windu	227
4	Kamojang – Darajat, WEST JAVA	PT. Pertamina Geothermal Energy (PGE)	PT. Pertamina Geothermal Energy (PGE)	Kamojang	200
	Kamojang – Darajat, WEST JAVA	PT. Pertamina Geothermal Energy (PGE)	KOB - Chevron Geothermal Indonesia, Ltd (CGI)	Darajat	270
5	Dataran Tinggi Dieng, CENTRAL JAVA	PT. Geo Dipa Energi (GDE)	PT. Geo Dipa Energi (GDE)	Dieng	60
6	Lahendong – Tompaso, NORTH SULAWESI	PT. Pertamina Geothermal Energy (PGE)	PT. Pertamina Geothermal Energy (PGE)	Lahendong	80
7	Ulubelu, *LAMPUNG*	PT. Pertamina Geothermal Energy (PGE)	PT. Pertamina Geothermal Energy (PGE)	Ulubelu	110
8	Ulumbu, *NTT*	PT. PLN Geothermal	PT. PLN Geothermal	Ulumbu	5

Table 1: Installed geothermal generating capacity in Indonesia.

Geothermal development is definitely addressed in Indonesian by Act No.27/2003 as implemented by Government Regulation No.59/2007, which relates to geothermal business activities. One of the objectives of the legislation is to encourage development of geothermal resources in order to meet the national energy demand and to support Presidential Regulation No.5/2006 related to national energy policies whose goals are the materialization of an optimal energy mix in 2025, namely the role of each type of energy relative to the national energy whose consumption of geothermal energy exceeds 5%, of oil less than 5%, of natural gas more than 30%, of fired coal more than 33%, of bio fuel more than 5%, of new energy more than 5%, of liquefied coal and more than 2%**.**

In order to meet the national electricity demand the supply of electricity in Indonesia has been conducted by PT Perusahaan Listrik Negara (Persero; "PLN"), as a state-owned electricity (SOE) company in Indonesia. Other parties such as private sector,

cooperative and public companies can be involved to build and operate power generation plants and to sell electrical power to PLN, known as private generators or Independent Power Producer (IPP).

The aim is to accelerate the development of power generation, and so the government has issued Ministerial Regulation of EMR No.21/2013 which is related to the list of accelerated projects for development of power generation through using renewable energy, coal, gas and related transmission, which will be conducted by PLN and IPP. It's known as government's crash program on 10,000 MW Phase II.

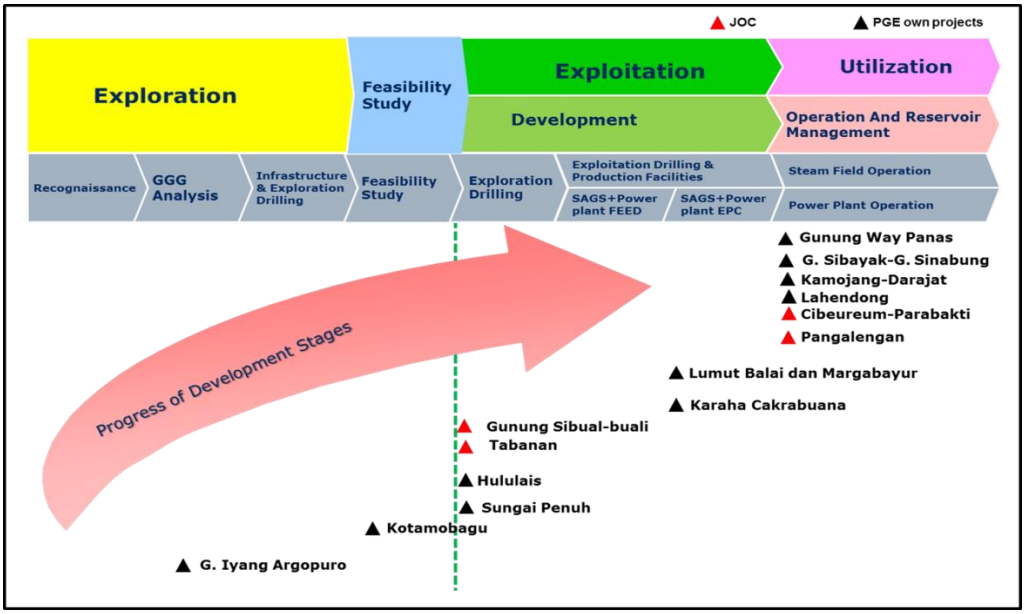

Figure 4: Development progress of PGE's GWA.

