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Multilateral Development Bank Support for Upstream Geothermal Development

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ABSTRACT

This paper shows how the Global Geothermal Development Plan (GGDP), a World Bank initiative led by the Energy Sector Management Assistance Program (ESMAP), mobilized $235 million through the Clean Technology Fund (CTF) to shift Multilateral Development Bank (MDB) support from downstream to upstream investments – from the power plant to the exploratory well. By using concessional financing to overcome the primary obstacle to geothermal expansion, the cost and risk of exploratory drilling, the GGDP has been effective at scaling up geothermal investments across the globe. To maximize value of concessional financing and leverage private sector financing, the support that is provided through MDBs is tailor-made to country and client's needs. The evolution and customization of MDB support is illustrated in the context of Indonesia, Turkey and Dominica.

1. ROLE OF MULTILATERAL DEVELOPMENT BANKS IN GEOTHERMAL DEVELOPMENT

The development of geothermal resources for productive uses has significantly depended on financial resources from the public sector. With a few exceptions, geothermal development in countries was kickstarted with the aid of Governments, international financial institutions and other organizations that used public funds to provide financing at a lower cost than private markets (henceforth public financing; ESMAP, 2016). For example, in the East African Rift Valley, the UNDP and national Governments provided grant financing for preliminary surveys and surface exploration during the 1970s while development donors and the government provided concessional loans in the 1980s to build a power plant in Olkaria, the first in the region.

In theory, public financing for geothermal energy can be argued based on incomplete and imperfect markets. Classical economic theory dictates that in a situation of complete and perfectly competitive markets, market outcomes are socially (pareto) optimal. In practice these conditions are rarely met, there are incomplete and/or imperfect markets and market forces alone yield sub-optimal outcomes which can be improved through public intervention. In the case of the geothermal sector, incomplete and imperfect markets broadly exist in the following forms: incomplete insurance and capital markets to hedge risks; imperfect competition due to barriers to entry, first mover advantages, potential economies of scale, incomplete and asymmetrical information; and spatial externalities resulting from the subterraneous mobility of geothermal fluids. More broadly, the state of energy markets beyond the geothermal sector can provide rationale of public financial support. Direct subsidies for fossil fuels amounted to $400B (IEA, 2019) in 2018 while mechanisms to internalize the externalities from their use are hardly existent. These price signals lead to an over-consumption of fossil fuels vis-a-vis other fuels. It is often argued that in such a second-best world, public financial support for geothermal (and other renewables) would at least level the playing field, and at best improve the allocative inefficiency of current energy markets.

For geothermal market failures exist after resource confirmation in the form of information constraints about the longer-term economic viability of the resource as well as the unfamiliarity of operators with geothermal technology. However, it is the high costs and risks of exploratory drilling, unique to geothermal, that perhaps provides the strongest rationale for public financing of geothermal. Given the heterogenous nature of geothermal resources, the quality of which for productive uses is not ascertained until significant investments have been made in exploratory wells, exploratory drilling is a high cost high risk endeavor. Geothermal development is a relatively specialized business that does not benefit from the economies of scale and scope the same way that the oil and gas business does due to the relative scarcity and geographic dispersion of the economically viable resources. As a consequence, firms in the industry are often unable to hedge the risks of tapping into an unproductive resource and/or unable to leverage sufficient financing to cover the high associated capital costs. The market fails because of incomplete insurance and capital markets, but also because of the high transaction and coordination costs that would be necessary to hedge risks, for example through a portfolio approach.

MDBs provide one channel for delivering public financial support for geothermal in developing countries. Development of geothermal resources demands a high level of technical expertise. This combined with the high upfront capital costs (typically $4-5 million per MW of installed generation capacity) and the unpredictability of the resource means that any public financial support will run the risk of wasting public funds unless well designed and executed. Developing countries have therefore been looking to MDBs to provide a combination of concessional financing, technical assistance for capacity building and use of their convening power to bring stakeholders together in support of geothermal development. MDB financing is primarily made available in the form of grants and loans at below market interest rates.

However, MDB support has historically been focused on downstream geothermal investments. Before 2013, 93% of MDB financing was made available for downstream geothermal investments – confirmation drilling, production drilling, steam above ground systems, power plants and transmission and distribution systems. Only 7% was made available for upstream investments – preliminary surveys, surface exploration and most importantly, exploratory drilling. This statistic reflects the lack of consensus within MDBs before 2013 that it is at the upstream stage where public financial support is most needed and justified.

