Nat. Volatiles & Essent. Oils, 2021; 8(1): pp 60-79
DOI: 10.37929/nveo

NVEO
Natural Volatiles & Essential Oils

REVIEW/RESEARCH ARTICLE/SHORT COMMUNICATION

CO2 EMISSION REDUCTION POTENTIAL AS CLEAN DEVELOPMENT MECHANISM IN GEOTHERMAL DEVELOPMENT FOR NATIONAL ENERGY SECURITY

Bagus Bramantio[1], Pantja Djati[2], Siswo H. Sumantri[3], Suyono Thamrin[4], Herlina Juni Risma S[5]

[1,2,3,4,5] Defense Science Doctoral Program, University of Indonesia Defense

Email: bagusbramantio@gmail.com/bagus.bramantio@idu.ac.id[1], spantjadjati@gmail.com[2], siswo_32@yahoo.com[3], suyono.thamrin@gmail.com[4], and herlina.saragih@idu.ac.id[5]

Submitted: 01.01.2020; Accepted: 01.01.2020

Abstract

The Clean Development Mechanism (CDM) according to the Kyoto Protocol is one of the solution to control the emission limitation in sustainable development of the earth. The goal of the CDM is to support developing nations attain long-term development by allowing them to gain from project activities that result in certified emission reductions. Indonesia's Nationally Determined Contribution (NDC) target in terms of energy is 314 million tCO2 where the target of reducing from NRE is 183 million tCO2. This study was carried out employing a qualitative descriptive research method, with data and parameters sourced from reliable sources. i.e., UNFCCC methodology, technical monitoring data, Grid Emission Factor from Indonesian Designated National Authority (DNA), and other data related with CDM. This report is using ACM 0002 version 12.1.0 in estimated emission reductions for geothermal power plant development project in PT. PGE which will be able to contribute as support in achieving NDC and NZE target. The amount of CO2 emissions from geothermal fields used for electricity production varies from one field to the other, however it is much lower than fossil fuels. Geothermal energy development is one of alternative solution to achieve NDC by reducing emission reduction as substitution of fossil energy.

Keywords: Clean Development Mechanism, Emission Reduction, Greenhouse Gas, Geothermal, Nationally Determined Contribution, Net Zero Emission

1.Introduction

From the different kinds of energy that exists in the universe, geothermal resources offer a clean and renewable source of energy. It has the ability supply an alternate energy source as a step toward attaining sustainable development by reducing reliance on fossil fuels as a primary source of electricity. Indonesia has a large geothermal energy potential of 27,000 MW, accounting for nearly 40% of the geothermal energy resources in the globe. [1], and about 1,189 MW (Ministry of Energy and Mineral Resource, 2011) had been built in 2010 from existing Geothermal Working Area (GWA), which is only less than 5% of 27,000 MWn.

Improvement of the air quality requires the geothermal energy as environmentally friendly to stop global warming through reducing the greenhouse gases (GHG) emission. The intensity of CO_2 emission largely determines the overall GHG intensity. The Clean Development Mechanism (CDM) project according to the definition of the Kyoto Protocol of United Nations Framework Convention on Climate Change (UNFCCC) is a project that encourages developing countries to minimize GHG emissions while also contributing to the host country's long-term development by providing emission reduction credits. [2].

Geothermal energy sources, due to recent technology, unable to be exported; instead, their use is largely designed to fulfill domestic energy demands, which bring benefits to Indonesia's attempts to enhance the usage of renewable energy sources. The potential for geothermal resources in Indonesia spans the whole volcanic eruptions' paths, and is typically occurs in isolated areas, necessitating suitable facilities and infrastructure development. They contribute Indonesia in a number of ways by developing and improving

DOI: 10.37929/nveo

citizens' quality of life as a consequence and realization of geothermal development, which should be conducted in light of current regulations.

From some perspectives, such as scientific, engineering, administrative, economic, environment, law and regulation, geothermal development in Indonesia is unique and a thorough process. Each of these activities has its own set of procedures and regulations that geothermal developers must understand and follow. Several existing laws and regulations that must be obeyed may pose a significant hurdle to geothermal development, increasing the developer's time, expense, and risk. Alongside those challenges, CDM can be an opportunity in developing geothermal which can become additionality in geothermal development.

The issue of climate change is very appropriate for the current condition, this is owing to the high emission of carbon dioxide in the atmosphere of the planet. This climate change can also become a threat in human security which is basically general in nature and does not differentiate into transboundary boundaries. Human security focuses on humans, not on the state. There are seven types of human security, namely economic security, food security, health security, environmental security, individual security, community security, and political security. To overcome climate change in the context of reducing carbon dioxide emissions, it is necessary to utilize new renewable energy resources

Renewable energy resources will increasingly become a crucial component to play in the future power generation, replacing fossil fuel energy production. Regarding replacing fossil fuel energy as stated in the INational Energy General Plan I(RUEN), the share of the energy mix in 2025 for EBT is targeted at 23% and increases the contribution to 45 GW (equivalent to 69.2 Mtoe) of generator INew and Renewable Energy (NRE) based electricity by 2025. The one of NRE that abundant and high potential is geothermal energy, where the RUEN has stipulated that the utilization of geothermal energy as a power plant is projected to be 7,200 MW in 2025 and 9,300 MW in 2030[3].

Geothermal energy is defined as renewable because it is based on natural heat limitless resource within the earth and reliable source of power that can reduce the need for fossil fuels for power generation. In addition to provide clean and renewable energy, geothermal has significant environmental advantages. Geothermal energy resource will become alternative energy in power generation industry to minimize the air pollution caused by carbon dioxide (CO_2) compared by the fossil fuel plants. The amount of CO_2 emissions from geothermal fields used for electricity production varies from one field to the other, however it is much lower than fossil fuels. Gaseous emission of geothermal power plants comes from the non-condensable gases (NCG) that is carried and dissolved in the geothermal fluid.

Geothermal energy resource will become alternative energy in power generation industry to minimize the air pollution caused by carbon dioxide (CO2) compared by the fossil fuel plants. Gaseous emission of geothermal power plants comes from the non-condensable gases (NCG) that is carried and dissolved in the geothermal fluid. NCG from turbine will accumulate in the condenser, then removed from the condenser to discharge in the atmosphere by cooling tower. CO2, hydrogen sulfide (H2S), methane (CH4) are the most prominent in geothermal steam and usually in very low concentration [4].

According to the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), a Clean Development Mechanism (CDM) project is one that takes place in a developing country and results in GHG emission reductions, as well as contributing to the host country's sustainable development and earning emission reduction credits (United Nations, 1998). These credits, known as Certified Emission Reductions (CERs), can be sold in a trading market to help developing countries, such as Indonesia, increase their usage of geothermal energy.

One of the geothermal operator companies is PT Pertamina Geothermal Energy (PGE) which has been preparing new geothermal power plant projects. This project report will be estimated and evaluated the CDM potential in expected emission reduction approach. PGE has been developing the geothermal as the renewable energy projects for power generation with less GHG emissions in six projects, which are: 1) Ulubelu Unit 3&4 (2 x 55 MW) located in Lampung Province. 2) Lahendong Unit 5&6 (2 x 20 MW) located in North Sulawesi Province. 3)Lumut Balai Unit 1&2 (2 x 55 MW) located in South Sumatra Province. 4) Lumut Balai Unit 3&4 (2 x 55 MW) located in South Sumatra Province. 5) Karaha Unit 1 (1 x 30 MW) located in West Java Province. 6) Kamojang Unit 5 (1 x 30 MW) located in West Java Province. All those six projects are categorized in "total project" business scheme.

