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11TH ITB INTERNATIONAL GEOTHERMAL WORKSHOP 2022

"Geothermal Competitiveness in Supporting Net-Zero Emission: From Technical to Business Model"

PROCEEDING BOOK

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Novianto	General Manager of PT. Medco Cahaya Geothermal	Company Update from PT. Medco Cahaya Geothermal
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PREFACE

ITB International Geothermal Workshop 2022 was an event organized by ITB Geothermal Master Program which was held on August 2 – 4, 2022 on an online basis through a live virtual workshop (Webinar) via Zoom and YouTube. Followed by over 2200 participants from many different aspects of the geothermal community, such as academia, industries, and government. This year's theme is "**Geothermal Competitiveness in Supporting Net-Zero Emission: From Technical to Business Model**", which focuses more on the Prospecting and Utilization of Geothermal Energy and collaborating Indonesia Geothermal Stakeholders by inviting speakers from various aspects in geothermal energy.

The 11th ITB International Geothermal Workshop is expected to become a melting pot for sharing knowledge, experiences and solving technical and non-technical geothermal issues in Indonesia. For this year's event, the focus of discussions would be the development and innovation of technology for the exploration, exploitation, and utilization of geothermal resources, socio-economics, green investment, and competitive business models.

ITB International Geothermal Workshop 2022 has several objectives:

1. To improve community understanding of geothermal energy from exploration, exploitation, environmental, and regulation aspects.
2. Discuss the latest condition of geothermal energy in Indonesia.
3. To draw attention from scientists, engineers, academicians, industrial stakeholders, and also geothermal leaders about the initiatives, strategies, opportunities, and challenges toward geothermal development in Indonesia.

Participant's benefit is exchanges of view, knowledges and experiences on latest technologies and researches by bringing together scientists, engineers, academicians, experts, and industrial stakeholders involved in geothermal and other renewable energy studies and developments.

As part of this year commitment, selected papers are published as open access volume of IOP Conference Series: Earth and Environmental Science. Other papers are published in the conference proceeding in print version. We hope wider geothermal communities will gain the same benefits as our conference attendees.

We would like to thank all the supports that have been given by LPPM ITB, Geothermal Technology Magister Program Staff, and all chairpersons, authors, presenters, paper reviewers and all Webinar sponsors for assistance and cooperation in support of this event.

Sincerely

Dr. Eng. Suryantini, S.T., Dipl. Geothermal En. Tech., M.Sc.
Chairperson of the 11th ITB International Geothermal Workshop (IIGW) 2022

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WORKSHOP DETAILS

The 11th ITB International Geothermal Workshop 2022 were conducted at times when Indonesia is still in Covid-19 pandemic restriction. As such, many people are still working from home using internet, although some of restrictions were started to be released incrementally.

The conference was organized into 3 days. The first day of the virtual workshop had an opening session scheduled for a set period of time at the beginning of the program. The author's paper presentations were presented on our YouTube channel “Geothermal ITB”. The presenter makes a video recording of the presentation and it will be shown on YouTube channel. The presentation was delivered in the form of a video with 15 minutes duration.

Technical team enabled all participants and presenters’ videos and recorded sponsors videos display. Organizers and hosts had opportunity to address their attendees in case of any circumstances or planned schedule. The event run for approximately 3 hours each day. We used video for a few minutes at the beginning of our sessions just to introduce the speakers and then we turned it off once the speaker moved into the actual presentation (recorded video) followed by live questions and answers. The time given for each presenter/invited speaker are approximately 25 minutes including questions and answers.

The discussions sessions were given at the end of the authors/keynote speakers presentations/sessions. The sessions include a broad range of content, from keynotes to panel discussions, questions were directly written on chat or Q&A boxes. Authors interacted with audiences in the last minutes (about 5 minutes) to respond to the questions.

The participants in the IIGW 2022 virtual workshop are from Indonesia and abroad. Other participants attended this workshop apart from Indonesia are New Zealand, United States, Japan, Tanzania, Australia, and United Kingdom. The overall participant who joined the webinar are 300-500 (870 on the first/opening day) people via online/internet infrastructure.

Academic delegates are from Institut Teknologi Bandung, Universitas Trisakti, Universitas Negeri Manado, Universitas Padjadjaran, Universitas Pembangunan Nasional “Veteran” Yogyakarta, Universitas Diponegoro, Institut Teknologi Sepuluh November, University of Chicago, Bochum University of Applied Sciences, Kyushu University, Universitas Lampung, Auckland University, Universitas Gadjah Mada, Universitas Sriwijaya, Universitas Indonesia, and Universitas Pertamina. The industry delegates are PT Pertamina Geothermal Energy, PT Supreme Energy, PT Geo Dipa Energi (Persero), Star Energy Geothermal, PT PLN (Persero), PT Sumbawa Timur Mining, PT LAPI ITB, PT Medco Cahaya Geothermal, Rigsis Energi Indonesia, PT Thermochem, PT Wellbore Integrity, Sarulla Geothermal Ltd, PT Anugrah Indonesia Lima (AILIMA), dan PT Bank Negara Indonesia (Persero), Tbk. Government representative is from the Ministry of Energy and Mineral Resources of Indonesia and the Geological Agency of Indonesia.

The following technologies were used to deliver the conference

- Webinar platforms: this platform was used because it allows virtual event attendees to interact with each other. The internet platform used for interactive session in this event is Zoom. The number of attendances on this platform are: 500 (day 1), 400 (day 2), and 300 (day 3)
- Live-streaming platform: live-stream videos were used by attendees on a live-streaming app to view the keynote speeches, event sessions and presentations. IIGW Virtual workshop 2022 used YouTube Live as internet streaming platform. The number of views on this platform are: 870 (day 1), 320 (day 2), and 500 (day 3)

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We used Zoom as our Webinar platform for delivering live sessions. One of the many reasons we selected Zoom is that, unlike other tools it allows and enable chat feature in addition to a Q&A feature during Webinars. Participants are increasingly comfortable using chat as a tool and we had some good exchanges during the sessions at our events. However, we also had some minor cases on technical session due to signal/network lost. On reducing these problems, we made sure we were prepared to ask relevant, provocative questions during sessions.

We used video for a few minutes at the beginning of all our sessions to introduce sponsors. Then we introduced the speakers and their topics. After that the speaker were given time for presentation. We experienced overall good quality of virtual presentation and conference. Internet bandwidth and infrastructures were mature enough in 2022 for event of this type of interaction, i.e., video presentations and followed by questions and answers session.

Location of organizers:
Geothermal Engineering Master Program,
Gedung Energi, Lt. 2
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11th ITB Geothermal Workshop 2022 Website:
https://geothermal.itb.ac.id/workshop2022/

IIGW 2022 Tele-Conference Events recording including paper presentation on YouTube Playlist:
https://bit.ly/YouTubePlaylistIIGW2022

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WORKSHOP EVENTS

ITB International Geothermal Workshop 2022 was an event organized by ITB Geothermal master's degree program as a contribution to the geothermal development all around the world especially Indonesia. This event held many activities such as pre-workshop courses, technical papers, field trip and field camp, plenary sessions, and post-workshop courses from June 13th – September 13th, 2022.

Pre-workshop courses consist of Geothermal Economic Project and Geothermal Drilling Courses. Followed by Fieldtrip to PT Geo Dipa Energi Patuha and Fieldcamp to Tangkuban Parahu. The virtual workshop consisted of plenary sessions by distinguished speakers with various expertise in the geothermal field.

Post-workshop courses consisted of 4 courses with different topics including geothermal geochemistry, Leapfrog training, Artificial intelligence application in geothermal well management, and business and regulation in geothermal.

Conference papers were presented on the YouTube channel "Geotermal ITB". The total full papers submitted this year were 32 papers, and were selected for presentation. The presenter makes a video recording of the presentation and it will be shown on YouTube channel. The presentation was delivered in the form of a video with a duration of 15 minutes. There were 26 videos submitted for oral presentation on YouTube Channel.

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THE THERMAL MANIFESTATION MONITORING PROGRAM AT MUARA LABUH CASE STUDIES

Mauliate Sihotang[1], Herwin Azis[1], Novi Ganefianto[1], Ghilman Azka[1], Nurul Aulia[1], Indra A. Nugroho[1], Suryantini[2], and Hendro Wibowo[2]

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The thermal manifestations at the Muara Labuh field are monitored regularly to see their behaviors in response to the field production. The monitoring results are then used to identify and mitigate any potential hazards associated with the thermal area changes. This paper presents the monitoring results on the main thermal features Idung Mancung (IM) fumaroles complex, located in the vicinity of the steam cap production zone in the Northeast (NE) Sector of the field. Due to its proximity to the main production area, this thermal complex is considered to be susceptible to any reservoir changes. The thermal manifestations characteristics monitored are areal extent, numbers of the thermal funnels, the activities, physical and chemical characteristics, and geophysical signatures. Baseline data were taken from previous remote sensing studies, geology maps, and thermal manifestation geochemistry surveys prior to production periods. Remote sensing studies using true color composite (TCC) and NDVI suggest that the IM fumarole area covers the wider area prior to stage-1 project development in 2017. After production, periodic aerial photo analysis suggests no changes in IM fumarole thermal area growth. The fact is supported by the periodic Thermal Infra-Red Image (TIR), which shows no sign of thermal anomaly still contained inside the IM fumarole baseline area. IM fumarole field checks show that lack of thermal area changes and no sign that the manifestations have become more aggressive. Temperature and flow rate observation on several manifestation funnels indicates that rainfall rate variation affects the manifestation activities and temperature. As for the fumarole gas chemistry, the IM main fumarole shows a decreasing trend in NCG and CO2 contents from 2016 to 2021 and increasing in H2S, which indicates the return of degassing fluid. After one year of field operation, the microgravity and leveling survey in the IM fumarole area show slight changes from -0.1 to -0.14 mGal. The changes correspond with the area subsidence rate of -10 to -15 mm/yr. These changes are still considered low compared to other operating geothermal fields and did not directly affect the thermal manifestation activity.

IDENTIFICATION OF VOLCANIC GEOTHERMAL SYSTEMS BASED ON INTEGRATED STUDY OF VOLCANOSTRATIGRAPHY, STRUCTURAL GEOLOGY, AND FLUID GEOCHEMISTRY IN SOUTHERN NGADA FIELD, INDONESIA

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Southern Ngada is one of the areas that shows occurrence of volcanic geothermal potential in East Nusa Tenggara. The spreading volcanoes in the study area raised a hypothesis that the Southern Ngada Geothermal Field consists of several geothermal systems. The spreading volcanoes showed the presence of at least three volcanoes and manifestation clusters, which are Nage, Keli-Bena, and Wolo Puti Clusters. This research aimed to identify the number, type, and characteristics of geothermal systems in Southern Ngada Geothermal Field. The identification is conducted through the integration of geomorphology, volcanostratigraphy, structural geology, and geochemistry of fluid manifestation. The determination of geothermal system in Southern Ngada Geothermal Field is important to identify the field characteristics and reduce exploration risks. The Southern Ngada Field constitutes of the pre-caldera, post-caldera, and recent volcanism products. The study area is intensively deformed through strike slip faults and resembled Riedel Shear patterns. Fluid manifestation geochemistry in the study area showed various type of waters, which consists of Cl-SO_4, SO_4, and SO_4-HCO_3 waters with meteoric water mixing. The solfatara is associated with active magmatic gases due to boiling of reservoir beneath cinder cones. The fluid mixing processes are explained furthermore in Schoeller diagram plot. The integration of analyses showed the presence of Nage, Keli-Bena, and Wolo Puti Geothermal Systems with each different volcanostratigraphy, structural setting, and fluid mixing processes. The Nage System is associated with inferred heat source beneath the Nage Caldera and eastern part master and antithetic fault. The Keli-Bena System is associated with inferred heat source beneath Bena Crater and western antithetic fault. The Wolo Puti System is associated with inferred heat source beneath cinder cone volcanoes and northern extensional structures.

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UPFLOW-OUTFLOW ZONE IDENTIFICATION BASED ON GEOCHEMISTRY INDICATOR AND FAULT FRACTURE DENSITY CORRELATION ANALYSIS IN MT. GEDE GEOTHERMAL CASE, WEST JAVA

Arthur Gemas Pradhana Nayoan[1], Krishna Agra Pranatikta[2], Anil[1], Fajar Hendrasto[1], and Sholikhatun Yuniasih[3]

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Upflow and outflow zones in a geothermal field are very important to identifying. These two zones are very useful in running a geothermal project such as simply in determining the drill point. Mt. Gede-Pangrango is one of the interesting geothermal fields in West Java province and is still included in the category the geothermal fieldwork (WKP) has not been further investigated which is the current research area especially on Mt. Gede. The method used to identify upflow-outflow zones is to correlate fault fracture density (FFD) analysis and geochemistry indicators with the early hypothesis that the geothermal upflow zone in the Mt. Gede is most likely located in the crater area to the volcanic body. Based on the FFD analysis, areas with high density of structural lineaments with a value of >2 km/km^2 tend to have a southwest-northeast pattern that describes the direction of geothermal fluid flow due to the presence of a permeable zone (fracture) from the crater area of Mt. Gede (upflow zone) towards the foot of the mountain (outflow zone) the Cipanas area, which is also supported by the presence of the bicarbonate hot spring manifestation in the area. Then based on the geochemistry indicator (HCO_3/SO_4, Na/K, CO_2 /H_2S, and Isotope ^{18}O), it can be seen that the upflow area is in the area of the volcanic peak to the body of the volcano and the outflow is at the foot of the volcano (Cipanas Area). From these two analyzes, it can be seen that the FFD and geochemical indicators are very well correlated in identifying the upflow and outflow zones of Mt. Gede and answered the early hypothesis that the upflow area tends to be in the volcanic crater area to the volcanic body of Mt. Gede.

