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COUNTRY UPDATE: MALAYSIA

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ABSTRACT

Malaysia in one of the ASEAN countries that sits close to the Pacific Rings of Fire, where it is known to be rich with volcanoes and hot springs. Discovered as a promising renewable energy, the Malaysia government is now focus in exploring and developing geothermal resources to generate clean renewable energy and reducing its dependency on the fossil fuel. Several geothermal fields have been identified, and detailed exploration study was now being conducted by various government agencies and universities to better understand its potential. Apas Kiri and Ulu Slim geothermal fields are among the two most important geothermal energy resources identified. Moving forward, a small 200kW Organic Rankine Cycle (ORC) geothermal power plant is expected to be constructed aiming to demonstrate the potential of the non-volcanic source in generating electricity. Despite its potential to generate clean energy, the geothermal resources in Malaysia have gain international recognition being utilized for tourism destinations. It has successfully boosted local economies and promoted infrastructural development. To instill awareness on the geothermal resources and potential, Malaysia geothermal Association (MyGA) was officially founded. MyGA has involve in various initiative, organizing program and drafting working paper for the development of geothermal resources in Malaysia.

KEYWORD: Geothermal**,** Malaysia, Proof of Concept, Geotourism, Malaysia Geothermal Association Malaysia

1. INTRODUCTION

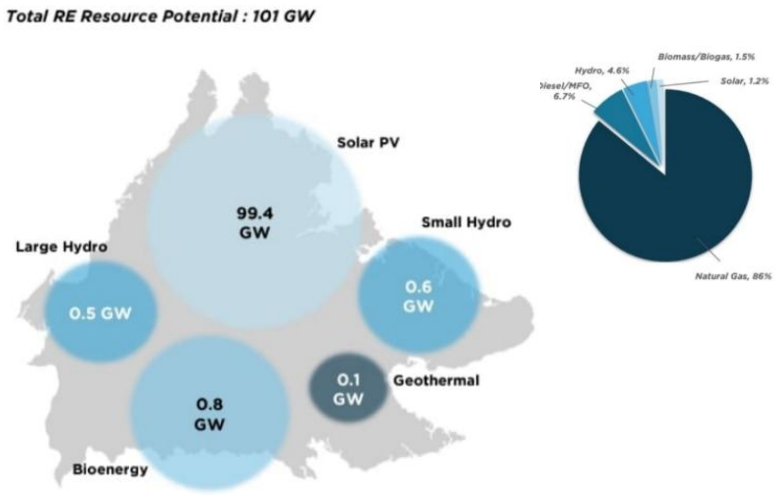
Malaysia strategic location in the hearth of Southeast Asia is blessed with its robust grid infrastructure and energy production facilities. This has positioned Malaysia a global destination for offshore manufacturing hub, energy exporter and recently it houses several important data centres that is use for telecommuting, AI and even for defence purposes. Based on recent report produce by the Malaysia government, Malaysia is facing significant pressure on its power generation capacity and need a massive addition by 2030 to avoid electricity shortage. Its reliance on its fossil produced to generate power has been significant with 38% of

its electricity generation is produce by coal fire power plant, 39% by gas and diesel with remaining 23% is generated by renewable energy of hydroelectric plant, biomass and solar farms (Figure 1).

Necessitating a strategic shift towards a low-carbon economy to mitigate climate change impacts and to boost its clean energy production. Malaysia has launched the National Energy Transition Roadmap (NETR) in 2023. It was an ambitious renewable energy target aiming to reduce GHC emission by 32% and increase the power output through renewable energy by 70% in capacity by 2050.

Geothermal is recognized as an important resource that could scale up Malaysia's renewable energy supply. The first detailed exploration study for geothermal power in Tawau is purposely to solve insufficient electric supply to the southeast coast area of the Borneo island by utilizing clean renewable energy of the geothermal. Report produced by the Sustainable Energy Development Authority (SEDA) indicates that Sabah has a wealth of renewable energy resources that are still underutilized. Tawau is the third largest city in Sabah, is an important economic hub and houses an important multi-purpose port serving as marine trade and logistic on the Celebes Sea region. With a population of 400,000 in 2021 Tawau electricity production is 180MW with the remaining 100MW power is supplied through a 275kW transmission line from power plants in Sandakan and Lahad Datu. Increase of 30 – 40% of electrical consumption is projected for the Borneo island states in Malaysia as significant development project by various offshore investors. For geothermal, a study commissioned by Department of Minerals and Geoscience Malaysia has identified an estimated 100 MW of geothermal resource potential in Tawau, Sabah.