2. Theory and formula

This research employed a qualitative descriptive method. In-depth interviews were used to collect data for this research and a review of the literature from various relevant sources.[5]. Library studies are attempts by scientists to acquire a range of data types of information, according to the topic being researched, namely by digging up various information that is derived from scientific books, research reports, scientific essays, theses and dissertations, regulations, and other written and electronic sources [6]. Data and parameters will be taken from a reliable source, i.e., UNFCCC methodology, technical monitoring data Kamojang Unit 4, Grid Emission Factor from Indonesian Designated National Authority (DNA), and other data related with CDM. Henceforth the estimation of emission reduction potential as mentioned is to be implemented as reference in Project Design Document (PDD) preparation. Main objectives of this project is to estimate and evaluate the emission reduction potential for CDM project based on UNFCCC approved methodology number ACM0002 version 12.1.0 for PGE's total projects.

3. Result discussions

3.1. Energy development

The world's energy demands will increase proportionately with the population growth, and in 2010, the global use of primary energy increased by 5.6%. Oil, natural gas, coal, nuclear power, hydroelectric, and renewables generally increased faster than the rest of the power generation industry. Coal's percentage of overall energy consumption is increasing, while oil continues to be the most popular fuel, accounting for 33.6 percent of global usage in 2010. [7]. Global economic stability and development necessitate a massive amount of energy. In 2009, two vital industries, including energy generation and transportation, accounted for roughly two-thirds of worldwide CO2 emissions. [8]. There is some correlation between energy use with greenhouse gas emissions and it affected to growing concerns over climate change. The majority of experts believe that if CO2 and other "greenhouse" gases continue to grow in the atmosphere, the earth's climate will warm. [9].

National resilience is the perseverance and endurance of a country that possesses the ability to develop national strength and determination of all threats, both external and internal, that wholly or partly endanger the nation and state's survival. Food, water, and energy security are essential aspects in ensuring national security, according to the Indonesian Defense White Paper.[4]. Government Regulation Number 79 of 2014 concerning National Energy Policy encourages the use of New Renewable Energy (EBT) and puts a brake on the use of fossil energy sources. In this policy, the target of the NRE mix is set for 2020 to 2050. Government Regulation No. 79 of 2014 which is a derivative of Law no. 30 of 2007 is one way to build energy security by creating national energy reserves consisting of operational reserves, energy buffer reserves (CPE), and strategic reserves. In PP No.79 of 2014 it is also explained that Natural resources which can be utilized as

DOI: 10.37929/nveo

both Energy Sources and Energy are referred to as energy resources. Nuclear, hydrogen, coal bed methane, liquefied coal, and coal are instances of new energy sources that can be produced with new technologies from renewable and non-renewable energy sources (gasified coal). Renewable Energy Sources, which include geothermal, wind, bioenergy, sunshine, water flows and falls, as well as movements and changes in sea layer temperature, are Energy Sources that are created from sustainable Energy Resources if correctly managed. The national energy policy also discusses reducing carbon emissions and one way to do this is by using new and renewable energy. Indonesia is currently developing a long-term strategy towards carbon neutrality in which Indonesia's energy demand will peak in 2040 and reach net zero by 2060 (or sooner with international assistance). In the discussion of ESDM in CCUS Indonesia is currently establishing the CCS/CCUS National Center of Excellence in 2017. This is supported by the implementation of CCS/CCUS in reducing GHG emissions in addition to increasing oil and gas production. Preparation of the Ministerial Regulation on the Implementation of CCS/CCUS as a technical guideline for the Presidential Regulation on the Economic Value of Carbon. Seeking financial support for the CCUS project through the Environmental Fund Management Agency (BPDLH). Mandatory implementation of CCS/CCUS for new fossil power plants (CCPPs + CCS/CCUS starting in 2031 and IGCC + CCS/CCUS in 2038).

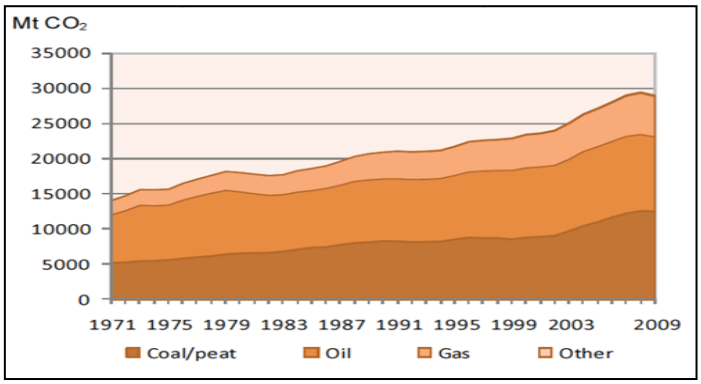
The Nationally Determined Contribution (NDC) is the commitment of each state party to the Paris Agreement. Indonesia has submitted the NDC to the UNFCCC Secretariat ahead of COP-22 Marrakech in 2016, as an elaboration of the NDC and at the same time replacing the INDC that was submitted to the UNFCCC Secretariat prior to COP-21 Paris. The First NDC Indonesia document as attached will be an integral part of the NDC Implementation Strategy. This NDC implementation strategy is intended to guide the synergy steps of every component of the nation starting from Ministries/Agencies, Local Governments, Academics, Business Sector, Non-Governmental Organizations and the General Society to achieve national commitments in reducing GHG emissions and achieving low-emission and climate-resilient development goals such as contained in the NDC document. The Ministry of Environment and Forestry as the National Focal Point for Climate Change in Indonesia, will make every effort in a joint effort to achieve the successful implementation of this NDC. Indonesia made a submission of Nationally Determined Contribution (NDC) paper to the UNFCCC Secretariat almost at the same time, which is a more detailed explanation and supersedes the Intended Nationally Determined Contribution (INDC) paper presented by Indonesia before to COP-21 Paris. Indonesia has been voluntarily reducing GHG emissions since 2017, as part of its pre-2020 commitment, by setting a GHG emission reduction target of 26 percent from BaU in 2020, and up to 41 percent if international support is provided. Learning from the implementation of these pledges has become a factor in defining targets for the years up to 2030. As a result of the ratification of the Paris Agreement and the long-term pilot in Indonesia, including an agreement between sectors on each quantitative target in the NDC (which is an outline of the transformation of Indonesia towards a low-emissions and climate-resilient future development), then to implement it requires the support and commitment of all parties. This support and commitment consistently and continuously requires follow-up actions to protect Indonesia's natural resources and environment for the better and contribute to preventing the earth's temperature from rising to no more than 2oC and towards 1.5oC compared to the pre-industrial era.

3.2. Global Geothermal Development

In 2009 (Figure 1), Coal, oil, and gas accounted for 43%, 37%, and 20% of CO2 emissions from fuel combustion, respectively. [8]. In 2009, the growth of these fuels was highly diverse, showing a variety of trends that are projected to persist in the future.

Figure 1: CO2 emission by fuel

DOI: 10.37929/nveo



Source: IEA (2011), sebaiknya diupdate dengan yang terbaru

Adjustments to current energy productions are required to meet rising energy demands while minimizing the environmental effect. Increased energy efficiency from fossil fuel combustion technologies, as well as an increase in the percentage of alternative energy generation technologies such as hydropower, wind energy, geothermal energy, and solar power, are all required. The use of geothermal energy is usually classified into two groups, direct use (direct application) and power generation (power plant). People have known the geothermal direct use and used the geothermal in daily life since the dawn of civilization many regions of the globe. Table 2 shows the activities of geothermal direct utilization and significant increasing for around 57% in every 5 years from 1995 to 2010.