COMPARISON OF SOLUTE AND MULTICOMPONENT GEOTHERMOMETRY: A STUDY CASE OF MOUNT RAJABASA GEOTHERMAL FIELD

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Geothermometry has always been a preferred method to estimate reservoir temperature in a relatively quick process at minimum cost. Among several types of geothermometry, solute geothermometry is the most common to be used due to its relatively uncomplicated calculation. However, it often involves high uncertainties thus the estimated temperature is occasionally rather inaccurate. This research aims at applying a new statistical approach to geothermometry to yield a more reliable reservoir temperature estimation. The new approach is called multicomponent geothermometry. This method uses the iGeoT code with a simple automatization for estimating unknown or poorly unknown constrained parameters. This method is applied to the Mount Rajabasa Geothermal Field in Lampung Province, Indonesia, and later validated against reservoir temperature from solute geothermometry. Results indicate both methods yield similar values close to 260°. Despite the similarity, multicomponent geothermometry is believed to offer better quality results since it takes into consideration of full chemical analysis and mineral saturation indices to obtain optimization. The application of multicomponent geothermometry jointly with solute geothermometry in the research area has proved to significantly increase accuracy and reliability in estimating reservoir temperature. The methods presented in this research may be advantageous for easy-to-handle analysis of other geothermal fields with standard geochemical data without the need for a sophisticated analysis yet earning more accurate results.

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WATER-ROCK INTERACTIONS IN THE METAMORPHIC COMPLEX OF GEOTHERMAL FIELD: CASE STUDY IN WAHLUA COMPLEX, BURU ISLAND

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In Indonesia, surface thermal manifestation is commonly found in a volcanic geological setting. However, hot springs and alteration minerals in study area occur on metamorphic rock. In order to study its correlation with the emergence of the thermal fluid, the objective of this study is to characterize each metamorphic zone based on rock chemistry and the appearance of index minerals. Consequently, the correlation with thermal fluid chemistry can be observed. Data for this study are surface rock samples and thermal manifestation data. Metamorphic zones were determined by integrating geomorphology, petrography, and X-Ray Fluorescence (XRF) analyses. Three metamorphic zones were identified, namely, Garnet Zone, Biotite Zone, and Chlorite Zone. Garnet Zone is characterized by high concentrations of CaO and Al_2O_3 due to the presence of garnet. The abundance of biotite and muscovite in Biotite Zone may contribute to the highest concentration of K_2O than the other two zones. Meanwhile, Chlorite Zone is characterized by the concentrations of SiO_2, Fe_2O_3, and MgO. However, the composition of MgO might be influenced by mineral-fluid reaction. There are two clusters of thermal manifestation, which are western and eastern cluster manifestations. Western cluster manifestations are in the Biotite Zone. Meanwhile, the eastern cluster manifestation is in the Chlorite Zone. However, both clusters' fluid chemistry shows significant differences in some elements such as SiO_2, Na, K, Fe, and Mg concentration. It might suggest that the enrichment and depletion of these constituents in thermal fluid might correlate with each metamorphic zone's characteristics. An inconsistent pattern between thermal fluid composition and rock chemistry was found in Mg concentration. It is most likely that the Mg concentration was influenced by groundwater dilution rather than the mineral-fluid interaction. The study concludes that the appearance of index minerals shows consistencies with composition variation of some elements in the manifestation fluid, such as SiO_2, Na, K, and Fe.

IDENTIFICATION OF GEOLOGICAL STRUCTURE BASED ON GRAVITY METHOD IN TANGKUBAN PARAHU VOLCANO, BANDUNG, INDONESIA

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Tangkuban Parahu Volcano, located in Cikahuripan, Lembang, West Bandung Regency, West Java, Indonesia, has a geothermal potential. However, this potential is accompanied by geohazard risks, one of which is a volcanic eruption that can interfere with the development of geothermal potential. On February 12, 2022, there was a gust of volcanic gas from Ratu Crater, indicating an increase in volcanic activity after an eruption in 2019. Based on the geological map of Tangkuban Parahu/Sunda Volcano Complex, it is estimated that there is a fault structure in a northwest-southeast direction, where if a volcanic eruption occurs, it will cause greater deformation because it cuts through Ratu Crater. Further studies with geophysical methods are needed to estimate the fault structure. The study of the subsurface geological structure of Tangkuban Parahu Volcano was carried out using the gravity method by studying variations in the gravitational field on the earth's surface to determine differences in rock density. The Complete Bouguer Anomaly (CBA) value from the gravity method at Tangkuban Parahu Volcano shows 68 – 73 mGal, and residual anomaly values ranged from -0.95 to 0.67 mGal. The negative residual anomaly value between -0.95 to 0 mGal shows the weak zone due to volcanism in the crater. On the other hand, high residual anomaly values ranging from 0 to 0.67 mGal are interpreted as the influence of Lava 1 Tangkuban Parahu (Tl1). Analysis using First Horizontal Derivative (FHD) and Second Vertical Derivative (SVD) shows a fault structure trending Northwest – Southeast, which can be a way out of the accumulation of high-pressure water vapor due to volcanic activity.

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THE EARLY CHEMICAL CHARACTERISTICS OF GEOTHERMAL SURFACE FEATURES OF MOUNT LOMPOBATTANG−BAWAKARAENG, GOWA AND BANTAENG REGENCY, SOUTH SULAWESI, INDONESIA

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The Early study of surface geothermal features characteristics, based on surface chemical characteristics fluids is compulsory for understanding the geothermal system. The geothermal area of Mount Lompobattang-Bawakaraeng is mostly located in Gowa and Bantaeng Regency, South Sulawesi and these data were taken in 2018. The stratigraphy is composed of Tertiary Volcanic Sediments and Lompobattang-Bawakaraeng Quaternary Volcanic. The geological structures consist of caldera rim on the peak of Mount Lompobatang-Bawakaraeng and the fault structure of southwest-northeast and northwest-southeast which controls the appearance of geothermal manifestations on the surface. The active thermal manifestations are only warm springs, i.e., Batu Belerang, Pencong, and Parangloe warm springs. Batu Belerang warm spring is situated at an altitude of around 1400 masl, while Pencong and Parangloe warm springs are about 24 km from Batu Belerang warm springs with a lower altitude of around 168 masl. The temperature of the warm springs is around 31- 49.2 °C. There is one inactive surface geothermal manifestation, i.e., the Cold Acid Crater Lake Blue Luraya (Danau Biru Luraya) at the elevation of 1561 masl, the water temperature of 17 °C. The result of water analysis shows that warm springs Pencong and Parangloe have more dominant HCO_3. The Batu Belerang and the Cold Acid Crater Lake Blue Luraya (Danau Biru luraya) are more dominated by SO_4. In the triangular diagram that compares the relative concentrations of Na, K, Mg shows that the Pencong group (Pencong and Parangloe warm springs) is plotted in the lower boundary zone of partial equilibrium, while Lompobattang group (Batu Belerang warm springs and Cold Acid Crater Lake Blue Luraya (Danau Biru Luraya) is plotted in the corner of Mg (immature waters zone). The temperature of the system is probably only estimated at the shallow part of the system by SiO_2 geothermometer about 125 °C and the Batu Belerang could be more than 125 °C.

HULULAIS FIELD REVIEW FROM GEOSCIENTIFIC EXPLORATION TO EXPLOITATION STAGE

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Geothermal studies in Hululais carried out by Pertamina was started in 1993 with an exploration survey. The detailed geological mapping as the earliest geothermal resource assessment of Hululais was done internally by Pertamina. The geochemical study was done together with the geological study. The geophysical study was carried out using three methods. The gravity survey was run in 1993 for 320 points along 12 trace lines, while the magnetotelluric survey was conducted in 2006 and 2012 for 64 locations with 1-2 km spacing. The microearthquake survey was done in 2012 for 115 days monitoring time by six sensors in 10 km spacing and in 2019. The conceptual model as a product of the integrated study of three geoscientific surveys shows that the upflow zone is interpreted in Suban Agung – Suban Gregok in the southern area. Fumarole, mud pool and steam-heated hot spring are found in this zone. The outflow zone is interpreted towards the north in Semelako area supported by the chloride hot spring. The appearance of these manifestations is possibly controlled by fault structure in Musi Segment zone of Sumatra Fault Zone (SFZ). The heat source comes from granodiorite intrusion below Bukit Beriti Besar – Bukit Gedang Hululais. The cap rock has 500 meters thick in the upflow zone and increases to 800 meters thick towards the outflow zone in the northern part of the study area. The upflow zone was proved by two exploration wells that drilled until 3000 mMD. The first well in Suban Agung has a high temperature reach 300°C with neutral reservoir fluids and good fault structure permeability. The second exploration well that drilled towards outflow zone shows a temperature of 205°C with neutral reservoir fluids but with low permeability. In the exploitation stage, 21 development wells have been drilled for making the update conceptual model. Among them, ten wells are production wells and the remains are reinjection ones. The permeability in the reinjection wells is not so good compared to the production wells. It might be due to secondary mineral filling in the fault structure permeability zone, so this situation causes a problem in injection water to the reservoir. Investigation of the subsurface permeability distribution in the Hululais reservoir is challenging, so further research should be done to answer this challenge.

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HEAT SOURCE IDENTIFICATION BY REPROCESSING GEOSCIENCE DATA TO UPDATE CONCEPTUAL MODEL OF PENTADIO GEOTHERMAL PROSPECT AREA

After Helfert Pasaribu, Angga Bakti Pratama, and Dedy Pramudityo

Geothermal Master Program, Faculty of Mining and Petroleum Engineering, Institut Teknologi Bandung

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https://orcid.org/0000-0003-3770-5971

The Pentadio Geothermal Prospect Area, Gorontalo, has been studied for geothermal development in the exploration stage. The previous conceptual model that has been produced shows that magma is the heat source of the geothermal system only based on geochemistry of manifestations that had high SO_4^{2-} concentrations. However, the presence of tertiary intrusion based on regional geological data and high SO_4^{2-} concentration cannot be strong evidence to prove the heat source is associated with magmatic system. The purposes of this research are updating the conceptual model, defining the heat source, and producing a different perspective from the previous study for the geothermal system in Pentadio Geothermal Prospect Area by providing a further analysis based on geoscience data reprocessing that had been acquired before. The methods consist of geological structure analysis that involves defining the permeability and geochemistry analysis for interpreting the type of reservoir fluid. Gravity data were reprocessing produced the regional and residual maps, and 3D modelling analysis for determining subsurface condition and heat source possibility in Pentadio Geothermal Prospect Area. The Pentadio Geothermal System is correlated with Gorontalo Graben which controls the permeability in the system. The fluid from geothermal manifestations near Limboto Lake has alkaline pH even though it has high SO_4^{2-} content and low magnesium content. Gravity data shows the regional fault (NW-SE) has a depth of more than 4 km and seems to have the possibility of producing heat influx to the near surface. It is suspected as a heat source of the geothermal system in this area. There is no evidence for magma intrusion to be a heat source in the subsurface by geology and geophysics model. The high concentration of SO_4^{-} in manifestations was influenced by sediment contamination in this area.

PRELIMINARY ESTIMATION OF GEOLOGICAL STRUCTURE BASED ON RELOCATED HYPOCENTER OF MICROEARTHQUAKE: CASE STUDY AT “X” GEOTHERMAL FIELD

Irfan Berrizki Hermawan[1], Mohammad Rachmat[2], Afnimar[3], Angga Bakti Pratama[1], Fernando Lawrens[2], Billy Sugiartono Prabowo[1], Rendy Delliansyah[1], Riskiray Ryannugroho[4], Firdaus Al Hakim[1], Wiku Widyoyudo[1], Chevy Iskandar[5], and Reza Jamil Fajri[5]

[1]Geothermal Engineering Master Program, Bandung Institute of Technology
[2]Seismology Exploration and Engineering Research Group, Bandung Institute of Technology
[3]Global Geophysics Research Group, Faculty of Mining and Petroleum Engineering, Bandung Institute of Technology
[4]Geophysical Engineering, Faculty of Mining and Petroleum Engineering, Bandung Institute of Technology
[5]PT Geo Dipa Energi (Persero), Indonesia

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https://orcid.org/0000-0002-1861-5279

Generally, analysis of geological structure in the geothermal field is carried out using remote sensing methods, geological mapping, and gravity analysis. These methods can provide the distribution of geological structure on the surface but cannot provide information on whether the structure is active or not. This study aims to utilize improved hypocenter location which can be used to delineate the distribution of active faults. This is useful for obtain a better interpretation of geological structures in geothermal areas. Hypocenter locations are determined by picking the arrival time of the P-wave and S-wave. This method sometimes leads to uncertainty of hypocenter location due to subjectivity of picking arrival time. The double-difference method is applied with additional input pairing events from waveform cross-correlation (WCC) to overcome the uncertainty of hypocenter location. The result shows 3 microearthquake clusters formed in the western, central, and eastern parts of the "X" Geothermal Field. The cluster formed in the western area shows that there are two orientations of conjugated hypocenter distribution with the orientation of NW-SE and NE-SW. These hypocenters reveal the presence of geological structures which provide permeability pathways for fluids rising in the western part of the geothermal field. Multiplet-clustering analysis in the middle cluster which coincides with the reservoir zone shows two different sub-clusters indicating the possibility of two different sources mechanism working in the area. By integrating all the analysis and hypocenter distribution, these methods provide a better interpretation of structure's distribution in the "X" Geothermal Field.