The Global Geothermal Development plan was launched by ESMAP in 2013 to shift MDB support from downstream to upstream geothermal development. Informed by a growing recognition that MDB financing was not addressing the key barriers to geothermal scale up in developing countries and the ESMAP Geothermal Handbook (ESMAP, 2012), ESMAP created the GGDP in 2012 and launched it in 2013 with the aim of refocusing MDB support towards the cost and risk of exploratory drilling. By March 2015 the GGDP had raised US$235 million through a new window within the CTF which helped leverage a further US$1 billion in World Bank lending for upstream geothermal development, as well as financing from other MDBs (most notably the InterAmerican Development Bank and the European Bank for Reconstruction and Development).

Through the GGDP, as a share of total MDB financing, support for upstream geothermal development increased from 6% in 1975-2012 to 39% in 2013-2020[1]. The impact of the GGDP is shown in the charts below. In the 1980s, MDBs supported exploratory drilling in the Philippines and Kenya. However, from 1989 to 2011 virtually no MDB finance was directed towards upstream development. Starting in 2012, the World Bank has supported upstream geothermal development in Armenia, Djibouti, Dominica, Indonesia and Turkey. These projects are expected to lead to an additional 1GW of capacity and reduce CO_2 emissions by an estimated 6.2 million tons per year over the course of their lifetime. Other MDBs have similarly scaled up support for upstream geothermal development by tapping into CTF funding to help de-risk geothermal fields in countries such as Chile, Mexico, Kenya, Indonesia, the Philippines and the Eastern Caribbean.

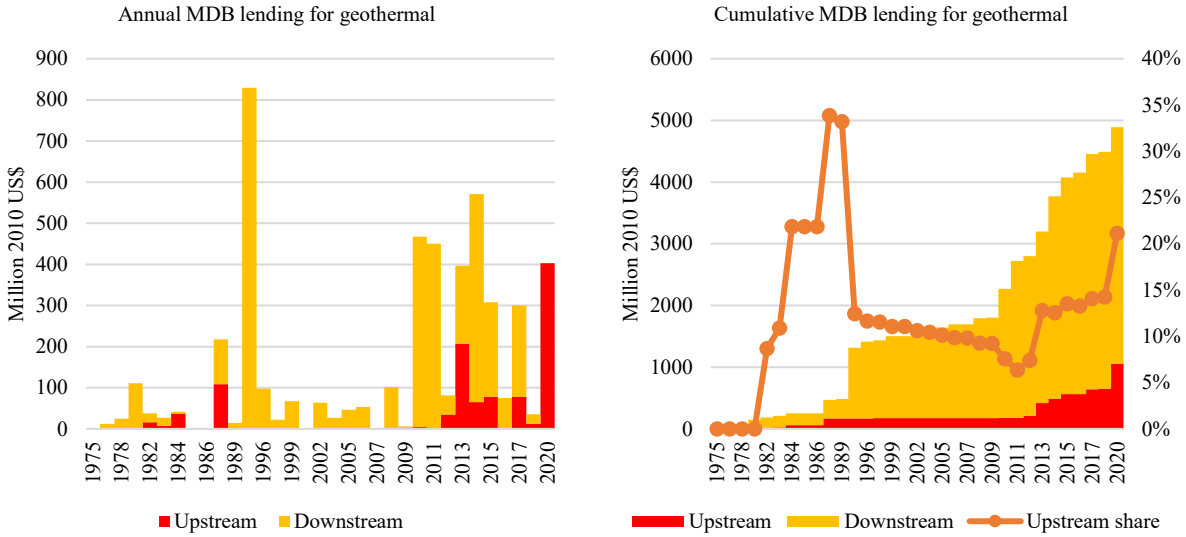

Figure 1: Annual and cumulative MDB lending for upstream and downstream geothermal development

Through the GGDP, the World Bank has gained substantial experience in the geothermal sector, the lessons from which are informing its continued support of the sector. MDB support for geothermal energy is addressing both the costs - through concessional financing - as well as risks of geothermal development – through cost-shared drilling and geothermal resource risk insurance mechanisms. Experiences from World Bank supported operations are informing the design of future projects to better tailor support to country and field context. What follows here are three country case studies illustrating these lessons learned: World Bank engagement with the Geothermal sector in Indonesia is a story about a gradual shift from downstream towards upstream support and increasing sophistication of support mechanisms; the experience in Turkey illustrates how risk sharing mechanisms and credit lines for capacity drilling and power construction go hand-in-hand to support upstream and downstream development and scale up geothermal in sector with significant technical capacity and a dynamic private market; World Bank engagement Dominica illustrates support in countries with more limited resources/scale, where geothermal may still have a unique role in an increasingly competitive market for renewable power.