Consider to the grew up of world energy consumption that dominated by power generation, thus according to the data, global CO2 emissions from fossil fuel usage will rise as well. There is some correlation between energy use with greenhouse gas emissions and it affected to growing concerns over climate change. Many experts believe that if CO2 and other so-called greenhouse gases begin to escalate as carbon dioxide levels in the atmosphere, the Planet's temperature will heat up. [9].

The CO_2 emission from renewable energy is relatively much lower when compared with fossil fuel combustion (Table 1), and it shows that geothermal only 23-45 $kgCO_2e/kWh$ estimated, and fossil fuel has the highest CO_2 emission about 1224 $kgCO_2e/kWh$. The amount of dissolved gases, also known as NCG, is determined by a number of factors, including the resource's properties and fluid composition. [11]

Improvements to current energy production activities are made to fulfill rising energy demands while minimizing environmental impact. Energy conservation gains from fossil fuel combustion advanced technology, as well as an increase in the share of alternative energy generation technologies such as hydropower, wind energy, geothermal, and solar power, are required. Direct and indirect geothermal application are the two most common types of geothermal utilization.

Geothermal energy is one solution to the power shortage in Indonesia, which is among the key drivers of growth and rapidly rising power demands. Geothermal energy is a clean renewable energy supply that can support Indonesia trimmed carbon dioxide emissions by 16% by 2025. [4].

Geothermal energy becomes one of the clean and renewable energy services that can provide an alternative energy source to reduce reliance on primary energy from fossil fuels. Oil, natural gas, and coal are part of fossil fuels that mostly depended on energy for electricity generation. The fossil fuels problem is non-renewable with limited supply that will be exhausted in accordance with the continuous exploitation and contributing massive greenhouse gas emission in power generation through combustion. Hence the sustainability of energy will depend on the managing of the energy demands along with the using of renewable energy sources development. Energy is critical to long-term development and attempts to

alleviate poverty because it affects all aspects of development, including social, economic, and environmental factors. Renewable energy resources will increasingly become a crucial componen to play in the future power generation, replacing fossil fuel energy production.

Geothermal energy, as a renewable energy resource with lower GHG emissions, offers a different approach to the current reliance on coal to supply a significant portion of base load demand. The potential volume of GHG emission reductions can be significantly related to a country's CDM perspective. The Kyoto Protocol of the UNFCCC is the most thorough and legally binding international pact to mitigate climate change to date, complementing various national policies and measures.

3.3. Indonesia geothermal power production

Indonesia as the tropic country which dominated by power generation utilization if it compared for direct use only 11,8 GWh/year for geothermal annual use [12]. Currently electricity supply in the country can give the significant increasing of the economic growth to community and enhancing the business industries and activities sector. Thus, it is very important if government support for the electricity supply to the community and the business. Power shortages have been experienced in Indonesia because the electric supply can not to fulfill the electricity demand. One of solution to fulfill the electricity supply is by using the geothermal energy as the clean and renewable energy, and Indonesia has a significant geothermal energy potential in the world. With an impressive 28,100 MW potential[4], Indonesia has around 40% of the world's geothermal energy reserves.

For further expansion, geothermal project has been developing by PGE which is one of the subsidiary companies from PT Pertamina (Persero) as the Indonesian Oil and Gas State Owned Company. PGE has 14 Geothermal Working Areas (GWA) that was scattered ever several islands to develop the geothermal resources. The expected result from geothermal total project is to support the government's crash program to address the problem of electricity shortage supply and to meet the rapidly growing electricity demand in Sumatra, Java, and Sulawesi. PGE has installed capacity amount 672 MW by own operation and 1205 MW by Joint Operation Contract.

PLN as the Indonesian Electricity State Owned Company has embarked upon a plan to scale up the expansion of power generation capacity, mostly through the expanded use of geothermal power generation (Indonesian Ministry of Energy and Mineral Resources, 2010) through government's crash program in 10,000 MW Phase II Project. A long time in the making and demanded by investors, a new decree on government (Indonesian Ministry of Energy and Mineral Resources, 2011), guarantees will aid in the building of geothermal power plants as part of the country's ambitious power generation plans, which include a 10,000 MW phase II project. Indonesia was one of country ratified the UNFCCC and to adopt the Kyoto Protocol where the CDM was defined, in order to successfully handle climate change challenges. As part of the CDM project, Indonesia will have a much higher possibility to cut carbon emissions in the global environment.

3.4. PGE Total Project

In Indonesia, especially Sumatra, Sulawesi, and Java, there have been power shortages that have resulted in frequent blackouts. The need for additional energy producing facilities to be constructed and commissioned during the next few years is critical, given current power constraints and projected rise in energy demand. To achieve the government's 10,000 MW Phase II Project's crash program, PGE and PLN have made commitment through Steam Sales Contract (SSC) and Energy Sales Contract (ESC). ESC will cover for "upstream project" while SSC will cover for "total project" which PGE will be conducted as IPP for total project. The total project involves the development of well clusters, Steam field Above Ground System (SAGS)

and a power plant, where all those geothermal project have potential to be CDM project. The following points illustrate necessity further sources of energy on a national and regional level, with the PGE's overall projects aiming to:

Contribute to the nation's energy needs for long-term growth;

Contribute to a broad energy base to meet Sumatra, Java, and Sulawesi's energy needs;

Provide energy that is consistent, dependable, high-efficiency, and renewable;

Generate economic and social benefits on a national and regional scale,

Provide possible job prospects to the local community;

Make a contribution to the local economy, as well as the social and technological infrastructure.

Enhance the diversity of energy resources

Decrease the greenhouse gas emissions in global environment at Indonesia as part of CDM project and gain CERs that will produce additional revenue

The geothermal whole project generates and transmits electricity using geothermal power plant technology. A geothermal power plant with a single flash steam turbine generator, a gas extraction system, a switchyard system, and a utility system are all part of the project. Geothermal generating wells will furnish the facility with steam, where the brine from separator and condensate returning from the turbine will be collected and re-injected back into re-injection wells to maintain (recharge) geothermal reservoir.

3.5. Formation of CDM

Organization (WMO) and the United Nations Environment Program (UNEP) as an effort by the United Nations (UN) to ensure the availability of the governments around the world with a clear scientific view in recognition of the problem of climate according to the global warming. The IPCC assessment report according to scientific evidence unveiled the importance of among nations to address the effects of climate change. As a result, it had a pivotal role in determining to the formation of UNFCCC, the most important international treaty for reducing global warming and dealing with its implications

As a consequence, Japan drafted "The Kyoto Protocol" in 1997 as part of the third conference of the parties (COP) in Kyoto, which officially mandates all Annex I (developed countries) to reduce GHG emissions by 5% on average from 1990 levels between 2008 and 2012 (United Nations, 1998) with three of mechanism to prevent or reduce GHG emission. The original copy is the final result of the Kyoto Protocol, which was presented for signature on March 16, 1998, at UN Headquarters, and was subjected to a post-Kyoto technical examination. [13]

The CDM is built around the concept of "emission reduction." Non-Annex I countries project these reductions, which are subsequently removed from the "baseline" of emissions. The emissions baselines are the emissions that would be expected if a specific CDM project did not exist. GHG emissions reductions are translated into Certified Emissions Reductions (CERs), which are units of emission reductions that have been certified by the Executive Board (EB). These CERs can be utilized by Annex I countries to assist them reach their Kyoto Protocol emission reduction targets. [2] and non-Annex I countries will gain benefit from the CERs.