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LITHIUM EXTRACTION METHOD FROM GEOTHERMAL BRINE TO FIND SUITABLE METHOD FOR GEOTHERMAL FIELDS IN INDONESIA: A REVIEW

Esty Mustika Suud[1], Suryantini[1,2], and Muhammad Zaki Mubarok[3]

[1]Geothermal Master Program, Faculty of Mining and Petroleum Engineering, Institut Teknologi Bandung
[2]Applied Geology Research Group, Faculty of Earth Science and Technology, ITB, Bandung, Indonesia
[3]Department of Metallurgical Engineering, Faculty of Mining and Petroleum Engineering, ITB, Bandung, Indonesia

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Lithium has become an essential metal for modern industries. Specifically, the growth of battery-based electric vehicles will demand much more lithium shortly. Many studies have been conducted to find the sources of lithium; one of them is geothermal brine. Indonesia has enormous geothermal resources; some fields have lithium content that can potentially be extracted. Various methods in the extraction process of lithium from the geothermal brine have been developed, both on laboratory and pilot projects. Conventionally, solar evaporation has been used to concentrate lithium from brine, but it takes a long time and depends on the weather. Thus, a more rapid and selective process is desired to fulfill the market demand and avoid weather constraints. This paper reviews the lithium extraction from the geothermal brine by direct extraction methods using solvent extraction, adsorption and ion exchange, membrane, and electrodialysis. The study is based on a desktop study and aims to summarize the knowledge, method, technology, and techniques of lithium extraction from geothermal brine that has already been used and to find out which extraction method is suitable for the Indonesian geothermal field. Multiple-stages solvent extraction from geothermal brine well X in Dieng performed by the authors demonstrated a lithium extraction efficiency of 94% and indicated an opportunity to be further investigated to extract lithium from the Dieng geothermal brine.

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ORAL PRESENTATION

EXPLORATION

ENGINEERING

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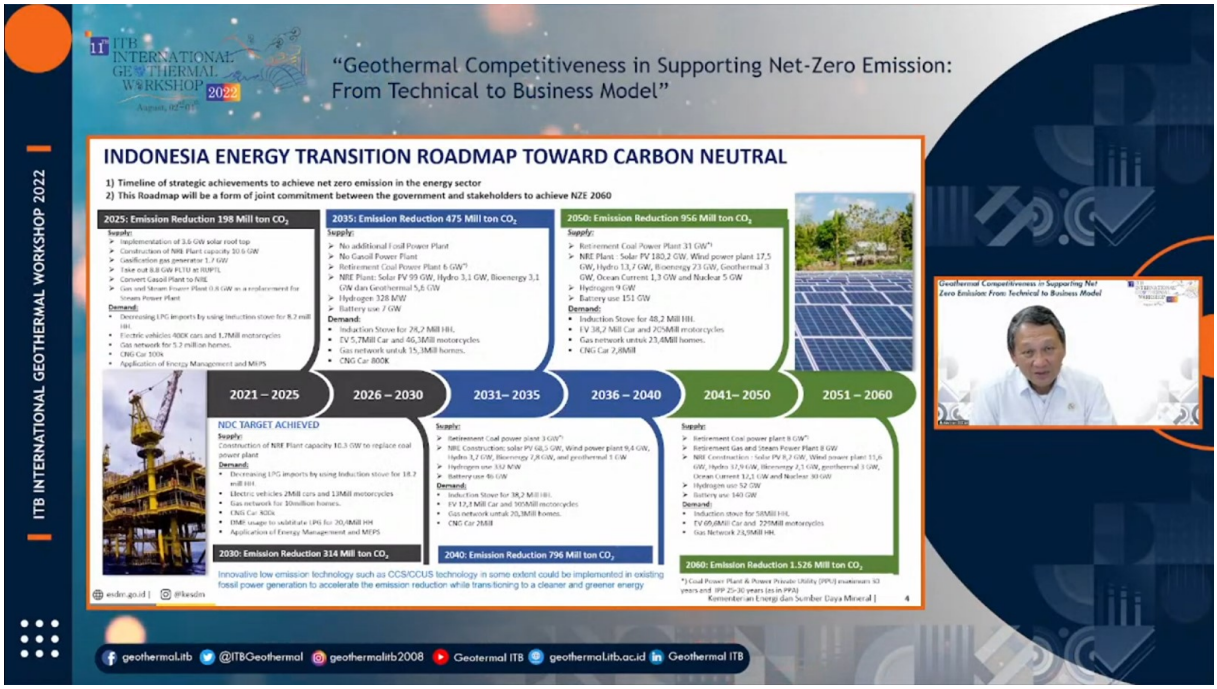
Day 1: August 2nd, 2022

Opening ITB International Geothermal Workshop's Main Event 2022
by Master of Ceremony (Alief Zaky T and Suminar Hartini)

Welcoming Remark by Chairman of ITB International Geothermal Workshop 2022
(Dr. Suryatini)

Officiating the Event
by the Head of Institute for Science and Technology Development ITB
(Prof. Ir. Taufan Marhaendrajana, M.Sc., Ph.D.)

Group Photo with Speakers and Moderator

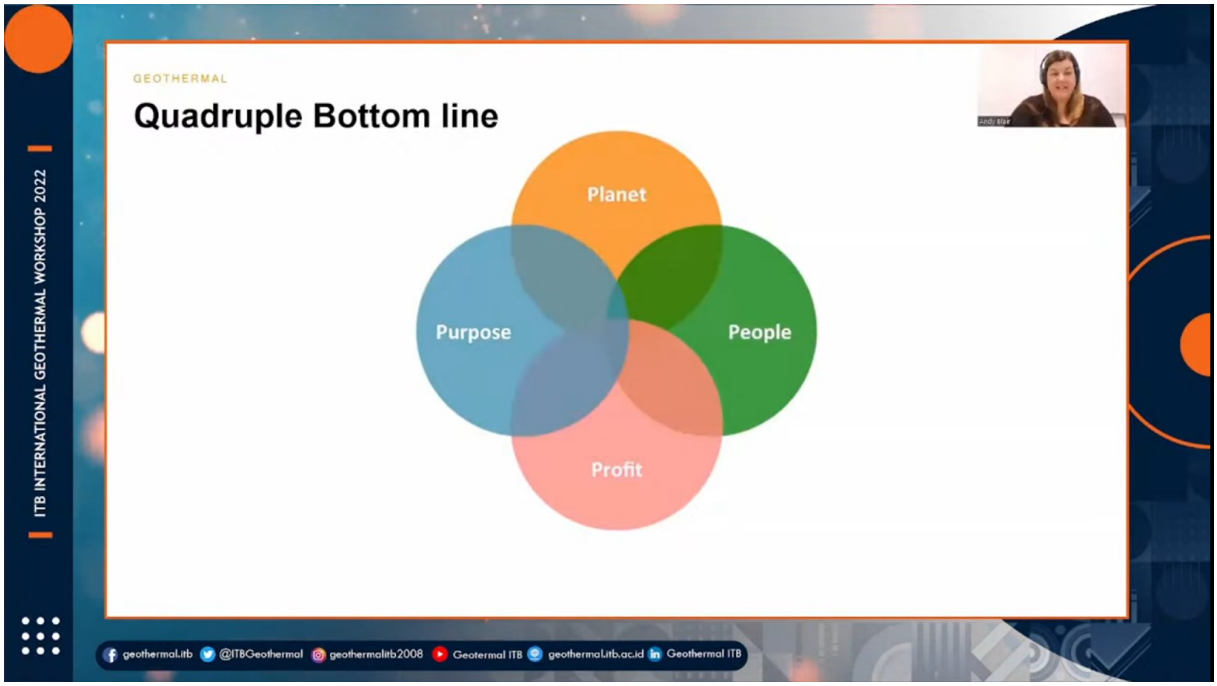


Keynote Speech
by Minister for Energy and Mineral Resources of The Republic of Indonesia
(Mr. Arifin Tasrif)

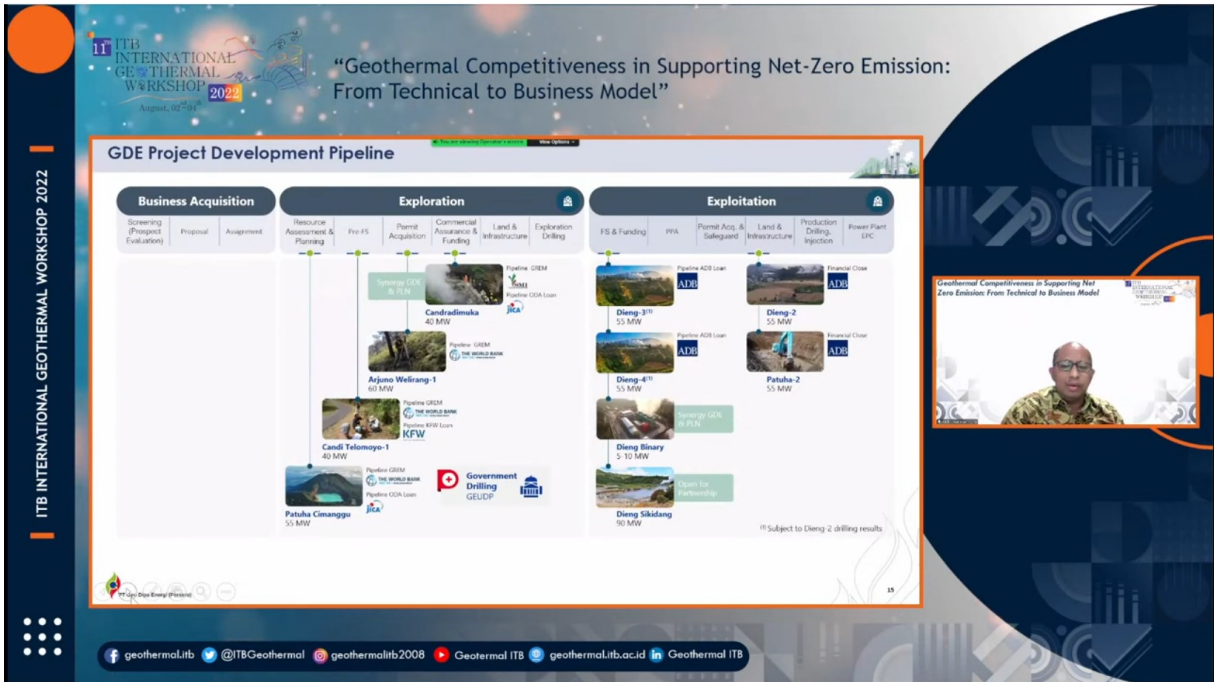
Memento to Speaker (Mr. Arifin Tasrif)
by Moderator (Prof. Tubagus Ahmad Fauzi Soelaiman)

Keynote Speech by Mr. Kevin Burnett
(New Zealand Ambassador for Indonesia)