2. INDONESIA

Indonesia has an installed geothermal power capacity of 1,948 MW. This represents only 7% of the country's estimated 29 GW of geothermal potential, which the government sees as a priority to develop. Indonesia holds roughly 40 percent of the world's known geothermal reserves. Geothermal energy, as a domestically available proven baseload clean technology, has been a priority in the Government of Indonesia (GoI)'s Roadmap for Accelerated Development of New and Renewable Energy 2015-2025, by which it aims to add 4.6 GW of additional geothermal installed capacity, requiring US$25 billion in investments.

Regulatory changes related to licensing and PPA-setting have failed to eliminate uncertainties and to achieve the expected scale-up of geothermal investments. In the early 2000s, Indonesia had difficulties in mobilizing financing for its ambitious geothermal development target, mainly due to (i) insufficient regulatory support, (ii) inadequate incentives and pricing mechanisms, (iii) limited institutional capability, and (iv) weak domestic capacity in resource assessment and equipment manufacturing. The Geothermal Law of 2014 endeavored to address some of these issues by stipulating that the Government will conduct a license tender for geothermal sites with adequate surface data and/or drilling information for which a geothermal work area (Wilayah Kerja

[1] World Bank fiscal year, which runs from July 1st to June 30th

Panas Bumi, or WKP) has been established. For areas without adequate data, potential developers are invited to obtain a Preliminary-Survey-Plus Exploration (PSPE) license, based on technical qualifications, and upon proof of successful exploration drilling, the Ministry of Energy and Mineral Resources (MEMR) will designate the project as a WKP and open a limited tender to obtain a full development license. Even though the PSPE-license holder will be offered to match the lowest alternative bid, there is a risk that the initial investment will be lost and the WKP handed over to someone else. Furthermore, developers can only negotiate a Power Purchase Agreement (PPA) with PLN after resource confirmation, so they cannot be sure that they will be guaranteed a reasonable return on their investment before they commit to exploration drilling.

A recent tariff regulation has also set back geothermal development as MEMR Regulation No. 50/2017 caps geothermal tariffs at the average regional electricity generation cost level (Biaya Pokok Penyediaan, or BPP). The BPP rule presents attractive tariffs in the diesel-based systems of the small- and medium-sized islands in eastern Indonesia; however, it may be challenging for geothermal energy to compete in the coal-dominated main power markets of Java-Bali and Sumatra, where the average generation cost is much lower. The tariff cap clearly does not account for the avoided economic costs associated with switching from geothermal to coal power generation or the subsidies to generated electricity which amounted to 2% of GDP in 2018 (IEA, 2019).

To enhance the investment climate and GoI's capacity to support sector growth, the World Bank in 2011 mobilized a US$4 million technical assistance grant from the Global Environmental Facility (GEF) and US$5 million from the GoI. On the investment side, the Geothermal Clean Energy Investment Project supported Pertamina Geothermal Energy (PGE) in the establishment of four geothermal generation units (a total of 150 MW) through a US$300 million blended loan that included a soft loan of US$125 million from the Clean Technology Fund (CTF) to finance the steam-above-ground systems and power plant construction. Besides displacing significant oil and coal-based power generation, the rationale for support was to kick-start a revival of the geothermal sector after a decade of relative standstill and building technical and management capacity of PGE so that they could become a world-class geothermal developer.

However, GoI also realized that the high risk and elevated costs of geothermal exploration remained a major impediment to sector development. Inspired by the experience from several developed economies, GoI decided to start a program for government-sponsored exploration drilling. Assisted by the World Bank, GoI initiated in 2017 the Geothermal Energy Upstream Development Project (GEUDP), which will channel US$104.25 million into exploration drilling of up to four greenfield WKPs. The Project is implemented by PT SMI, a non-banking financial institution. Upon resource confirmation, the data package will be tendered out by MEMR, where the winning bidder will be required to pay back the drilling costs plus a premium. If no resource is found, the cost will be absorbed by CTF contingent grant. Repayments and premiums are intended to support future exploration drilling as part of a revolving mechanism. The GEF grant, together with New Zealand's parallel grant financing, plays a crucial role in building capacity in PT SMI's exploration drilling management and environmental and social safeguards management. The Project expects to have drilling on the first site (on the island of Flores) by the end of 2019.