The CDM has been defined in Article 12 of Kyoto Protocol is the mechanism whereby Annex I states must adhere to their emission reduction targets of GHG up to a certain number per year in 2012 as had been

DOI: 10.37929/nveo

stipulated in the Kyoto Protocol, and to assist the as the non-Annex 1 (developing counties) to implement projects that can reduce or absorb emissions of at least one of six types of GHG as attached in Annex A of Kyoto Protocol.

GHG emission reductions are converted into credit terms in tonnes of CO2 equivalent called Certified Emission Reductions (CERs), which are Executive Board (EB) certified emission reduction units. The following is Project Cycle Activity of CDM:

- Project Design, Project Participants (PP) prepare Project Design Documents in a format developed by the Executive Committee according to CDM modalities and procedures. PP can use the approved emissions baseline and monitoring methodology or propose the new baseline and/or monitoring methodology to EB for review and approval. PDD is a document that contains information about the technical aspects and activities as well as regulation of the project as a basis for national approval and in assisting the host country's long-term development. Other common component in PDD consists of overview of project activities, project crediting duration, justification of baseline methodology, monitoring plan methodology, calculation of GHG emissions reduction (ER), the environmental impact, and comments of stakeholders.
    - National Approval, it is important to receive some information from Designated National Authority (DNA) about the requirements and procedures for obtaining approval, Indonesian DNA known as the National Committee on CDM. The letter of approval from CDM National Committee which indicates that The Kyoto Protocol has been ratified by the host nation, project participation is optional, and a statement indicating the planned CDM project activity benefits to environmental sustainability has been submitted. The letter of approval from CDM National Committee will require some document such as: PDD, statement that the project has met the criteria for sustainable development, Environmental Impact Assessment (EIA), public consultation report and other documents to support justification of project.
    - Validation, upon receiving the approval letter from the CDM National Committee, project participant must choose and contract the The PDD is validated by a Designated Operational Entity (DOE), which is a private third-party certifier. Validation is the process of a DOE assessing a particular project independently according to CDM modes and procedures.

Registration, DOE typically submits a registration request to the CDM Executive Board (EB) for the registering of a planned CDM project activity once determining that the proposed project activity is legitimate and exceeds CDM verification and validation criteria.Registration fee is required as the “share of proceed” (SOP) to cover administrative costs in this stage (CDM Executive Board, 2010). After receiving payment of administrative fees and all complete documents, CDM-EB sets up the validation report and PDD on UNFCCC sites to obtain public comment. The verification, certification, and issuance of CERs relating to the current project require registration.

- Monitoring, participant of the project is capable of tracking the project's actual GHG emission reductions using the specified methodology and preparing the monitoring report as outlined in the PDD. The collection and maintenance of associated data is essential for establishing the baseline, measuring GHG emissions by sources inside the project boundary, and detecting CDM leakage (if any). ACM0002 methodology (CDM Executive Board, 2010) is used for geothermal project monitoring, every three months at the very least, and more frequently if necessary.

> According to ASTM Standard Practice E1675 for sampling 2-phase geothermal fluid for chemical analysis, non combustion gasses must be examined at production wells and at the steaming field-power station interface. This also pertains to testing single phase steam. (CDM Executive Board, 2008).

Verification, is a DOE-mandated independent review that occurs on a regular basis to the reduction by sources of GHG emissions that is generated from the CDM registered projects. At this stage the results of monitoring will be reviewed, including the methodology used in conducting monitoring, and then provides a verification report to the PP, the parties involved and the CDM Executive Board. The report will be made publicly available. The claimed reduction amount of GHG must be contained in the report according to approved monitoring plan. Certification is the legal guarantee by the DOE that CDM projects are concerned during a certain period that the emission reduction has been achieved by the project activity as verified.

CER Issuance, DOE submits verification report upon the request for CERs issuance to CDM Executive Board. Once the CDM Executive Board received the request for issuance of CERs, the CDM Executive Board shall instruct the CDM registry administrator to issue a specified quantity of CERs, the number of CERs after deducting the SOP for adaptation fund then it is placed into the appropriate account in the CDM registry under the supervision of the CDM Executive Board. The SOP for adaptation fund is 2% of CERs issued.

3.6. Emission Reduction of CDM

PGE has great potential to gain the CERs from development of CDM projects. To achieve this, emission reduction calculation will be needed as part of PDD for CDM registration. Potential of Emission reduction will be estimated and evaluated in PGE's total project for first phase of seven years crediting period (2015-2021) approach to each project which may be renewed at most two times [14].

3.6.1. Baseline scenario

The methodology that appropriate with geothermal project is using ACM0002 version 12.1.0 (CDM Executive Board, 2008) which is a UNFCCC-approved technique for large-scale CDM project activity [15], and which is relevant for project construction and maintenance of a renewable-energy power plant supplying power to the grid from a greenfield power plant or capacity addition, retrofit, or replacement of a current power plant.

PGE's construction project is the construction of a new grid-connected renewable power plant per unit, and the fundamental premise is that the power supply delivered to the grid by the latest project would be developed by another grid-connected power plant operation and the influx of new generation sources. The power generated will be delivered to the project:

"Sumatra" interconnected grid from Ulubelu Unit 3&4; Lumut Balai Unit 1&2; and Lumut Balai Unit 3&4.

"Suluttenggo" interconnected grid from Lahendong Unit 5&6.

"Jamali" interconnected grid from Karaha Unit 1; and Kamojang Unit 5.

3.6.2. Baseline emission

ACM0002 version 12.1.0 is the approach that is suitable for geothermal projects. [16] The UNFCCC has authorized this method for large-scale CDM project activities [15]. ACM0002 version 12.1.0 is for the construction and operation of a renewable-energy power plant that will supply electricity to the grid from a greenfield power plant or a capacity increase, retrofit, or replacement of an existing power plant.

DOI: 10.37929/nveo

Current grid-connected power plants and the construction of new grid-connected power plants are assumed to have produced all project electricity beyond basal levels. The following is a formula for calculating the Baseline Emission:

$BE_y = EG_{PJ,y} \times EF_{grid,CM,y}$ (1)

Where:

BEy = Baseline emission in year y (tCO2/year)

EGPJ,y = The amount of net electricity generated and fed into the grid as a result of implementing the CDM project activity in year y (MWh/year).

EFgrid,CM,y = The total margins CO2 emission ratio for grid connected power generation (tCO2/MWh)

The PGE's total project classified as "a Greenfield renewable energy power plants" with reasons that all PGE total project are operated in a different power plant building and are separate distinctly from each other. Each project indicating the separate geothermal field resource and steam supply system thus it does not influence steam supply of existing units. Grid Emission Factor ($EF_{grid,CM,y}$) will use the "ex-ante" data from Indonesian DNA [17] with information as follow:

Emission Factor of "Sumatra" interconnected grid = 0.743 tCO2e/MWh.

Emission Factor of "Suluttenggo" interconnected grid = 0.161 tCO2e/MWh.

Emission Factor of "Jamali" interconnected grid = 0.891 tCO2e/MWh.