Figure 1: Demographic of Sabah energy and renewable energy as complied by Energy Commission of Sabah (ECoS)



Launched in 2022 the LAO PDR – Thailand – Malaysia – Singapore Power Integration Project (LTMS PIP) or better known as Asean Power Grid is a tripartite energy wheeling agreement, as an initiative of the ASEAN country to further enhance energy corporation and accelerate the region's energy transition by enabling greater integration of clean energy across interconnected power system (Figure 2). The grid allows Malaysia to act as a central hub for regional renewable energy trading generating revenue through wheeling charges and enhancing energy security. The ASEAN Power Grid will facilitate the development of resilient regional interconnection infrastructure that can withstand the impact of rising energy demands, climate imperative and reducing the dependency of the ASEAN country to fossil fuel to generate electricity. Geothermal energy

is a crucial high potential renewable resources for ASEAN countries. This report paper explores the obstacle, challenges and initiative for Malaysia to adopt geothermal as its new energy source.

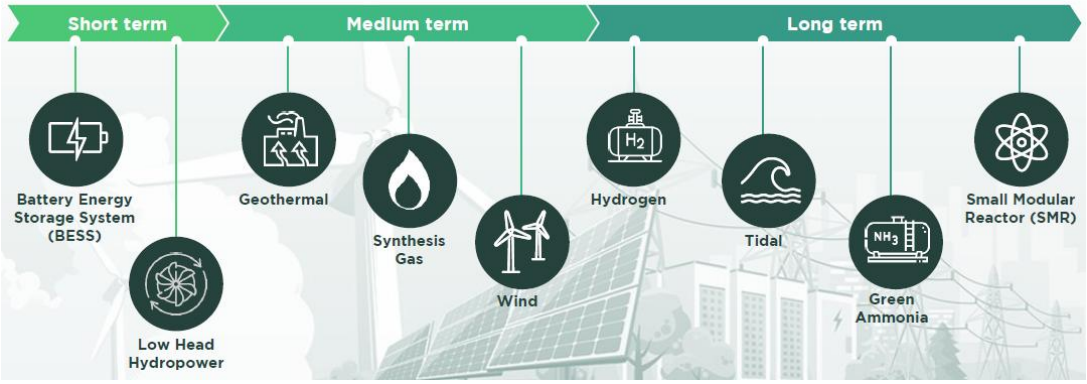


Figure 2: Planning for short-medium-long term of renewable energy for Thailand-Malaysia- Singapore

2. GEOTHERMAL POTENTIAL

Malaysia houses a significant low to medium enthalpy of both non volcanic and volcanic geothermal resource (Abdalmajed et al, 2025a & 2025b). The non volcanic resource is mainly found in the Peninsular of Malaysia while volcanic geothermal potential scattered within eastern part of Sabah. More than 100 hot springs were mapped by various researchers and government agencies, 22 hot springs were categories as highly potential for geothermal power development with estimated resources capacity of 468MW (Table 1). Exploration study conducted by the Department of Mineral and Geosciences Malaysia (JMG) confirmed potential geothermal resources of 162MW in Ulu Slim Perak and 67MW in Apas Kiri, Sabah.

These non-volcanic resources are highly concentrated near the major fault zone within the main range granite of the Banjaran Titiwangsa. Permeable fracture from the major fault zone provides a good medium of meteoric water transportation that allows it to seep down underground. The volcanic resource in Malaysia primarily concentrated in Tawau near the Mount Maria volcanic complex and Sungai Jepun area of Semporna.

Table 1 : Location of hot spring and geothermal potential in Malaysia with resource capacity (MW)

No	State	Number of Hot Spring	Geothermal Potential	*Resources Capacity (MW)
1	Kedah	8	1	12
2	Perak	27	5	226
3	Selangor & Kuala Lumpur	15	5	50
4	Negeri Sembilan	11	1	9
5	Melaka	3	2	17
6	Johor	3	1	20
7	Pahang	3	1	12
8	Terengganu	4	1	10
9	Kelantan	11	1	30
10	Sabah	7	3	67
11	Sarawak	8	1	15
Total		100	22	468

*Resources capacity compiled based on current data and finding from limited 3G survey and drilling program.

a) Non-Volcanic Geothermal

Malaysia is well known for tin extraction industries within its granitic region. The tin extraction activity produces by-product known as amang that contains radiogenic material that is mainly radioisotope such as uranium (U-238), thorium (Th-232) and potassium (K-40).