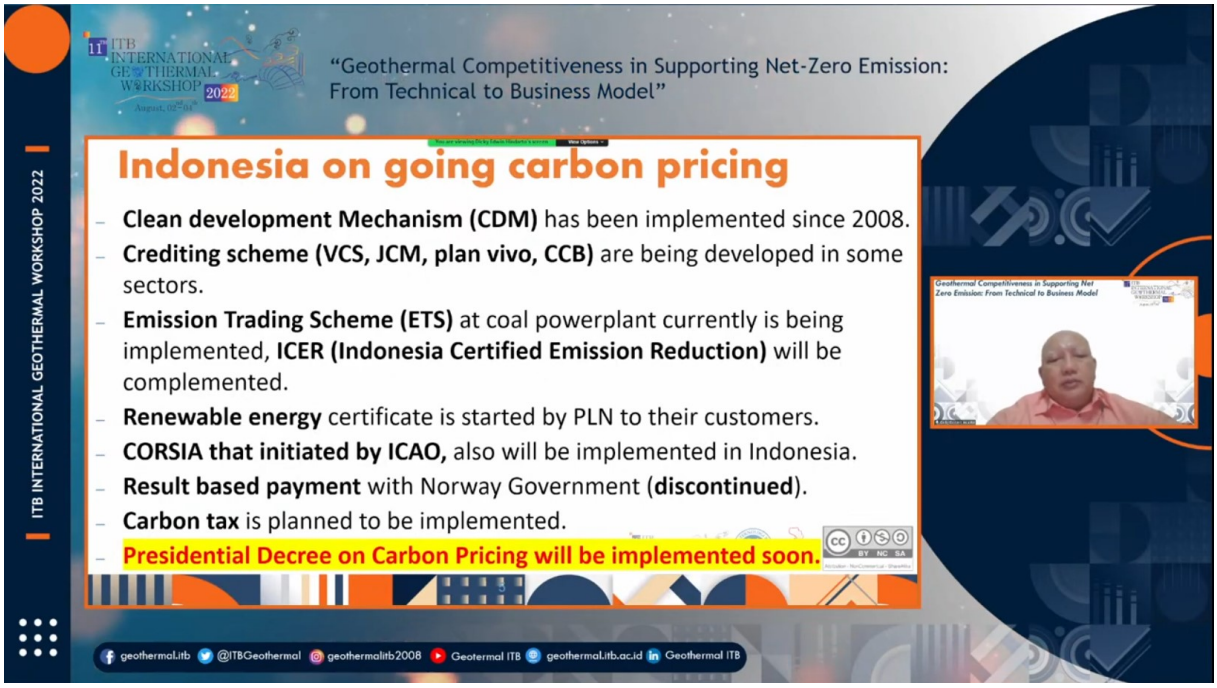
. Keynote Speech by Mr. Prijandaru Effendi
(Chairman of Indonesian Geothermal Association)



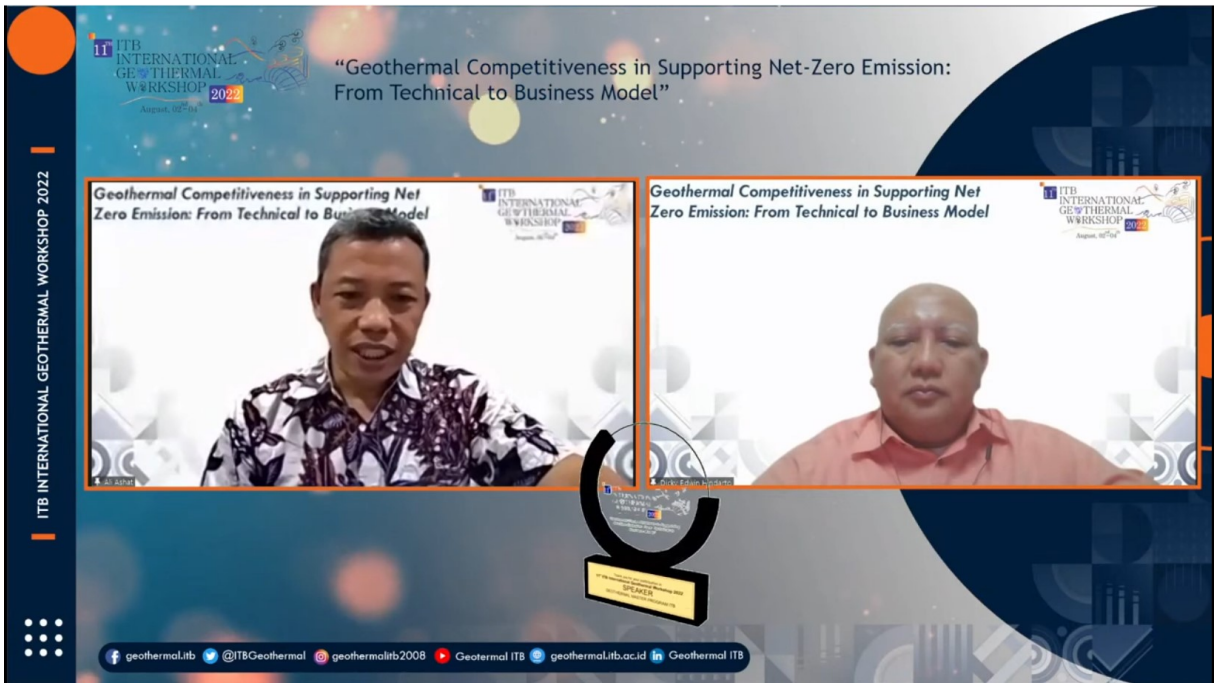
Presentation by Ms, Andrea Blair
(President of International Geothermal Association (IGA)



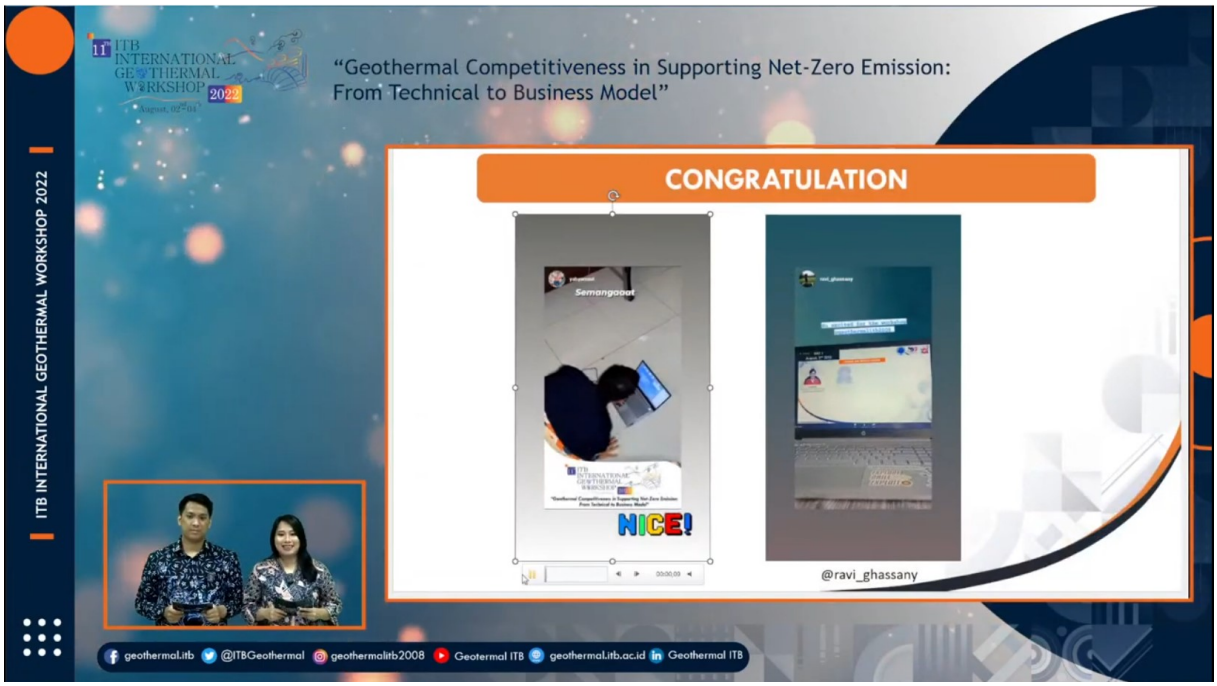
Presentation by Speaker from PT. Geo Dipa Energy
(Mr. Yudistian Yunis)



Presentation by Mr. Dicky Edwin H
(Consultant for Decarbonization)



Memento to Speaker (Mr, Dicky Edwin H)
by Moderator (Mr. M. Ali Ashat)

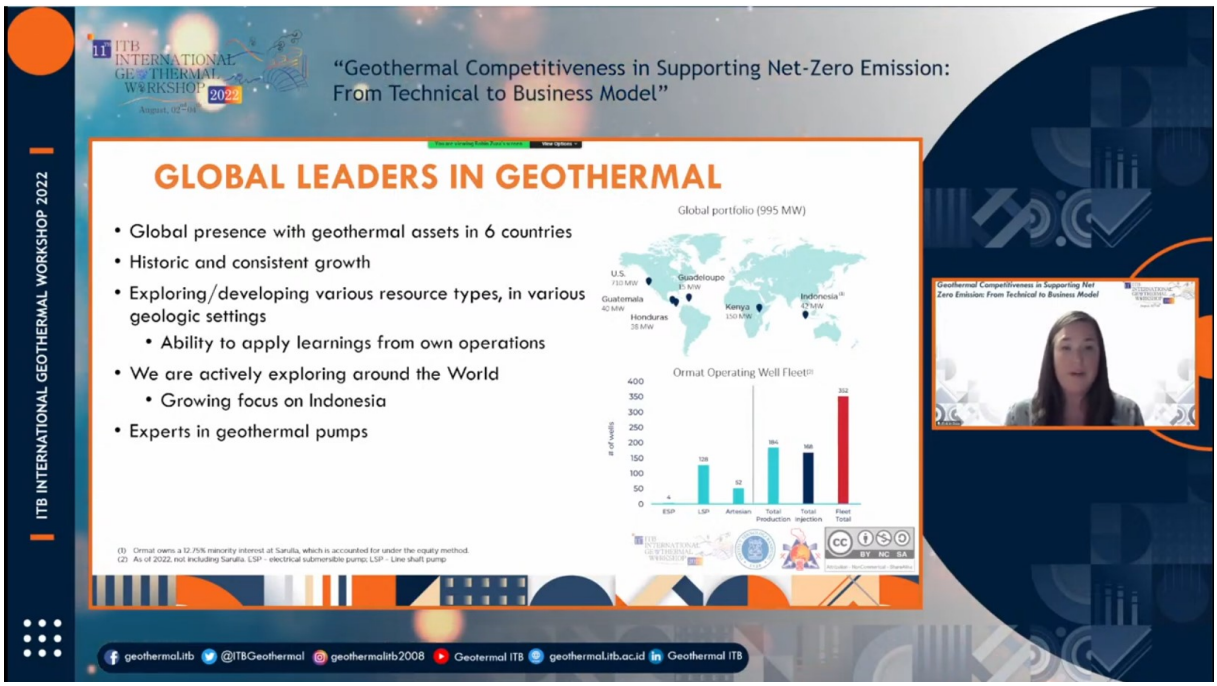


Closing by Master of Ceremony on Day 1
(during Announcement for the Winner of Instagram Update)

Day 2 (August 3rd, 2022)

Opening ITB International Geothermal Workshop's Main Event 2022
by Master of Ceremony (Amerensia Leticia S) on Day 2

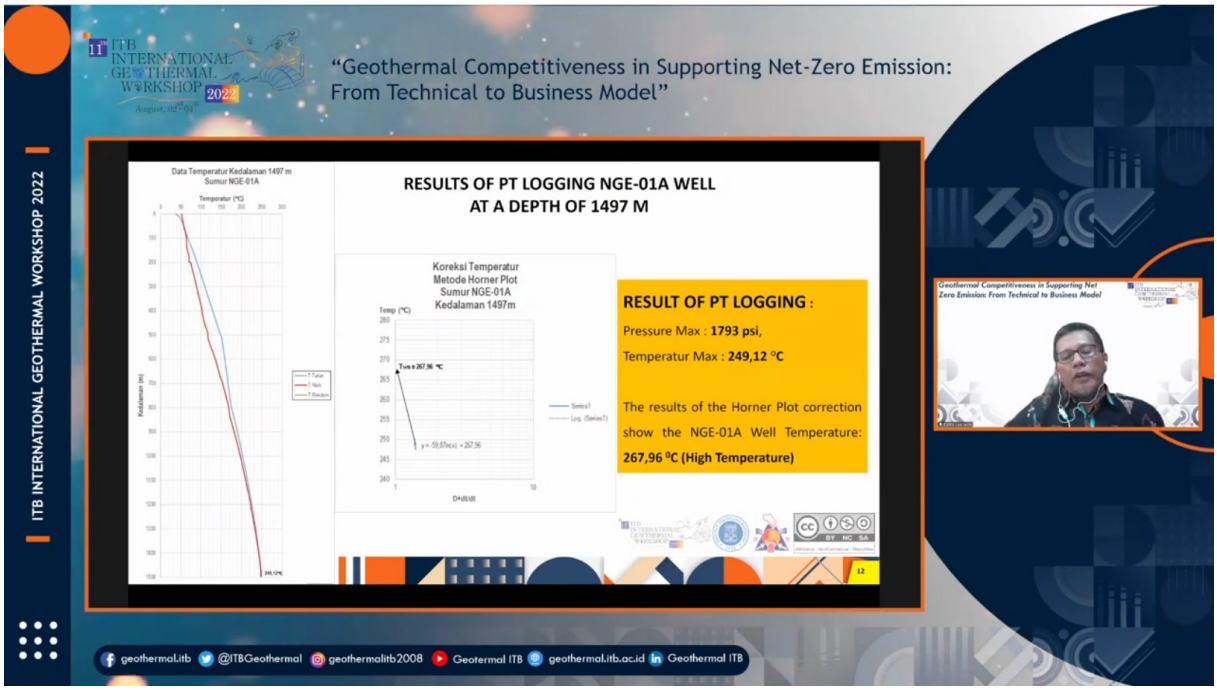
Group Photo between Speakers and Moderators



Presentation Regarding Geothermal Competitiveness and Opportunities
by Ms. Robin Zuza (Director of Global Exploration at Ormat Technologies, Inc.)