3.6.3. Project emission

Most renewable energy generation project activities have PEy=0, but some projects such as geothermal power plants may involve some project emissions. The project emits CO2 and CH4 due to the release of NCG carried by the reservoir fluid (PEGP,y) produced by the geothermal power plant. For geothermal projects, CO2 emissions from fossil fuel combustion should be included in project emissions (PEFF,y). PEFF,y shall be calculated in accordance with Version 02 of the Tool for Calculating Emissions of Fossil Fuel Combustion Projects or Leakage CO2 (CDM Executive Board, 2008). These emissions shall be accounted for as project emission by using the following equation:

$PE_y = PE_{FF,y} + PE_{GP,y}$ (2)

Where:

PEy = Project emission in year y (tCO2e/year)

PEFF,y = Project emission from fossil fuel consumption in year y (tCO2/year)

PEGP,y = Project emission from the operation of geothermal power plants due to the release of non-condensable gases in year y (tCO2e/year)

$PE_{FF,y} = PE_{FCj,y}$ (3)

$PE_{FCJ,y} = \sum FC_{i,j,y} \times COEF_{i,y}$ (4)

$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,y}$ (5)

PEGP,y = (Wsteam,CO2,y + Wsteam,CH4y × GWPCH4)

DOI: 10.37929/nveo

× Msteam,y (6)

Where:

PEFF,y = is the CO_2 emission in the process of burning fossil fuels *j* during the *y* year (tCO_2e/year)

ECi,y = is the type of fuel quantity *i* combusted in manufacturing process *j* throughout the year *y* (mass or volume unit/year) will use the mass of diesel oil (m = ⍰⍰× v)

i = is the type of fuel combusted in process *j* during the year *y*

NCVi,y = is the weighted average mass percentage of carbon in the type of fuel i in year y (GJ/mass or volume unit)

EFCO2,y = is the weighted average CO2 emission type of fuel factor i in year y (tCO2/GJ)

PEGP,y = Emissions from geothermal power plant operations due to the discharge of non-condensable gases in year y are projected (tCO2e/year)

Wsteam,CO2,y = Average mass fraction of carbon dioxide in the produced steam in year y (tCO2e/t steam)

Wsteam,CH4y = Average mass fraction of methane in the produced steam in year y (tCH4/t steam)

GWPCH4 = .Global .warming potential of methane valid for the relevant commitment period . (tCO2e/tCH4)

Msteam,y = .Quantity of steam produced in year y .(t steam/year)

The project emissions of fossil fuel combustion associated to the functioning of the geothermal power plant is analogous to the use of a diesel generator for backup or emergency purposes. The data required to the equation will be adopted from official data resource and monitoring data of Kamojang Unit 4 which is the existing of PGE geothermal power plant project. The data included as :

- Volume of diesel oil = 6,525 l/year, data from average of Kamojang Unit 4 diesel oil consumption in 2008-2010.
- $M_{steam,y}$ = 6.84 t_{steam}/MWh, data from average of Kamojang Unit 4 power plant steam consumption in 2008-2010.
- $W_{steam,CO2,y}$ = 0.008745 tCO_2e/t steam, data from NCG sampling of Kamojang Unit 4 using ASTM Standard Practice E1675.
- $W_{steam,CH4y}$ = 0.00000345 tCH_4/t steam data from NCG sampling of Kamojang Unit 4 using ASTM Standard Practice E1675.
- Density of diesel oil = 0.843 kg/l, data from density of diesel oil of Pertamina.
- $NCV_{i,y}$ = 0.043 GJ/kg (Garg et al, 2006).
- $EF_{CO2,y}$ = 0.074 tCO_2/GJ (Gomes et al, 2006).
- GWP_{CH4} = 21 tCO_2e/tCH_4 (CDM Executive Board, 2010).

3.6.4. Leakage

No leakage emissions are considered in ACM0002 version 12.1.0 [16] for geothermal power plant project. Emissions resulting from operations such as power plant building and upstream emissions from fossil fuel

DOI: 10.37929/nveo

consumption are the most likely sources of leakage in the context of electric sector projects (e.g. extraction, processing, transport). These are all the sources of emissions that are ignored.

3.6.5. Emission reduction

PGE has already been constructing geothermal energy projects for power generation, and since geothermal energy could be designated as a CDM project, PGE stands to gain a lot of CERs from CDM project development. Emission reduction (ER) calculations will be required as part of the project design document for CDM registration in order to accomplish this. Potential of ER for first year will be estimated and evaluated in PGE total project. PGE as project participant should prepare an estimated emission reduction as part of the Project Design Document for the proposed crediting period. The emission reductions are calculated as follow:

$ER_y = BE_y – PE_y$ (7)

Where

ERy = .Emission reduction in year y (tCO2e/year)

BEy = .Baseline emission in year y (tCO2e/year)

PEy = .Project emission in year y (tCO2e/year)

The CDM Executive Board will issue the quantity of CERs after deducting the SOP for adaptation fund as 2% of emission reduction from project activity (UNFCCC, 2001). The SOP of adaptation fund ($SOP_{Adap\ Fund}$) and CERs issuance are calculated as follows:

SOPAdap Fund = ERy × 2% (8)

CERs = ERy – SOPAdap Fund (9)

In table 1 shows the result of the summary of CERs calculation for 1 (one) year period whereby the calculations have been made by using spreadsheet. With the average of annual estimated electricity generation of 565,020 MWh/year is equivalent to CERs of 359,447 tCO2e/year that will reduce the GHG and contribute to CDM project**.** Beside the SOP for adaptation fund and registration fee, project participant has to spend some cost related the operational activities in order to fulfill the requirement, i.e., project due diligence, PDD preparation, stakeholder consultation, etc., whereby the amount of the cost will be different for each project.

Table 3: Estimated of CERs potential in PGE total projects

DOI: 10.37929/nveo

Geothermal Project	Electricity Generation	Estimated				
		Baseline Emission	Project Emission	Emission Reduction	SOP Adaptation Fund	CERs
	(MWh/year)	(tCO_2e/year)	(tCO_2e/year)	(tCO_2e/year)	(tCO_2e/year)	(tCO_2e/year)
Ulubelu Unit 3&4	867,240.00	644,359.32	52,338.41	592,020.91	11,840.42	580,180.50
Lahendong Unit 5&6	315,360.00	50,772.96	19,043.29	31,729.67	634.59	31,095.08
Lumut Balai Unit 1&2	867,240.00	644,359.32	52,338.41	592,020.91	11,840.42	580,180.50
Lumut Balai Unit 3&4	867,240.00	644,359.32	52,338.41	592,020.91	11,840.42	580,180.50
Karaha Unit 1	236,520.00	210,739.32	14,286.84	196,452.48	3,929.05	192,523.43
Kamojang Unit 5	236,520.00	210,739.32	14,286.84	196,452.48	3,929.05	192,523.43
Total	**3,390,120.00**	**2,405,329.56**	**204,632.18**	**2,200,697.38**	**44,013.95**	**2,156,683.43**
AVG	**565,020.00**	**400,888.26**	**34,105.36**	**366,782.90**	**7,335.66**	**359,447.24**

Source: Courtesy PGE

3.7. Indonesia NDC Target

The Paris Agreement obligated participating countries the responsibility to develop Nationally Determined Contribution (NDC), namely specific emission reduction plans, which can be calculated in a clear timeframe and nationally. In the Paris Agreement article 4 to achieve the long-term goal of global temperatures, namely an increase below 2 ℃ and towards 1.5 ℃, global emissions must experience a significant reduction so that there must be a net zero emission, i.e., rising emissions must be balanced with technology that can absorb emission. IPCC states that to achieve Net Zero Emission (NZE), emissions from fossil fuels in 2040-2070 must decrease and become zero. Indonesia's NDC target in terms of energy is 314 million tCO2 (the target of reducing from New and Renewable Energy is 183 million tCO but the realization is only 64.4 million tCO) in 2020 [18].