Research that was conducted in Malaysia prove that radiogenic granite in the upper crust of Peninsular Malaysia contribute to the increase of thermal output. This radiogenic heat production (RHP) in granite is associated with the existence of hot spring within the tin rich area. Previous study conducted by the Universiti Kebangsaan Malaysia (UKM) on various granite collected from the geothermal and tin mining area show higher Radiogenic Heat Production (RHP) than non-associated granite (Abdalmajed et al 2025b). Heat source in this granite is linked to radiogenic decay of unstable isotopes within the rock.

One of the most important geothermal areas that host the highest out flow temperature of 92°C is the Ulu Slim geothermal field. Ulu Slim geothermal is located within the rich tin ex mining area that produces tin ores and radiogenic amang. The Ulu Slim field is located within the main range granite of the Banjaran Titiwangsa and the metasedimentary of Terolak Formation.

The Ulu Slim field, like most others Peninsular geothermal field is primarily controlled by multiple fault intersection within its fault zone system. Highly fractured granite provides a good path for meteoric water circulation. Almost all the geothermal fields in the Peninsular produce bicarbonate (HCO_3) water with low to medium range of total dissolved solid of 90 – 500 ppm. The low sulphate (SO_4) content of the geothermal water suggested a combination model between the cooling magma and thermal gradient fault control geothermal models. The granitic intrusion represents the cooling radiogenic magma that increases the temperature of all rocks in the area while the fault represents the permeable zone which offers rapid penetration of ground or meteoric water to depth where the rocks are hot enough to generate a convection up flow for the hot water (Figure 3).

Exploration study of the Ulu Slim field was first documented by the JMG. In 2024, 'Pre-Feasibility Study' to better evaluate the potential of the Ulu Slim geothermal was done by PETRONAS and Geothermal Resources Sdn Bhd (GRSB) a turnkey company that is set up by the UKM that focus on prefeasibility, exploration and development work of geothermal resource in Malaysia.

Among the most significant non volcanic geothermal resources in the Peninsular Malaysia are the Sungai Kelah field in Perak, Sungai Ber field in Kelantan, Hulu Langat geothermal complex in Selangor and Gadek geothermal field in Melacca.

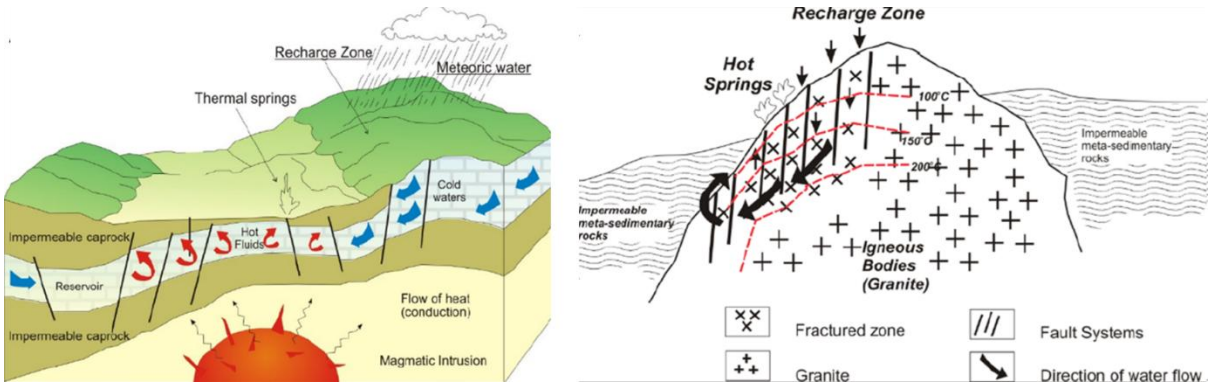


Figure 3: Illustration of a conceptual model for fluid circulation of hot spring system in Ulu Slim (Arnout, 2024)

b) Volcanic Geothermal

The Eastern Borneo island covering most of the Sabah geological setting is situated on the ophiolitic basement of Cretaceous to Eocene age rock. Study conducted by the JMG found that the Tawau-Semporna region area of high potential for geothermal energy resources. The initiative to investigate and identify the geothermal fields was conducted since the late 80's. Detailed study to map and collect comprehensive data of surface geothermal manifestation shows promising areas in Apas Kiri and Sungai Jepun. Both the geothermal area is volcanic associated with a heat source beneath the Pleistocene age Quaternary volcanic rock of Mount Maria and Mount Andrassy volcano. The highest surface temperature of the Apas Kiri geothermal is recorded at 84°C while the Sungai Jepun geothermal is 75 °C. Figure 4 shows the simplified model for Apas Kiri, Tawau by Mohammad Noor Akmal Anuar et al 2021). A new proposal was prepared to conduct more detail study for Sungai Jepun in near future.