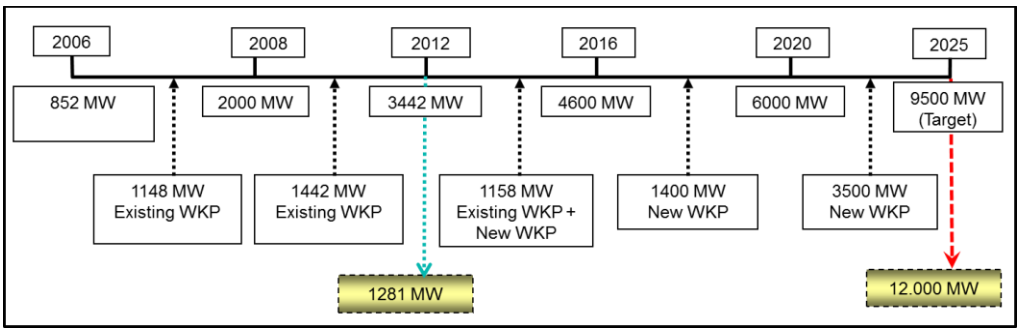

Figure 5: Road map of Indonesian geothermal development, 2006-2025 (Ministry of Energy and Mineral Resource, 2012).

3.2 Geothermal Working Area of PGE

PGE in order to improve Ministerial Regulation of EMR No.2067K/30/MEM/2012 has been developing geothermal energy resources in fourteen existing GWA as well as to generate electricity from these resources and to sell such geothermal energy or electricity to PLN. The fourteen GWA known as "existing GWA" are being developed by PGE in some existing projects as part of government's crash program on 10,000 MW Phase II for 402 ME installed capacity.

The form of Power Purchase Agreement (PPA) within two types of business scheme projects that are applied in "own operation" projects at PGE based on Head of Agreement (HOA) between PGE and PLN, which is commonly called "upstream project" and "total project" business scheme. Each project has its own different contract agreement between PGE and PLN. Total project means PGE as IPP will develop all geothermal steam field facility (upstream project) as well as the power plant facility (downstream project) including the related transmission, therefore PLN will buy the energy of electricity from PGE based on Energy Sales Contract (ESC). Meanwhile upstream project means PGE will develop the geothermal steam field facility only, and PLN will develop the power plant facility, hence PLN will buy the steam from PGE based on Steam Sales Contract (SSC). The strategy of the company to increase the capacity up to 2.3 GW by 2025 needs to accelerate the current ~1GW development projects and ensure that the projects would be accomplished on time and budget. PGE has been preparing to expand towards new exploration and production in new prospects of existing GWA up to ~1 GW and also develop additional ~0.3GW by new GWA through GWA bidding.

Once the commissioning activities have been accomplished it is necessary to prove that the field facilities and the power plant are working properly. At this stage the geothermal power plant have been working operationally and commercially, thus the main activities are to maintain the continuity of steam production from the production wells and electricity production from the power plant to the transmission grid system, which is owned and managed by PLN for 30 years. The production period may be extended in accordance to the validity period of GWA and agreement in ESC or SSC. The utilization of geothermal projects for generating

electricity to meet the increasing demand, and also supporting the increasing economy through the Corporate Social Responsibility (CSR) programs needed by communities, such as: education, health, environment, economic empowerment, etc.

4. EMISSION REDUCTION

In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was held in Rio de Janeiro, Brazil under the guidance of Intergovernmental Panel on Climate Change (IPCC) with the objective to stabilize greenhouse gases (GHG) concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. UNFCCC has been signed by a large number of countries in the world including Indonesia, and through the Act No.06/1994 which Indonesia has ratified the UNFCCC.

The third conference of the parties (COP) at Kyoto, Japan in 1997 has produced "The Kyoto Protocol" which legally requires all Annex I (developed countries) to joint in reducing of GHG emissions at an average of 5% from 1990 emission levels in the period 2008 to 2012 (United Nations, 1998). The Clean Development Mechanism (CDM) was defined in Article 12 of Kyoto Protocol, which is a form of new investments in developing countries to encourage industrial countries to undertake emission reduction activities and achieve GHG emission reduction targets. In this regard it is very important for Indonesia to ratify the Kyoto Protocol by Act No.7/2004.

The CDM is based on the production of "emission reduction", these reductions are produced by non- Annex I countries project and then subtracted to "baseline" of emissions. The emissions baselines are the emissions that are predicted in the absence of a particular CDM project. Emissions reduction of GHG converted into a term of credit in ton CO_2 equivalent known as Certified Emissions Reductions (CERs) which means a unit of emission reductions that have been certified by Executive Board (EB). Annex I countries can take advantage of these CERs to help meet their emission reduction targets as specified in the Kyoto Protocol (United Nations, 1998), and non-Annex I countries will gain benefit from the CERs.

Indonesia is a country that has ratified the Kyoto Protocol and is part of non-Annex 1 countries, hence Geothermal projects of PGE could be classified as part of CDM project activities in large scale, because the capacity of each project is greater than 15 MW (UNFCCC, 2007) and geothermal is a renewable energy with a low contribution of GHG emissions when compared with fossil fuels.