Since every project has a potential up to 15 MW [15] and geothermal is a renewable energy source with lower GHG emissions than fossil fuels, PGE's geothermal projects can be defined as major CDM project tasks because Indonesia has approved the Kyoto Protocol and is not an Annex 1 country.

The government still has to work towards achieving the NZE as seen in the Long-Term Strategy for Carbon Emission Reduction and Climate Resilience 2050 designed by the Ministry of Environment and Forestry, which targets net zero emissions by 2070. Analysis results from the Institute for Essential Services Reform (IESR), Indonesia is able to achieve NZE before 2050, by reducing greenhouse gas (GHG) emissions in the power generation, transportation and industry sectors which can contribute to a total of 406.8 million tons of CO2e or around 93% of the total GHG emissions of the energy sector in 2015. According to Director General of Climate Change Nur Masripatin said that geothermal in the context of Indonesia's NDC or Indonesia's overall commitment through the energy sector is targeted at 11% of the 29% of the promised target, or 14% of the total 38% with international support.

NDC will provide a starting point for Indonesia to increase its efforts to improve people's welfare, such as forest protection, environmental protection, developing new and renewable energy applications, increasing sustainable transportation, low-emission agriculture and food security, environmentally friendly industries, environmentally friendly buildings, and interconnected waste management. This can open up opportunities, among others, to build coherent action at the national level by all components of society, research development, mobilization of resources through international partnerships and cooperation as well as other opportunities related to national development. NDC is also strongly influenced by new and renewable energy, as discussed in this journal, geothermal is one of the new renewable energies that aims to reduce carbon emissions. The development of new and renewable energy for the next few years has a huge impact on the condition of the earth, both in terms of climate change. As for Indonesia's energy policy, the 2017 National Energy General Plan[1] [3] has been prepared. RUEN stated that in preparing its national energy

DOI: 10.37929/nveo

plan, it had considered Indonesia's commitments contained in the Nationally Determined Contribution (NDC). However, Indonesia's commitment is not a priority in the drafting of the RUEN, but a National Energy Policy established through Government Regulation No. 79 of 2014 which prioritizes the fulfillment of national energy with an energy policy direction that does not include mitigating greenhouse gas emissions from the energy sector. , as well as efforts to reduce these emissions. Defined Nationally (NDC) with a national energy policy. In the National Energy General Plan, the government has begun to set a new final energy target that increases the use of new and renewable energy (EBT), although in practice the government is still unclear in setting policies on renewable energy[19].

3.8. Net Zero Emission

As reported in Carbon Neutral 2050 by Ministry Energy and Mineral Resource 2021, Massive warming of the earth that occurs throughout the world in a span of time length has put life on Earth at risk. The heating makes an increase sea level, causing the sinking of thousands of hectares of coastal lowlands beaches around the world. The lives of millions of citizens living in dozens of countries are in danger.

The warming is triggered by the formation of Greenhouse Gases resulting from carbon emissions resulting from human activities in various sectors. Therefore, the nations agreed to develop a strategy together in an effort to prevent a faster rise in the earth's temperature and halt extreme sea level rise. The agreement is contained in The Conference of Parties (CoP) which later resulted in the Paris Agreement

or the Paris Agreement.

The Indonesian government in collaboration with international forum members through the Conference Parties to the 21st. United. Nations Framework Convention on Climate Change United Nations on Climate change) on 12 December 2015 in Paris, France has ratified the Paris Agreement to the United Nations Framework Convention on Climate Change . (Paris Agreement on the United Nations Framework Convention on Climate Change) which was followed up with the signing of the said agreement on April 22, 2016. in New York, United States.

According to IEA Report 2021 about Net Zero Emission 2050, The power sector accounted for roughly .three-quarters of today's greenhouse gas emissions, and it specifically refers to preventing the worst impact of climate change, which is arguably humankind's most pressing issue. Efforts to maintain world average temperature under 1.5 degrees Celsius over the big scheme of things are coherent with diminishing carbon dioxide (CO2) emissions to 0 by 2050. This necessitates a fundamental paradigm shift in .how we .produce, move, and consume energy. The emerging political consensus on net zero emissions provides cause for optimism about long - term vision, but the changes required to reach net zero emissions globally by 2050 are incompletely known. To turn today's remarkable objectives into reality, a tremendous lot of work is required, particularly given the wide variation of situations among countries and their varying capacity to implement the required reforms. .This special IEA section details a way to achieving this objective, which will lead in a cleaner and sustainable energy system that will considerably increase human prosperity and well-being.

Until now, commitments have fallen far short of what that road requires. Over the previous year, the number of countries proposing to attain net-zero emissions has increased dramatically, currently accounting for almost 70% of global CO2 emissions. This is a significant advancement. Most pledges, however, have yet to be backed up with policies and measures that will be implemented in the near future. Furthermore, even if all pledges are met, global CO2 emissions in 2050 will be roughly 22 billion tonnes. If this pattern continues, 2100 will see a temperature rise of roughly 2.1 degrees Celsius. Because of the Covid19 crisis, global

DOI: 10.37929/nveo

emissions decreased in 2020, but are currently increasing quickly as economies recover. If we don't act now to reverse this trend, we won't be able to achieve net zero by 2050.

A crucial element of the these initiatives is a big foreign attempt to improve energy efficiency, with annual electricity efficiency improvements reaching 4% by 2030, approximately three times the overall rate over the previous two decades. The energy sector's reducing emissions aren't limited to CO2: a global, a massive effort to implement all obtainable mitigation strategies and technology reduces methane emissions from fossil fuel supply by 75% over the next ten years, according to our forecast.

Without citizen support and engagement, a shift of the magnitude and speed outlined by the net zero pathway will be impossible to realize. The changes will have an impact on many elements of people's lives, including transportation, heating, and cooking, as well as urban planning and employment. We estimate that consumer decisions like buying an electric vehicle, renovating a home with energy efficient technologies, or installing a heat pump are responsible for roughly 55% of the pathway's total emissions reductions. Changes in behavior, especially in developed economies, such as replacing car trips with walking, cycling, or public transportation, or foregoing a long-haul flight, account for about 4% of total emissions reductions.

Energy demand on a global scale in 2050 will be roughly 8% lower than it is today, but it will serve an economy more than twice as large and a population of 2 billion more people if the net zero road is followed. As the world economy grows and access to energy is given to all, more efficient energy use, resource efficiency, and behavioral changes combine to offset rising demand for energy services.

The NetZero Emissions by 2050 Scenario (NZE). . entails an unprecedented global energy system transition in terms of speed and breadth. Where energy needs cannot be fulfilled simply or affordably by electricity, achieving net zero emissions will need the use of low-emissions fuels. This is probable to result for long-distance transportation (trucks, planes, and shipping) and also the transfer of heat and feedstock in industrialization. Some low-emission fuels are effectively decline, implying they work with existing fossil fuel distribution network and end-use technologies with little to no device or vehicle modifications.