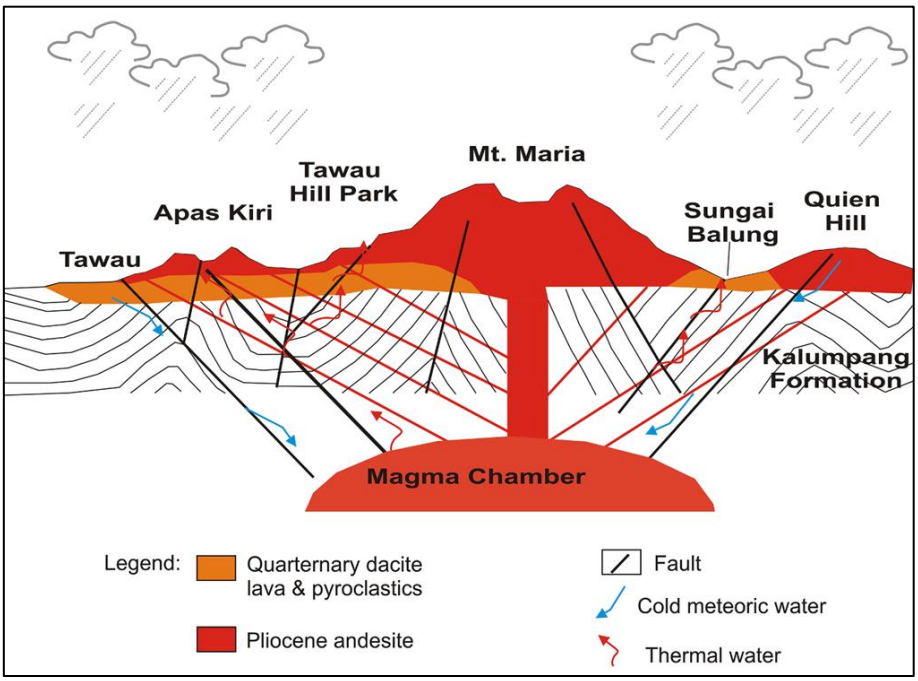


Figure 4: Illustration of a conceptual model of a volcanic system in Apas Kiri Sabah (Mohammad Noor Akmal Anuar et al 2021)

3. GEOTHERMAL DEVELOPMENT

3.1. Drilling Attempt

Detail exploration study conducted by the JMG in Apas Kiri Geothermal field show a promising area for the development of Malaysia first geothermal plant. With an initial investment of RM35 million from the Malaysia Federal Government, Tawau Green Energy a state own company, was granted permission to initiate detail exploration and drilling works. In 2016 the first exploration well (AK-1D) was drilled to a depth of 1,449 meters. The bottom hole temperature of 191°C was recorded and subsurface study was successfully done to evaluate the potential of the geothermal field. It is found that the geothermal source is likely to encountered in the central up flow region closer to the summit of Mt Maria. Apas Kiri geothermal field is suitable to house Malaysia first 30MW Binary Organic Rankine Cycle (ORC) geothermal power plant, that will cost RM600 million for its development. Delay on the plant development stage the project was canceled in 2018.

3.2. Proof of Concept

The proposal on proof of concept (PoC) for a geothermal power development project was submitted by Malaysia Sustainable Energy Development Authority (SEDA). The submission seeks to secure funding from the Electricity Supplies Industry Trust Account (AAIBE) for an in-depth feasibility study.

The proposal details the rationalize and methodology to access the viability of geothermal energy extraction from Malaysian non volcanic geothermal resource. Ulu Slim geothermal field were selected to house Malaysia first 200kW geothermal power plant as the source has been studied in detail by various researcher and academician. The project that will also involve the participation of Department of Mineral and Geosciences Malaysia, Universiti Kebangsaan Malaysia (UKM) and PETRONAS involvement remains subject to project sanction by its management. The proposal defines a comprehensive plan to evaluate the potential, technology suitability and economic viability for Malaysia to develop its own geothermal power plant and addressing the current gap in Malaysia renewable energy portfolio.