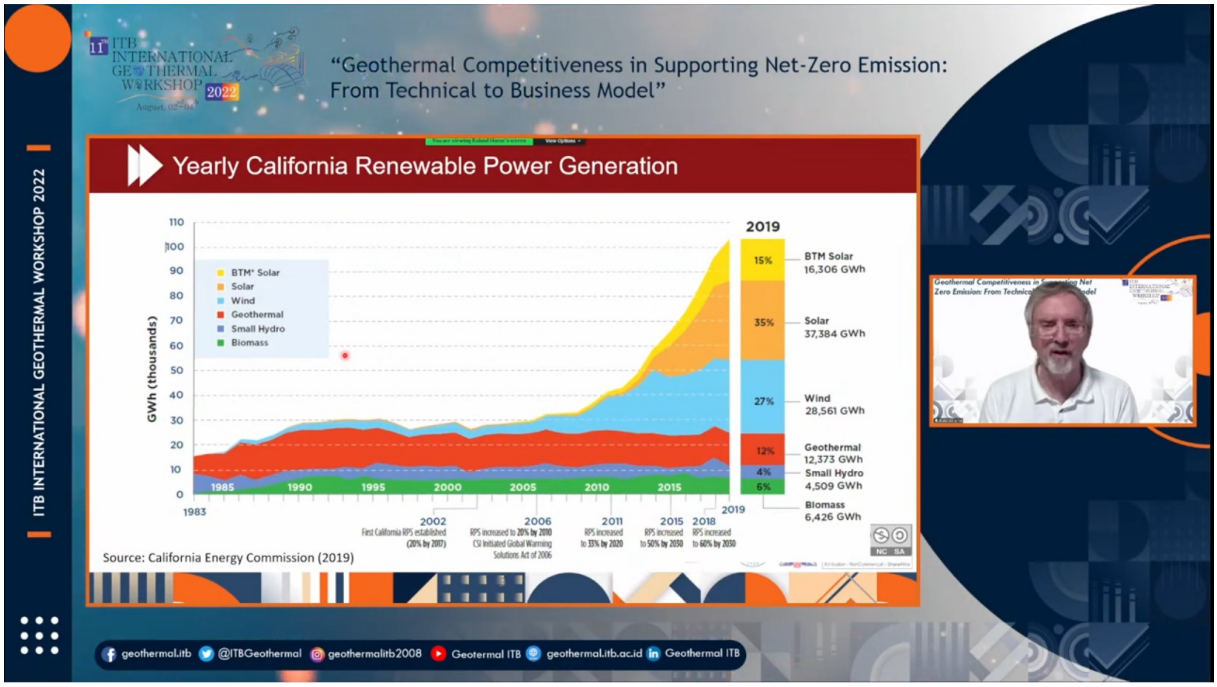
Question and Answer Session Speaker (Ms. Robin Zuza)
with Moderator (Mr. Angga Bakti P)

Memento to Speaker by Moderator



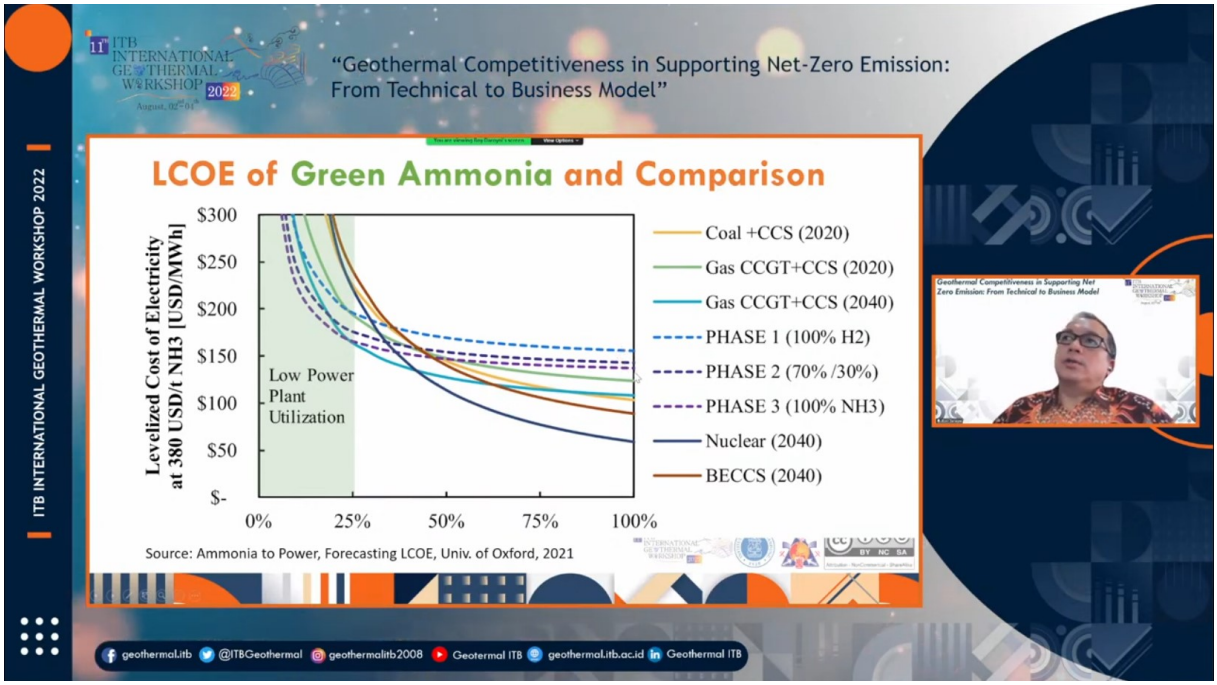
Presentation by Mr, Hariyanto
(Head of Center for Mineral, Coal, and Geothermal Resource)

Group Photo with Speakers and Moderator

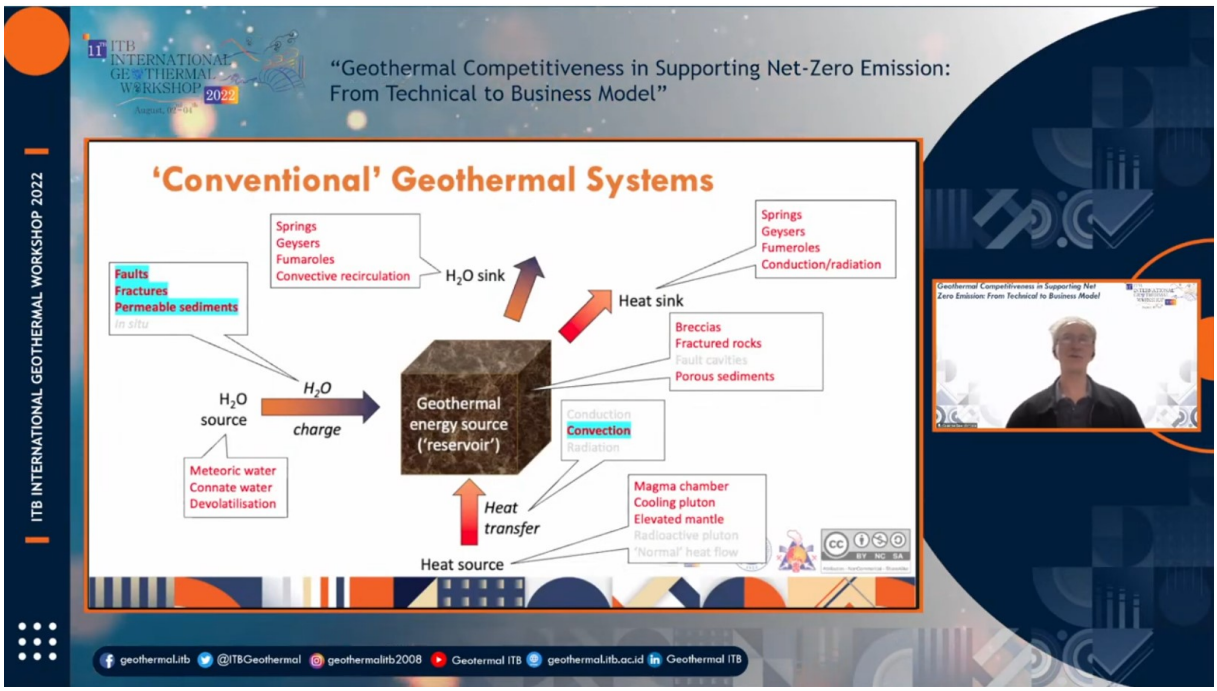


Presentation by Prof. Ronald N. Horne
(Professor of Standford University)

Memento to Speaker (Prof. Ronald N. Horne)
by Moderator (Mr. Alfend Rudyawan)



Presentation by Mr. Roy Daroyni
(Business Development, SE-Asia & Australia, Technology Solution,
Kellogg Brown & Root LLC)



Presentation by Mr. Graeme Beardsmore
(Secretary of the Asia-Western Pacific Regional of the International Geothermal Association)

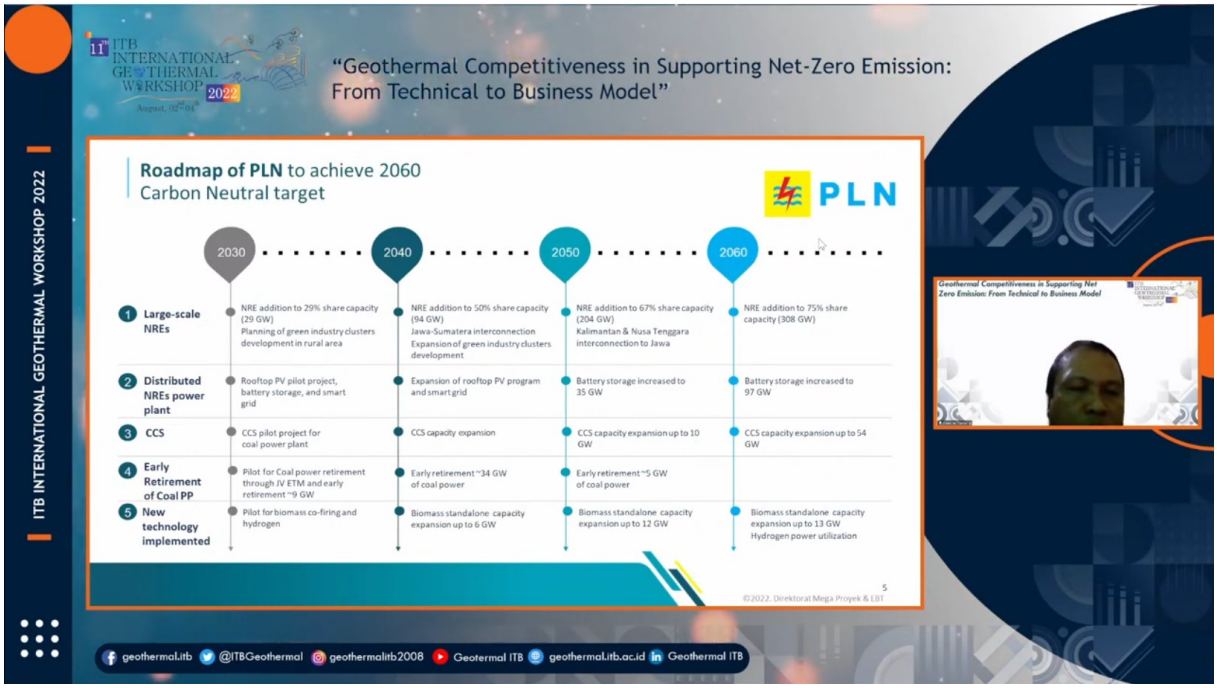
Memento to Speaker (Graeme Beardsmore)
by Moderator (Mr. Dimas Taha Maulana)

Closing by Master of Ceremony on Day 2

Day 3 (August 4th, 2022)

Opening ITB International Geothermal Workshop's Main Event 2022
by Master of Ceremony (Yahya Maulana) on Day 3