Renewable energy technologies are critical for lowering emissions from electricity generation on a worldwide scale. For decades, Hydropower has long been a major source of low-emission energy, However, wind and solar development will triple renewables power in the NZE by 2030 and more than eightfold by 2050. Renewable energy's share of total electricity generation rises from 29% in 2020 to over 60% in 2030 and over 90% in 2050. To do this, yearly wind and solar capacity additions between 2020 and 2050 will be five times larger than the average over the previous three years. Dispatchable renewables, together with other low-carbon sources, energy storage, and reliable power networks, are essential for ensuring energy security. In the NZE, the main dispatchable renewables globally in 2050 are hydropower (12% of generation), bioenergy (5%), concentrating solar power (2%) and geothermal (1%).

.Dispatchable power is critical for the safe transition of energy systems, and it is increasingly coming from low-emissions sources in the NZE. Today, hydropower plays an important role in many electrical systems, and this will continue in the future, with a focus on increasing hydropower plants. Although designed for baseload generation, nuclear power and geothermal facilities allow some flexibility in the NZE, but there are limits to how much these supplies may be developed. Thermal power facilities that are equipped with carbon capture or employ low-emission fuels will continue to play an important role. The use of sustainable biomass or low-emissions ammonia in existing coal plants, for example, allows these facilities to continue to contribute to flexibility and capacity adequacy while lowering CO2 emissions. Additional steps will be required to keep the electricity grid stable.

DOI: 10.37929/nveo

.Low-emissions fuels today account for only 1% of global final energy consumption, but the NZE predicts that by 2050, that percentage will have risen to 20%. .By 2050, .liquid biofuels will account for 14% of global transportation energy demand, up from 4% in 2020; hydrogen-based fuels will account for another 28%. Low-carbon gases (biomethane, synthetic methane, and hydrogen) will fulfill 35% of global gas consumption in 2050, up from nearly zero now.

Renewable energy has essentially replaced fossil fuels in the energy sector. Wind, solar, bioenergy, geothermal, and hydro energy will account for two-thirds of total energy supply in 2050. Net zero implies a significant reduction in the use of fossil fuels. By 2050, They will have dropped from nearly four-fifths of total energy supply to just one-fifth. Fossil fuels that are still used in 2050 are used in items that have carbon embodied in them.

In 2050, electricity will account for over half of all energy usage. It is crucial for the production of low-emission fuels and plays a key role in all industries – from transportation and buildings to industry. Between now and 2050, total electricity generation must expand by more than two-and-a-half times. Simultaneously, There must be no final investment choices for new unregulated coal plants, coal plants with the lowest efficiency should be phased out by 2030, and the remaining coal plants still in service by 2040 should be upgraded.

The macroeconomic impacts of various locations fluctuate significantly. Government investment and policy, on the other hand, are critical for attracting huge quantities of private capital and helping to offset the decreases in fossil fuel income that many countries will face. The massive efforts to invent required to bring new clean energy technologies to market could enhance productivity and establish totally new businesses, allowing them to be located in places where incumbent industries are losing jobs. Air quality improvements deliver significant health benefits, with 2 million fewer early deaths from air pollution in 2030 than today if we follow our net zero pathway. In emerging economies, obtaining universal resource efficiency by 2030 would bring a significant increase to well-being and productivity.

Indonesia is a part of and fully involved in the Conference of the Parties and declares its commitment to reduce greenhouse gas (GHG) emissions which are a real threat to the Earth the one. As a co-signator of the Paris Agreement, Indonesia followed up with stipulate Law Number 16 of 2016 concerning Ratification of the Paris Agreement to the United Nations Framework Convention on Climate Change

United Nations on Climate change). The Government of Indonesia through the Ministry of Environment and Forestry (KLHK) projects Carbon Neutral in 2070, which is marked by a significant reduction in the amount of carbon resulting from various kinds of human activities in various sectors such as forestry, agriculture, waste, industrial processes and energy – including transportation in them.

Electrical energy is one of the most important sectors that gets attention considering that contribution in the formation of Greenhouse Gases. The government is committed to reducing emissions Greenhouse Gases by 29% of the projected emissions of business scenarios that are run normally (business as usual) by 2030. The development of New and Renewable Energy (EBT) is an important priority, so that an increase in the NRE mix in the national electricity supply by 23% in 2025. EBT power plants are projected to accumulate to reach 10 Giga Watt (GW) in 2025, increase again to 15 GW by 2029.

In addition to encouraging the use of NRE in the supply of electricity, efforts are also made to transfer materials fuel switching and exhaust gas utilization as much as possible. Diversion of resources primary energy generation from fuel to gas at PLTG, PLTGU, and PLTMG followed by mixing

DOI: 10.37929/nveo

biofuel or biodiesel energy in PLTD plants. Diversion of generator fuel This is also done to achieve the target of reducing fossil coal energy by a maximum of 55% in 2025.

The supply of electricity until 2029 will continue to be influenced by generators fossil fuels, especially coal. However, efforts to reduce plant operations significant amount of coal has been determined, including the use of coal based methane (CBM) if the economy has met and is able to compete with conventional fossil fuels. Besides that, the use of innovative technologies such as the Integrated Gasification Combined Cycle (IGCC) and Carbon Capture Utilization and Storage (CCUS) to significantly reduce GHG emissions, is also included as part of the Government's commitments and targets to reduce GHG emissions during the transition from fossil-based energy to clean energy.

In addition, in the transition process the Government is also committed to using more fuel biomass-based to be used together (Co-Firing) with coal in several PLTU existing and PLT that have been planned or contracted to be built to meet needs national electrical energy up to 2030.

New Energy is a source of energy that comes from energy sources as a result of the invention or human innovation that has never been used before, whether from energy sources renewable and non-renewable energy sources, including nuclear, hydrogen, coal methane bed methane), liquefied coal and gas filed coal. Besides that, NRE sources that can be used as electrical energy include biomass, biofuels, biogas and marine energy, OTEC (ocean thermal energy conversion), bio CNG, and fuel cell. NRE development in the transition period up to the next 10 years is carried out intensively by while maintaining a balance of supply and demand.

Strategic initiatives are also needed in order to ensure adequate supply and increase the energy mix from New and Renewable Energy (EBT) generators in the future with the price of electrical energy from EBT generators that are increasingly optimal. Strategic initiatives to increase the mix and use of NRE as a power plant supply electricity is carried out, among others by: constructing NRE power plants while keeping supply and demand in check, availability of the electric power system and economy; resource utilization renewable energy, both from the type of energy flow and waterfall, geothermal energy (including small scale/ modular), biofuels, wind energy, solar energy, biomass, waste and others.

The development of NRE continues to take into account the reality of energy needs, reasonable economics, common goal in the future is to provide clean energy for future generations future. For this reason, a road map and planning are needed which are calculated based on projections national electricity production.

To get to Carbon Neutral, it is necessary to have a green strategy in the electricity sector during the prepared transition period using three scenarios, namely Optimistic, Moderate, and Pessimistic scenarios. Each scenario has the consequence of cost impact from the completion of the power plant contract originating from non-NRE.

The selected scenario should match the macroeconomic framework, subsidy policy, capacity countries, and practices of other countries. Meanwhile, the speed of absorbing technology that supports the ease of implementation of NRE will be have an influence on the success of developing clean energy based on EBT in Indonesia.

For this reason, strategic policies need to be formulated and directed to form a development ecosystem and the widest use of NRE so that the development of EBT runs effectively until an ecosystem is formed to accelerate NRE growth and overcome various obstacles.