The two years project is divided into two stages; the first stage involves details resource evaluation, engineered well drilling and geothermal resources assessment. A single slim well design will be considered of 500m to 700m depth. During the first phase thermal properties measurement of rock, core, and water samples, well logging and evaluation of subsurface data that involve hydraulic stimulation, circulation test of the working fluids and various performance models will be derived to better understand the resource characteristics, energy transmissivity and suitability for the geothermal power plant that will be constructed.

The second stage will be the installation of a 200kW geothermal power plant. A local geothermal proof of concept (PoC) ensures that the specific site, regulations, infrastructure, and market conditions are ready for full-scale commercial deployment. It de-risks investment, accelerates regulatory approvals, and builds stakeholder confidence after systematically reducing exploration, policy, offtake, and financing risks.

Data collected from the PoC will also help SEDA in evaluating and rationalize suitable fit in a Feed-in Tariff (FiT) system that involve determining whether future geothermal development project meets the technical, legal and economic criteria to secure long term contract for exporting electricity to the Malaysian grid.

3.3. Geothermal for Recreational Tourism

Geothermal resources in Malaysia are primarily utilized for recreational, wellness and eco-tourism. More than 50 geothermal field in Malaysia has been developed for tourism and are popular for their mineral rich water which is often tapped for spa treatments, public swimming pools and hot spring parks. The development of the hot spring facilities by various government link agencies and private own companies has significantly contributed to local economies through job creation, increased tourism revenue and various business opportunities. The historical and cultural unique identities of these geothermal sites are also leveraged for geotourism promoting educational programs that advocate for natural resources conservation and sustainability development. The Sunway Lost World of Tambun is one of the geosites that in Kinta Valley Geopark, it is located on an intrusive contact between main range granite batholiths and metasedimentary rocks, primarily by 400 million years old limestone and marble hills. The development of the Tambun geothermal field has transformed an abandoned tin mined mining wasteland into an important tourist destination. Proper planning by the local government, sufficient allocation and revenue generated from the tourism activities help to preserve several geothermal fields in Malaysia, among them are the Ulu Legong in Kedah, Lubuk Timah in Perak, Tok Bok hot spring in Kelantan, Bentong hot spring in Pahang, Annah Rais in Sarawak and Poring in Ranau, Sabah.

4. GEOTHERMAL AWARENESS

A tripartite agreement was signed between UK-based consultancy Primeval Energy, the Institute of Geology Malaysia (IGM), and Digital Geoscience Global Sdn Bhd (DGeG) to conduct thorough assessments of geothermal energy potential in Malaysia. The partnership will focus on facilitating the development of geothermal energy project in Malaysia.

The first Malaysia International Geothermal Conference (MIGC 2024) was held in UKM in 23 – 25 September 2024. The conference has gathered both local and international speakers, sharing knowledge and findings on geothermal. The event keynote speakers were Prof. Dr. Yunus Daud from University of Indonesia and Dr Wipada Ngansom, Ramkhamhaeng University of Thailand and Mr. Fredolin Javino from JMG. Next, which is 2nd MIGC will be conducted in 2027.

The Malaysia Geothermal Association (MyGA) was formally established in 2025 as a strategic collaboration to unify the fragmented landscape of geothermal expertise across the nation. Administratively, MyGA successfully appointed its inaugural Leadership Team and Council Members during the Annual General Meeting (AGM) on 20 March 2025. By fostering a triple helix collaboration, MyGA integrates the intellectual capital of academia, the regulatory oversight of the government, and the technical execution of the private industry to accelerate geothermal development in Malaysia. Internationally, the signing of a Memorandum of Understanding (MOU) between MyGA and International Geothermal Association (IGA) has successfully integrated Malaysia into the global geothermal community, facilitating a vital transfer of knowledge and best practices.

With the collaboration of several Malaysian universities, government agencies and industries has successfully organize Malaysia first International Geothermal Week Malaysia (IGWM 2025) on 4 – 12 October 2025. With objective of creating public awareness on the importance sustainable development of Malaysia geothermal resources. Programs include knowledge sharing sessions, STEM education, exhibition, site visits to the Ulu Slim hot spring and local community's services together with special edition of stamps with Pos Malaysia. During IGWM 2025, the Geothermal Research Centre (GRC) was also officially introduced to the public. The research center initiative emerged from the earlier pre-feasibility study undertaken by GRSB and PETRONAS with the purpose of encourage more research and findings that could foster sustainable development of geothermal resource in Malaysia.

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