Group Photo Moderator and Speakers Session 1 on Day 3



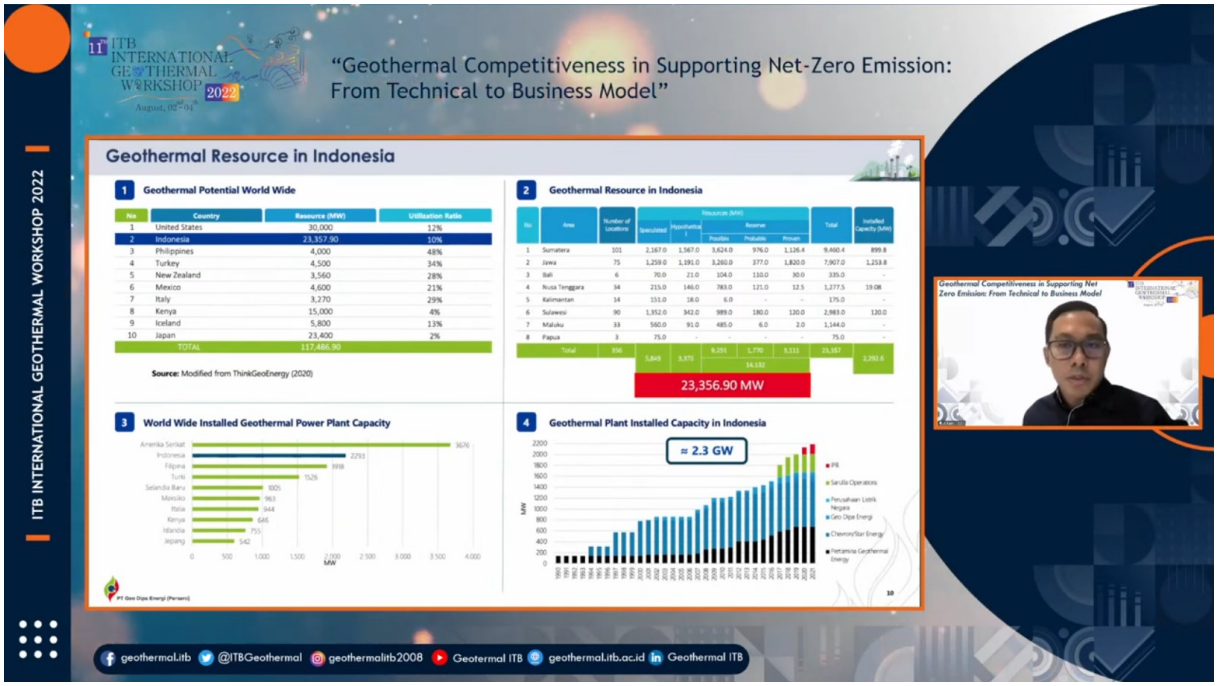
Presentation by Mr. Hendra Yu Tonsa Tondang
(Vice President of New Renewable Energy PT. PLN Persero

Question and Answer Session
led by Moderator (Ms. Riostantieka Mayandari Shoedarto)

Memento to Speaker (Mr. Hendra Yu Tonsa Tondang)
by Moderator (Ms. Riostantieka Mayandari Shoedarto)

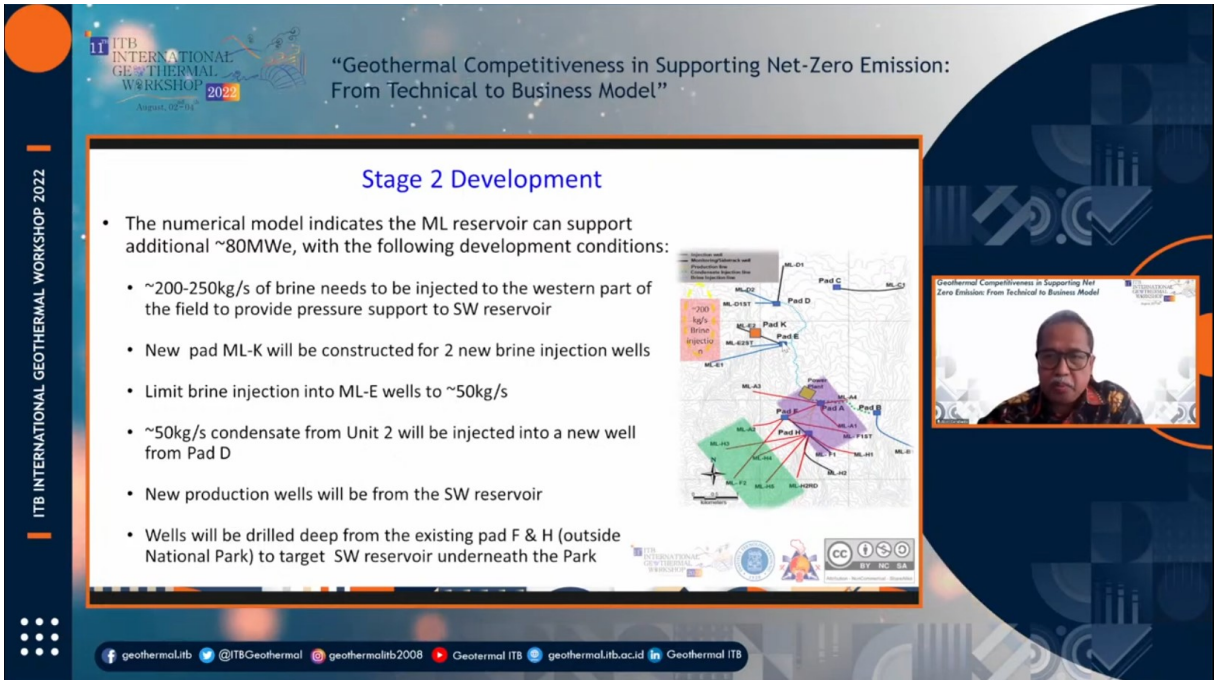
Presentation by Mr. Ahmad Yuniarto
(President Director of PT. Pertamina Geothermal Energy)

Presentation by Mr. Novianto
(General Manager of PT. Medco Cahaya Geothermal)



Presentation by Mr. Idham Purnama
(Vice President of Operation & Business Development of PT. Geo Dipa Energy Persero)

Group Photo Moderator and Speakers Session 2 on Day 3



Presentation by Mr. Novi Ganefianto
(Vice President of Exploration & Subsurface Engineering of 69. PT. Supreme Energy)

Question and Answer Session
led by Moderator (Ms. Betseba br Sibarani)

Memento to Speaker (Mr. Novi Ganefianto)
by Moderator (Ms. Betseba br Sibarani)

Presentation by Mr. Iwan Setiawan
(Director of Research Center for Geological Resources
National Research and Innovation Agency (BRIN))

Presentation by Mr. Hisao Nakano
(CEO of Sarulla Operation Ltd)

Presentation by Mr. Dion Murdiono
(PT. ORMAT Geothermal Technologies)

Closing Ceremony by Chairman of IIGW 2022
(Dr. Suryatini)

Closing by All Master of Ceremony (Day 1- Day 3)

Gedung Perpustakaan Pusat ITB
Lantai Basement, Jl. Ganesa No. 10
Bandung 40132, Jawa Barat
Telp. 022 2504257/022 2534155
e-mail: office@itbpress.itb.ac.id
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Anggota Ikapi No. 034/JBA/92
APPTI No. 005.062.1.10.2018

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Online Conference Technical Report

11th ITB INTERNATIONAL GEOTHERMAL WORKSHOP 2022

Bandung, August 02nd–04th , 2022

INSTITUT TEKNOLOGI BANDUNG

Table of Content

1 Introduction

Conference Name	:	11th ITB International Geothermal Workshop 202
Conference theme	:	Geothermal Competitiveness in Supporting Net-Zero Emission: From Technical to Business Model
Date	:	August, 02nd–04th, 2022
Venue	:	Online Virtual Conference, Kampus ITB, Bandung

ITB International Geothermal Workshop 2022 was an event organized by ITB Geothermal Master Program which was held on 02nd-04th August 2022 on an online basis through a live virtual workshop (Webinar) via Zoom and YouTube. Followed by over 2200 participants from many different aspects of the geothermal community, such as academia, industries, and government. This year's theme is "Geothermal Competitiveness in Supporting Net-Zero Emission: From Technical to Business Model", which focuses more on the Prospecting and Utilization of Geothermal Energy and collaborating Indonesia Geothermal Stakeholders by inviting speakers from various aspects in geothermal energy.

The 11th ITB International Geothermal Workshop with the theme "Geothermal Competitiveness in Supporting Net Zero Emission: From Technical to Business Model*"* is expected to become a melting pot for sharing knowledge, experiences and solving technical and non-technical geothermal issues in Indonesia. For this year's event, the focus of discussions would be the development and innovation of technology for the exploration, exploitation, and utilization of geothermal resources, socio-economics, green investment, and competitive business models.

ITB International Geothermal Workshop 2022 has several objectives:

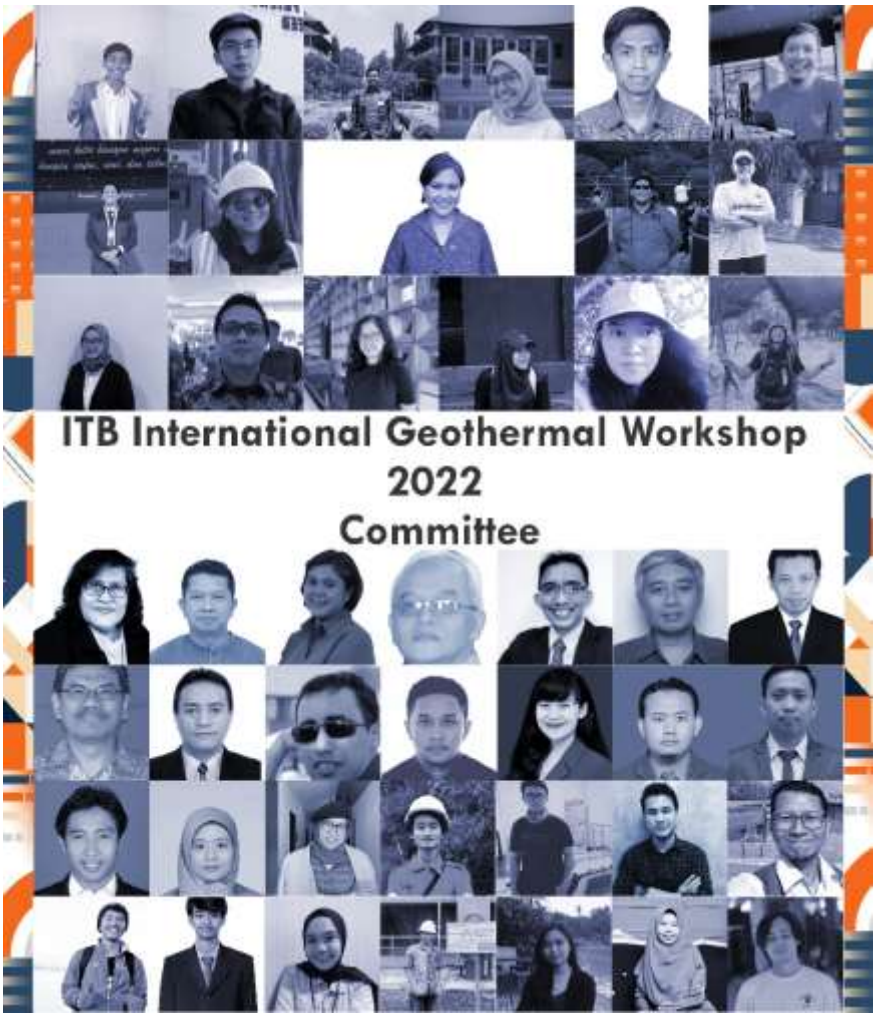
1. To improve community understanding of geothermal energy from exploration, exploitation, environmental, and regulation aspects.
2. Discuss the latest condition of geothermal energy in Indonesia.
3. To draw attention from scientists, engineers, academicians, industrial stakeholders, and also geothermal leaders about the initiatives, strategies, opportunities, and challenges toward geothermal development in Indonesia.

Due to the COVID-19 pandemic which does not allow physical IIGW activities to be carried out, this year's activities will be held virtually or via Webinar. Information about the event and its activities can be accessed at the following address:

- IIGW 2022 website: https://geothermal.itb.ac.id/workshop2022/
- IIGW 2022 YouTube playlist: https://www.youtube.com/watch?v=TbQzw9AU-DQ&list=PLtqSR-V6HMjTQyHXFYPc-tK8ftjMc3PbX

This document contains information about the Committee and Personnel, Keynote Speakers, Documentary Pictures, a detailed report on the ZOOM Teleconference, and lastly the number of video views on YouTube and ZOOM.