PGE has been developing geothermal projects for power generation, and as known that geothermal energy could be classified as part of CDM projects thus PGE has a great potential to gain the CERs from the development of CDM projects. To achieve this goal emission reduction (ER) calculations will be included in the Project Design Document (PDD). The methodology, which is appropriate with geothermal project, uses ACM0002 (CDM Executive Board, 2008), and is the approved methodology by UNFCCC for large scale CDM project activities (UNFCCC, 2010). ACM0002 is applicable for project construction and operation of a power plant that uses renewable sources and supply electricity to the grid from a green field power plant or capacity addition of an existing power plant, retrofit or replacement.

Some projects in PGE's on going Total Projects have been registered for CDM Projects in year 2012, Figure 6 shows the summary of potential CERs estimated for 1 (one) year period based on valid PDD that has been accepted by EB for 6 (six) on going Total Projects in PGE with a total of annual estimated electricity generation of ~3,390,120 MWh/year is equivalent to CERs of ~2,180,861 tCO_2e/year that will contribute to reduce the GHG emissions and potential additional revenue from CDM projects. In consequence of the transition phase of Post Kyoto Protocol-2012 it will influence the CER price fluctuation, hence PGE considered to develop and upgrade the CDM Projects into Gold Standard scheme. Gold Standard is an upgrading for carbon credit mechanism under Gold Standard Foundation, which is certified carbon credits at premium rate due to their high quality and sustainable development benefits.

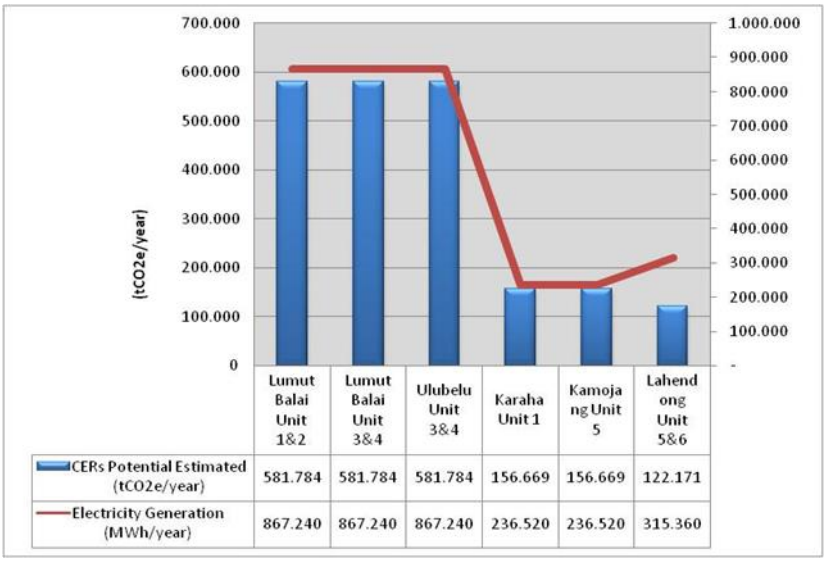

Figure 6: Estimated of CERs potential in PGE Total Projects.

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5. CONCLUSIONS

In order to reduce carbon emissions and with a commitment to the environment new renewable energy sources will be required as an alternative energy to achieve a sustainable development and to reduce the dependence on fossil fuel as primary energy for electricity generation. Geothermal energy is one type of renewable energy that potentially could be developed in Indonesia with an enormous geothermal energy for substantial resources to contribute to the national electricity demand and government roadmap target; hence it needs government support in regulation and policy for the economic project improvements that are needed by geothermal developers to make more attractive the investment.

PGE targets to produce 2,300 MW of electricity from geothermal sources by year 2025. This is a company's effort to satisfy the national energy demand based on renewable energies. PGE, in agreement with the government in the fourteen GWA, has developed the operation of own projects and reached 402 MW of installed capacity in 2014. Some projects with a total capacity of ~655 MW are being tilled by the company until year 2019, and another new development projects included in the Joint Operation Contract (JOC) have been operating commercially in existing GWA for ~874 MW, henceforth it's expected to be raised by a total target of ~2,300 MW in year 2025. In order to accelerate the implementation of geothermal projects it is needed some support that allows investment can deliver attractive returns to investors, a faster permitting process, long-term guarantees from the government to operate in the area of geothermal resources as these resources are usually located in forest nature reserves and protected areas.

Indonesia is a country that has ratified the Kyoto Protocol and is part of non-Annex 1 countries, hence geothermal total projects in Indonesia could be classified as part of CDM project activities; therefore it could make a significant contribution in reducing GHG concentrations when compared with fossil fuels and additionally provide potential revenue for geothermal development projects.

ACKNOWLEDGEMENTS

The author would like to gratefully acknowledge the PGE management, Khairul Rozaq and Dirgo Rahayu for their input reviewing the paper and constant support contributing with valuable data as well as suggestions for the improvement of it and made this paper possible.

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