DOI: 10.37929/nveo

Introducing innovative energy-related technology to market can take decades, but the goal of reaching net zero emissions globally by 2050 requires considerably faster progress. Government involvement has been proved to be critical in reducing the time it takes to bring new technology to market and disseminate it widely. The government's duty also includes citizen education, funding research and development, providing knowledge exchange networks, protecting intellectual property, boosting deployment through public procurement, assisting businesses in innovation, investing in enabling infrastructure, and establishing regulatory frameworks for markets and finance.

4.Conclusion

The most expected achievement of NDC targets is from geothermal energy as registered in the United Nations Framework Convention on Climate Change (UNFCCC). Meanwhile, referring to the UNFCCC website (2020) regarding the Kyoto Protocol Compliance Mechanism, it is stated that if a country has an emission reduction target that exceeds the target amount, the consequence is that the country is declared non-compliant and obliged to make a difference between its emissions and the amount that is targeted. During the second term of committment, as well as an additional 30% for the resulting emission reductions (meaning the country has a tighter target).

Geothermal energy contributes to reducing GHG emissions and even Indonesia itself has taken advantage of the carbon market opportunities that exist in the world under the auspices of the UNFCC from GHG reduction by Geothermal Power Plant in the Clean Development Mechanism (CDM) mechanism. Achieving the goal of reducing carbon dioxide emissions by utilizing new renewable energy natural resources has an impact on national security and resilience. National resilience prioritizes the realization of individual/human resilience on the grounds that resilience on a national scale can only be realized if all individuals have strong resilience.

Annually estimated of CERs Potential in PGE Geothermal CDM with current existing geothermal project is around 2,156,683.43 tCO2e/year and it has potential solution to achieve the NDC of Indonesia. In line with achieving target emission reduction total 314 million tCO2 in 2030 or 183 million tCO2 targeted from New and Renewable Energy (NRE) sector, PGE’s CDM able to reduce emission from 2021 until 2030 (10 years) approximately 21,566,834.3 tCO2e and this amount about 6,87% of total target NDC Indonesia in 2030 or 11,78% of NRE sector. Regarding Indonesia's NDC or Indonesia's overall commitment through the energy sector is targeted at 11% of the 29% of the promised target, the percentage 11,78% contributing to meet of energy sector emission reduction that targeted at 11%. In addition, if development geothermal power plant which environmentally friendly become massive strategy to supply energy, it also supports the clean energy that contribute to the emission reduction and prevent from climate change.

Therefore, maintaining collective awareness of the urgency of climate change mitigation and meeting NDC targets must remain one of the top agendas, for both government, state-owned enterprises, private sector entities and the international community. Geothermal energy development is one of alternative solution to achieve NDC by reducing emission reduction as substation of fossil energy. In addition, if development geothermal power plant which environmentally friendly become massive strategy to supply energy, it also supports the clean energy that contribute to the emission reduction and prevent from climate change.

The Paris Agreement is an international treaty on climate change that aims to keep the global average temperature rise below 2°C above pre-industrial levels and continue efforts to suppress temperature rises to 1.5°C above pre-industrial levels. . In addition, the Paris Agreement is directed at increasing the ability to adapt to climate change's negative consequences, climate resilience, and low-emissions growth without threatening food production, and preparing funding schemes for low-emissions and climate-resilient

development. At the national level, participation in the Paris Agreement will inspire individuals to adjust their lifestyles to become more ecologically friendly and to develop life patterns that are adaptable to climate change consequences. Meanwhile, at the global level, international cooperation within the Paris Agreement could improve global climate change management efficacy. The Paris Agreement will be successful (entry into force) if at least 55 (fifty five) countries that represent at least 55% of the total global Greenhouse Gas (GHG) emissions have delivered their ratification document to the Secretariat General of the United Nations (UN). Indonesia as a country that has vulnerability to the adverse impacts of climate change is very interested in pushing for the implementation of the Paris Agreement.

The commitment of Indonesia in this regard was indicated by the signing of the Paris Agreement on April 22, 2016 in New York, United States of America, which also declared its desire to ratify the agreement. The current ratification status gives reason for optimism for the Paris Agreement's prompt entrance into force, since 26 (twenty-six) nations have ratified the agreement, accounting for 39.06 percent of global greenhouse gas (GHG) emissions as of September 4, 2016. For the evidence, according to data from the United Nations Framework Convention on Climate Change (UNFCCC), the amount of Indonesia's GHG emissions is 0.554 Gt CO2eq equivalent to 1.49% of total global emissions. Indonesia is a country that has natural resources, especially forests with a large enough area, therefore it has an important role to absorb carbon. Indonesia is also an archipelagic country that has a high level of climate vulnerability so that it is highly affected by climate change. Thus, in addition to having great potential for Indonesia to be negatively affected by climate change, it also has great potential to contribute to mitigating adaptation to the negative impacts of climate change. Recognizing this position, Indonesia has been actively involved in negotiations both at regional and international levels related to climate change, one of which is in the UNFCCC which has been ratified by Indonesia through Law Number 6 of 1994 concerning Ratification of the United Nations Framework Convention on Climate Change. (United Nations Framework Convention on Climate Change). Indonesia's active involvement in negotiations under the UNFCCC has proven to provide good implications and advantages for Indonesia's interests and position at the international level, for instance, Indonesia participates actively in UNFCCC negotiations and contributes to the direction of decisions on the Reducing Emissions from Deforestation and Degradation (REDD+) initiative.

REFERENCES

Garg, A., K. Kazunari and T. Pulles. (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories Chapter 1 Introduction.

United Nations. (1998). Kyoto Protocol to United Nations Framework Convention on Climate Change.

P. N. 22 RUEN, “Presidential Regulation Number 22 of 2017 on the General Planning for National Energy (RUEN).” 2017.

Dipippo, R. (2008). Geothermal Power Plant-Principles, Applications, Case Studies, and Environmental Effect

L. J. Moleong, “Metodologi Penelitian Kualitatif,” Bandung: Remaja Rosdakarya, 2005.

Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta, 2018.

British Petroleum. (2011). BP Statistical Review of World Energy.

International Energy Agency. (2011). CO2 Emission from Fuel Combustion Highlights.

Intergovernmental Panel On Climate Change. (2004). 16 Years of Scientific Assessment in Support of the Climate Convention.

K. Pertahanan, “Buku Putih Pertahanan Indonesia,” *Jakarta Kementeri. Pertahanan Republik Indones.*, 2015.

Thain, I. (2009). Review of Carbon Emission Factors in Draft Stationary Engine and Industrial Process Regulations: Using Geothermal Fluid.

Lund, J. W., D.H. Freeston, and T.L. BOYD. (2010). Direct Utilization of Geothermal Energy 2010 Worldwide review.

Depledge, J. (2000). Tracing The Origins of The Kyoto Protocol An Article By Article Textual History.

United Nations Framework Convention On Climate Change. (2001). Report of the Conference of the Parties on its Seventh Session.

United Nations Framework Convention On Climate Change. (2010). CDM Methodology Booklet.

CDM Executive Board. (2008). Methodological Tool, Tool to Calculate Project or Leakage CO2 Emission from Fossil Fuel Combustion Version 02.

Ministry of Energy and Mineral Resources. (2021). Carbon Neutral 2020.

Kusdiana Dadan. (2021). CCUS And Hydrogen For Indonesia Towards Net Zero Emission. Ministry of Energy and Mineral Resources. Jakarta.

P. 79 K. Energi, “PP Nomor 79 2014.pdf.” 2014.