2. Committee and Personnel



Steering Committee	**Sutopo (Chairman of ITB Geothermal Master Program) and Staff of Geothermal Master Program, FTTM – ITB**
Chairman	Suryantini
Vice Chairman	Fanzly Togap Zisochi Lase
Secretary	Yutty Hendrawati, Suminar Hartini
Treasurer	Fasya Mediati Hapsari
Sponsorship	Prihadi Sumintadiredja, Willy Adriansyah, Zuher Syihab, Irwan Iskandar, Jooned Hendrarsakti, Yahya Maulana Amerensia L F A Soetjahjo, Esty Mustika Suud
Creative, Publication and Media	Suhendi, Taufiq Rachman, Naomi Nadya A. Siregar

	Zul Fadli, After Helfert Pasaribu, Adrian Tawakal Dinda Permatasari R. B.
Plenary Session	Nenny Miryani Saptadji, Ali Ashat, Rachmat Sule, Prihadi Setyo Darmanto, Hendro H. Wibowo, M. Ridwan Hamdani, Agung Aji Nugroho, Lydia Irianti, Machrani, Dedy Pramudityo, Fadhil Karunia Hammad, Irfan Berrizki Hermawan, Riostantieka M. Shoedarto, Alief Zaky Taftazanni, Taufiqurrahman
Field Trip/ Field Camp	Muhammad Iqbal Maulana, Masdukhan Aris W, Albertus Ivan, Nindyan Agna Ramadhan, Maulana Fatwa Putra
Technical Paper	Hendra Grandis, Asep Saepuloh, Dimas Taha Maulana, Heru Berian Pratama, Angga Bakti Pratama, Betseba br Sibarani, Canadia Tessa Pradani, Muhammad Yoan Mardiana, William Abraham Rasu, Nashir Huda, Fauziah Maswah,
Reviewer Team	Suryantini (ITB), Hendro Wibowo (ITB), Nursanty Elisabeth (Geo Dipa), Jantiur Situmorang (AILIMA), Mahesa Pradana (Thermochem), Prihadi Soemintadireja (ITB), David Sahara (ITB), Riostantieka Mayandari (BRIN), Irwan Iskandar (ITB), Prihadi Setyo Darmanto (ITB), Fitri Oktaviani (ADB), Yudi Indra Kusumah (Star Energy), Jooned Hendrarsakti (ITB), Yuniar Zhafira (Geo Dipa), Dewi Permatasari, Angga Bakti Pratama (ITB), Sutikno Bronto (Badan geologi), Abu Dawud (Star Energy), Bagus Mudiantoro (Researcher), Prihadi Setyo Darmanto (ITB) , Arie Naftali (ITB), Supremlehaq Taqwim (Geo Dipa Energi), Nenny Saptadji (ITB), Yudi Hartono (Geo Dipa Energi), Ali Ashat (ITB).

2.1 List of Speakers

No	Name	Position	Session	Date
1	Prof. Ir. Taufan Marhaendrajana, M.Sc., Ph.D.	Head of Institute for Science and Technology Development, Institut Teknologi Bandung	Opening Speech	August 2nd, 2022
2	Ir. Arifin Tasrif	Minister of Energy and Mineral Resources, Republic of Indonesia	Keynote Speech 1: "Government of Indonesia's Commitment to Meet Net-Zero Carbon Emission by 2050"	August 2nd, 2022
3	Kevin Burnett	New Zealand Ambassador for Indonesia	Keynote Speech 2: "Future New Zealand and Indonesia Collaboration for Geothermal Development and Capacity Building"	August 2nd, 2022
4	Ir. Prijandaru Effendi M.Eng	Chairman of the Indonesian Geothermal Association	Keynote Speech 3: "Feed in Tariff to Accelerate Geothermal Development"	August 2nd, 2022
5	Andrea Blair	President of International Geothermal Association (IGA)	"IGA Plans and Roles in Supporting Net Zero Emission"	August 2nd, 2022
6	Yudhistian Yunis	Director of Business Development and Exploration PT. Geo Dipa Energi (Persero)	"PT. Geo Dipa Energi to Support Net Zero Emission"	August 2nd, 2022
7	Dicky Edwin Hindarto	Consultant for Decarbonization	"Carbon Trading in Geothermal"	August 2nd, 2022
8	Robin Zuza	Director of Global Exploration Ormat Technologies, Inc.	"Smart Business Strategy to Develop Low to Medium Enthalpy"	August 3rd, 2022
9	Dr. Ir. Hariyanto M.T.	Head of Center for Mineral, Coal, and Geothermal Resources	"Center for Mineral, Coal and Geothermal Resources-Government Drilling Update"	August 3rd, 2022
10	Prof. Roland N. Horne	Professor at Stanford University	"Integrating Geothermal into a Large Renewable Electricity Portfolio"	August 3rd, 2022
11	Roy Daroyni	Business Development Director SE-Asia & Australia, Technology Solution, Kelogg Brown & Root LLC	"Prospect of Geothermal in Green Ammonia Production"	August 3rd, 2022

12	Andrew Fleming	Founder and CEO GeoX Energy Inc.	"GeoX's Supercritical 10X Performance Geothermal"	August 3rd, 2022
13.	Graeme Beardsmore	Secretary of the Asia-Western Pacific Regional Branch of the International Geothermal Association (IGA-AWPRB)	"Hot Dry Rock System"	August 3rd, 2022
14	Hendra Yu Tonsa Tondang	Vice President of New Renewable Energy PT. PLN (Persero)	"Company Update from PT. PLN (Persero)"	August 4th, 2022
15	Ahmad Yuniarto	President Director of PT. Pertamina Geothermal Energy	"Company Update from PT. Pertamina Geothermal Energy"	August 4th, 2022
16	Novianto	General Manager of PT. Medco Cahaya Geothermal	"Company Update from PT. Medco Cahaya Geothermal"	August 4th, 2022
17	Idham Purnama	Vice President Operation & Business Development PT. Geo Dipa Energy (Persero)	"Company Update from PT. Geo Dipa Energy (Persero)"	August 4th, 2022
18	Novi Ganefianto	Vice President Exploration & Subsurface Engineering of PT. Supreme Energy	"Company Update from PT. Supreme Energy"	August 4th, 2022
19	Dr. Iwan Setiawan, M.T.	Director Research Center for Geological Resources National Research and Innovation Agency (BRIN)	"The Opportunity for Research Collaboration on Critical Elements and Medical Geology in Indonesia's Geothermal System"	August 4th, 2022
20	Hisao Nakano	CEO of Sarulla Operation Ltd	"Company Update from Sarulla Operation Ltd"	August 4th, 2022
21	Dion Murdiono	President Director of PT. ORMAT Geothermal Indonesia	"Company Update from PT. ORMAT Geothermal Indonesia"	August 4th, 2022

3. Documentary Picture

3.1. Day 1 (August 2nd, 2022)

Opening ITB International Geothermal Workshop's Main Event 2022 by Master of Ceremony (Alief Zaky T and Suminar Hartini) on Day 1

. Welcoming Remark by Chairman of ITB International Geothermal Workshop 22 (Dr. Suryatini)

Officiating the Event by the Head of Institute for Science and Technology Development ITB (Prof. Ir. Taufan Marhaendrajana, M.Sc., Ph.D.)

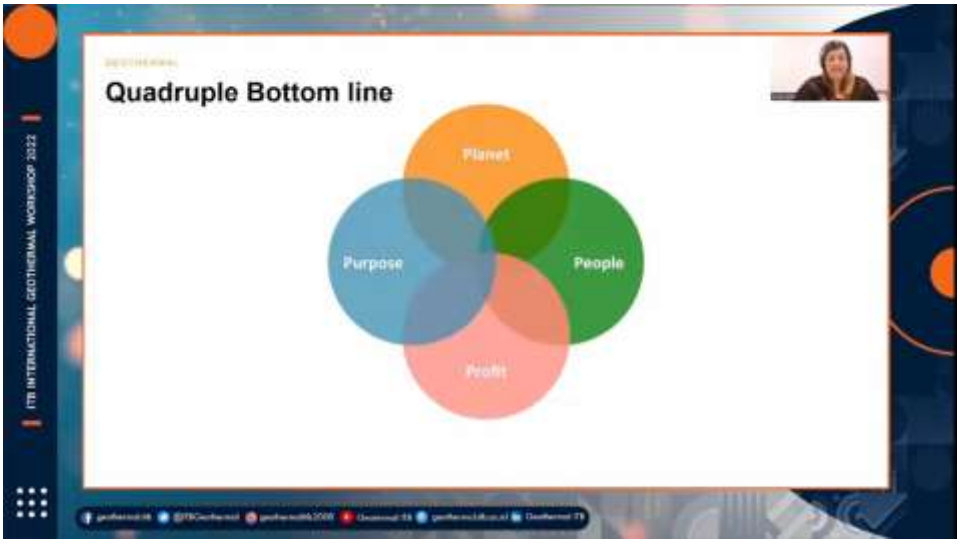
Group Photo with Speakers and Moderator

Keynote Speech by Minister for Energy and Mineral Resources of The Republic of Indonesia (Mr. Arifin Tasrif)

Memento to Speaker by Moderator (Prof. Tubagus Ahmad Fauzi Soelaiman)

Keynote Speech by Mr. Kevin Burnett (New Zealand Ambassador for Indonesia)

. Keynote Speech by Mr. Prijandaru Effendi (Chairman of Indonesian Geothermal Association)

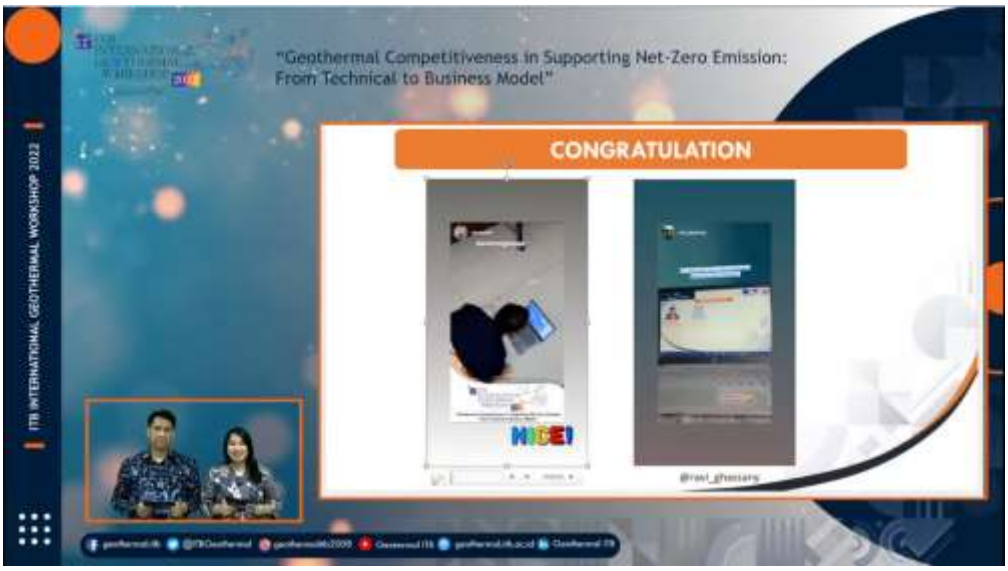


Presentation by Ms, Andrea Blair (President of International Geothermal Association (IGA)

Presentation by Speaker from PT. Geo Dipa Energy (Mr. Yudistian Yunis) during Plenary Session about Geothermal for Net Zero Emission on Day 1

Presentation by Mr. Dicky Edwin H (Consultant for Decarbonization)

Memento to Speaker (Mr, Dicky Edwin H) by Moderator (Mr. M. Ali Ashat) during Plenary Session about Geothermal for Net Zero Emission on Day 1



Closing by Master of Ceremony on Day 1 (during Announcement for the Winner of Instagram Update)

3.2. Day 2 (August 3rd, 2022)

Opening ITB International Geothermal Workshop's Main Event 2022 by Master of Ceremony (Amerensia Leticia S) on Day 2

Group Photo between Speakers and Moderators

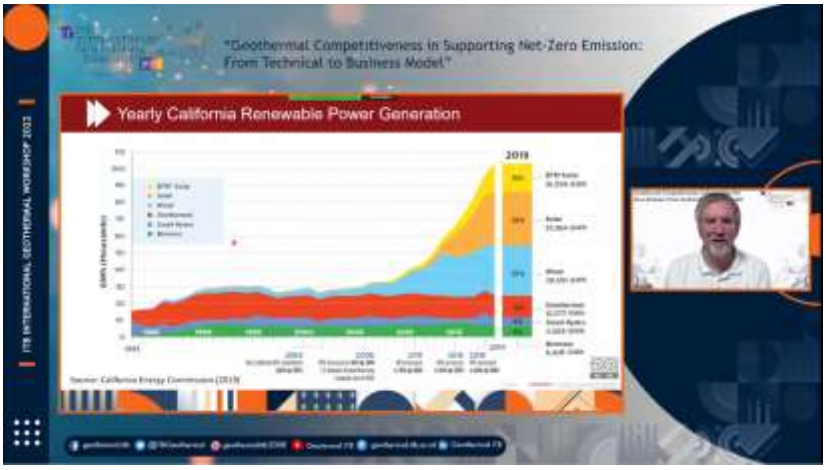
Presentation Regarding Geothermal Competitiveness and Opportunities by Ms. Robin Zuza (Director of Global Exploration at Ormat Technologies, Inc.

Question and Answer Session Speaker (Ms. Robin Zuza) with Moderator (Mr. Angga Bakti P)

Memento to Speaker by Moderator

Presentation by Mr, Hariyanto (Head of Center for Mineral, Coal, and Geothermal Resource)

Group Photo with Speakers and Moderator



Presentation by Prof. Ronald N. Horne (Professor of Standford University)

Memento to Speaker by Moderator (Mr. Alfend Rudyawan)

Presentation by Mr. Roy Daroyni (Business Development, SE-Asia & Australia, Technology Solution, Kellogg Brown & Root LLC)

Presentation by Mr. Graeme Beardsmore (Secretary of the Asia-Western Pacific Regional of the International Geothermal Association)

Memento to Speaker by Moderator (Mr. Dimas Taha Maulana)

Closing by Master of Ceremony on Day 2

3.3. Day 3 (August 4th, 2022)

Opening ITB International Geothermal Workshop's Main Event 2022 by Master of Ceremony (Yahya Maulana) on Day 3

Group Photo Moderator and Speakers Session 1 on Day 3

Presentation by Mr. Hendra Yu Tonsa Tondang (Vice President of New Renewable Energy PT. PLN Persero

Question and Answer Session led by Moderator (Ms. Riostantieka Mayandari Shoedarto)

64. Memento to Speaker by Moderator

Presentation by Mr. Ahmad Yuniarto (President Director of PT. Pertamina Geothermal Energy)

Presentation by Mr. Novianto (General Manager of PT. Medco Cahaya Geothermal)

Presentation by Mr. Idham Purnama (Vice President of Operation & Business Development of PT. Geo Dipa Energy Persero)

Group Photo Moderator and Speakers Session 2 on Day 3

Presentation by Mr, Novi Ganefianto (Vice President of Exploration & Subsurface Engineering of 69. PT. Supreme Energy)

Question and Answer Session led by Moderator (Ms. Betseba br Sibarani)

Memento to Speaker by Moderator

Presentation by Mr. Iwan Setiawan (Director of Research Center for Geological Resources National Research and Innovation Agency (BRIN))

Presentation by Mr. Hisao Nakano (CEO of Sarulla Operation Ltd)

Presentation by Mr. Dion Murdiono (PT. ORMAT Geothermal Technologies)

Closing Ceremony by Chairman of IIGW 2022 (Dr. Suryatini)

Closing by All Master of Ceremony (Day 1- Day 3)

4. Report on Virtual Workshop

4.1. Day 1 (August 2nd,2022)

Participant

Zoom : 500 Participants

Youtube : 870 Participants

Country : Indonesia, New Zealand, United States, Japan, Tanzania, Australia, United Kingdom

4.1.1 Opening and Welcoming Speech

a. Welcoming Speech : Dr. Suryantini (Chairman of 11th IIGW)

b. Opening Speech : Prof. Ir. Taufan Marhaendrajana, M.Sc., Ph.D. (Head of Institute for Science and Technology Development ITB)

4.1.2 Keynote Speech

a. Keynote Speech 1 : Ir. Arifin Tasrif (Minister of Energy and Mineral Resources, Republic of Indonesia)

b. Keynote Speech 2 : Mr. Kevin Burnett (New Zealand Ambassador for Indonesia)

c. Keynote Speech 3 : Ir. Prijandaru Effendi M.Eng (Chairman of Indonesian Geothermal Assosiation)

d. Moderator : Prof. Ir. Tubagus Ahmad Fauzi Soelaiman, MSME, Ph.D. (Institut Teknologi Bandung)

4.1.3 Plenary Session

a. Plenary Session 1 : Ms. Andrea Blair (President of International Geothermal Association (IGA))

b. Plenary Session 2 : Mr. Yudhistian Yunis (Director of Business Development and Exploration PT. Geo Dipa Energi (Persero))

c. Plenary Session 3 : Dicky Edwin Hindarto (Consultant for Decarbonization)

d. Moderator : Ir. M. Ali Ashat Dipl. Geothermal Tech (Institut Teknologi Bandung)

4.2 Day 2 (August 3rd, 2022)

Participant

Zoom : 400 Participants

Youtube : 320 Participants

Countries : Indonesia, New Zealand, United States, Japan, Tanzania, Australia, United Kingdom

4.2.1 Plenary Session

a. Plenary Session 1: Ms. Robin Zuza (Director of Global Exploration Ormat Technologies, Inc.)

b. Plenary Session 2 : Dr. Ir. Hariyanto M.T. (Head of Center for Mineral, Coal, and Geothermal Resources)

c. Moderator : Mr. Angga Bakti Pratama, S.Si., M.T (Institut Teknologi Bandung)

d. Plenary Session 3 : Prof. Roland N. Horne (Professor at Stanford University)

e. Plenary Session 4 : Mr. Roy Daroyni (Business Development Director SE-Asia & Australia, Technology Solution, Kelogg Brown & Root LLC)

f. Moderator : Alfend Rudyawan, S.T., M.Sc., Ph.D. (Institut Teknologi Bandung)

g. Plenary Session 5 : Mr. Andrew Fleming (Founder and CEO GeoX Energy Inc.)

h. Plenary Session 6 : Mr. Graeme Beardsmore (Secretary of the Asia-Western Pacific Regional Branch of the International Geothermal Association (IGA-AWPRB)

i. Moderator : Mr. Dimas Taha Maulana, S.T, M.T.(Institut Teknologi Bandung)

4.3 Day 3 (August 4th, 2022)

Participant

Zoom : 300 Participants

Youtube : 500 Participants

Countries : Indonesia, New Zealand, United State, Japan, Tanzania, Australia, United Kingdom

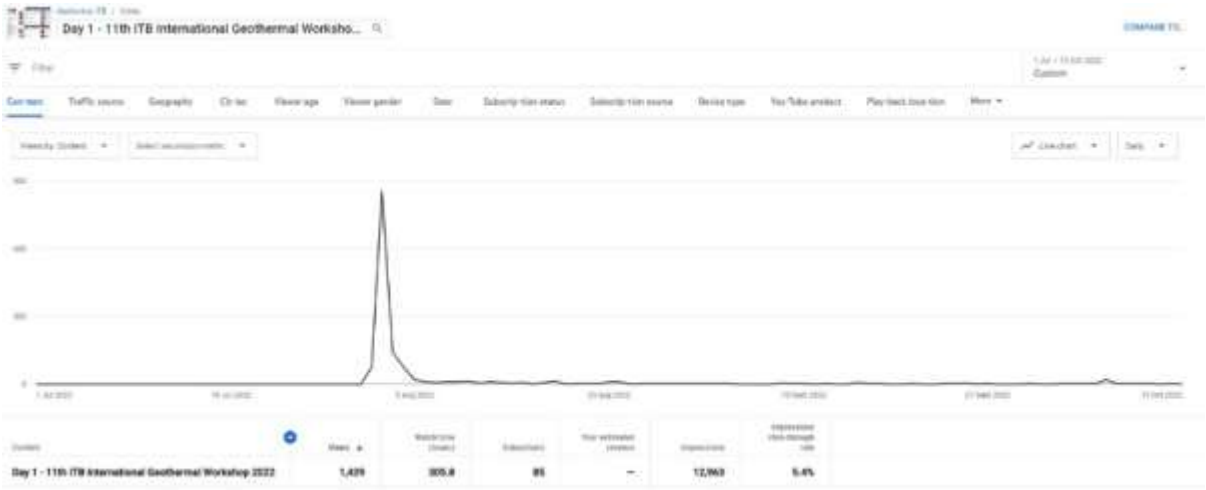
4.3.1 Plenary Session

a. Plenary Session 1	: Mr. Hendra Yu Tonsa Tondang (Vice President of New Renewable Energy PT. PLN (Persero)
b. Plenary Session 2	: Mr. Ahmad Yuniarto (President Director of PT. Pertamina Geothermal Energy)
c. Plenary Session 3	: Mr. Novianto (General Manager of PT. Medco Cahaya Geothermal)
d. Plenary Session 4	: Mr. Idham Purnama (Vice President Operation & Business Development PT. Geo Dipa Energy (Persero))
e. Moderator	: Riostantieka Mayandari Shoedarto, Ph.D. (National Research and Innovation Agency Republic of Indonesia (BRIN))
f. Plenary Session 5	: Mr. Novi Ganefianto (Vice President Exploration & Subsurface Engineering of PT. Supreme Energy)
g. Plenary Session 6	: Dr. Iwan Setiawan, M.T. (Director Research Center for Geological Resources National Research and Innovation Agency (BRIN))
h. Plenery Session 7	: Mr. Hisao Nakano (CEO of Sarulla Operation Ltd)
I. Plenary Session 8	: Mr. Dion Murdiono (President Director of PT. ORMAT Geothermal Indonesia)
j. Moderator	: Betseba br Sibarani, S.T., M.T. (Institut Teknologi Bandung)

5. Video views and attendance

5.1 . Day 1

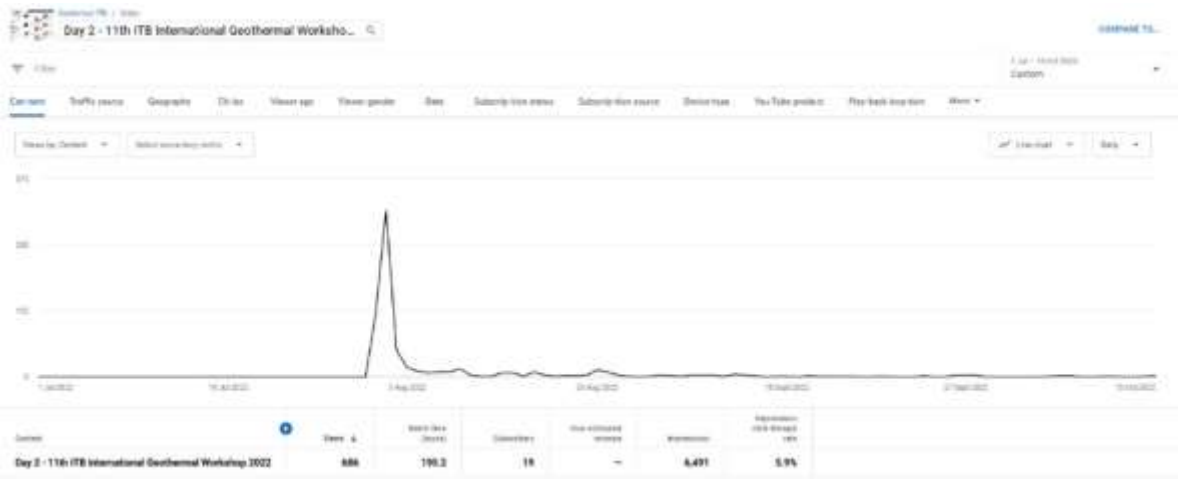
Youtube link : https://www.youtube.com/watch?v=OrYgNczIOmc&t=330s



Accumulated Day 1 youtube video viewers from July 1st - October 15th, 2022

5.2 Day 2

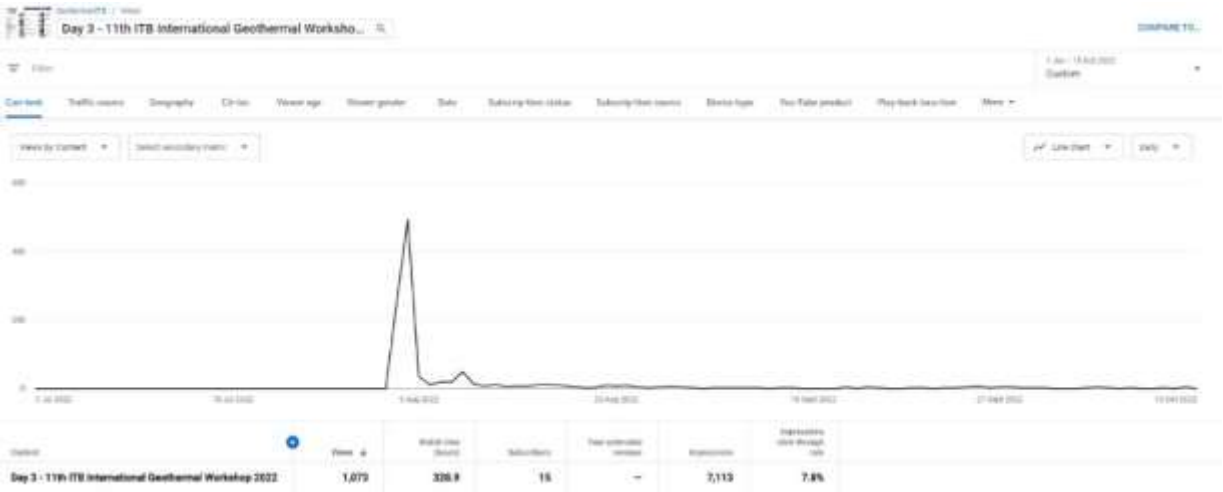
Youtube link : https://www.youtube.com/watch?v=AApnIzKQ0_M&t=8928s



Accumulated Day 2 youtube video viewers from July 1st - October 15th, 2022

5.3 Day 3

Youtube link : https://www.youtube.com/watch?v=fql9uC69X9w



Accumulated Day 3 youtube video viewers from July 1st - October 15th, 2022

5.4 Zoom & Youtube Webinar Attendances

Day 1 (August 2nd, 2022)

a. Zoom : 500 Participants
b. Youtube : 870 Participants

Day 2 (August 2nd, 2022)

a. Zoom : 400 Participants
b. Youtube : 320 Participants

Day 3 (August 2nd, 2022)

a. Zoom : 300 Participants
b. Youtube : 500 Participant