In recognition of the tremendous geothermal resources still to be developed and the significant capacity of the key public and private sector actors, GoI decided to broaden the support to geothermal exploration through establishment of the Geothermal Resource Risk Mitigation (GREM) Facility. The Facility will provide blended finance with soft loans and reimbursable grants where the latter is deployed as at-risk capital for resource confirmation and therefore will significantly reduce developer's equity requirements. The total possible grant support in case of unsuccessful drilling is 37.5% of exploration costs (with a maximum support of $15 million). However, the grant support may be scaled down based on Fair Market Value (FMV) of the Developer SPV. If exploration results indicate good steam resources, then FMV will be high, and all or part of the reimbursable grant needs to be paid back. The US$840 million Facility will be implemented by PT SMI during 2019-2029 in two phases. The first phase consisting of US$400 million from the International Bank for Reconstruction and Development (IBRD), the Green Climate Fund (GCF), CTF and Government funds through the Infrastructure Financing for Geothermal Sector (Pembiayaan Infrastruktur Sektor Panas Bumi, or PISP), was approved by the World Bank Board on September 26, 2019 and will finance between 15 and 20 greenfield exploration projects. The Facility is also financing technical assistance to address the persistently challenging policy framework. Most of the key players in the market have expressed strong interest in the Facility, which will contribute to significantly scaling up geothermal development in Indonesia in the next decades through its efficient risk sharing approach.

TURKEY

A key driver of geothermal development in Turkey has been the public de-risking of geothermal fields. Between 1962 and 2007, the General Directorate of Mineral Research and Exploration of Turkey (MTA) undertook surface exploration across the country, resulting in the identification of almost 200 geothermal sites, 25 of which were prioritized for exploration drilling due to their potential for electricity production (Dagistan et al., 2015). MTA's exploration drilling activities focused mainly on fields in three provinces in Western Turkey, namely Aydin, Manisa and Denizli (the Menderes and Gediz Grabens), where most of the geothermal power production now takes place. Licenses for these explored fields were auctioned by MTA to private investors, while other developers also obtained exploration licenses in adjacent areas from the provincial authorities.

More recently, a supportive legal framework, feed-in tariffs and market liberalization have accelerated geothermal development. The Geothermal Law of 2007 clarified the right of economic use of subterranean resources and introduced clear licensing procedures for exploration and exploitation. Feed in Tariffs of 10.5 USc/kWh (plus up to 2.7USc/kWh for local content) introduced in 2010 ensured a steady stream of revenues, while and a strong local private sector and local drilling services also played an important role. As a result, Turkey increased installed geothermal capacity from 23 MW in 2007 to 1370 MW in June 2019. Looking ahead, Turkey's 2014 National Renewable Energy Action Plan has set a target of 1,000 MW by 2023, which was recently revised by the Government to 4,000 MW by 2030

However geothermal exploration has slowed down since MTA's mandate to undertake geothermal exploration drilling ceased with the opening of the sector to private participation in 2007. Central and eastern provinces where a significant share of the geothermal market expansion is expected, remain largely unexplored. This slowdown results from greenfield licenses holders having limited

technical and financial capacity for taking on geothermal resource risk, a risk that also prevents commercial financing from entering the exploratory and resource development phases in a geothermal project.

To address this situation, the World Bank approved the Turkey Geothermal Development Project (GDP) in 2016. It aims to support the continued development of the geothermal market in Turkey and facilitate private sector exploration in areas outside the current hotbeds of geothermal development in Western Turkey. The project has two components – a Risk Sharing Mechanism (RSM) for upstream development - resource validation, including exploration and confirmation drilling, and a Loan Facility for downstream development - capacity/production drilling and construction of steam gathering systems and power plants.

The Risk Sharing Mechanism covers 40% of the eligible drilling costs of unsuccessfully explored wells drilled inside the Aydin, Manisa and Denizli provinces, and 60% of the drilling cost outside those districts. The rationale for this difference in coverage is to incentivize exploration in the less explored geothermal areas of the country. The RSM has been capitalized with a US$38 million contingent grant from the Clean Technology Fund. Standard agreements under the RSM will cover three wells, with an option for an additional fourth and fifth well at the discretion of the RSM management. Maximum coverage will be US$4 million per project and agreements will be terminated after two unsuccessful wells. In case of success, the license holder will be required to contribute to the RSM a "success fee" of 10 percent of the incurred expenditures. Success criteria are defined on a case by case basis for the drilling projects supported under the RSM. These are based on the well output requirements of the beneficiary's business plan and will be assessed against the results of certified well testing for enthalpy and flow parameters, which will be used to calculate the estimated power output by applying pre-defined power conversion efficiencies over a range of temperatures.

The first round of application for the RSM, managed by the Development and Investment Bank of Turkey (TKYB), was launched in July 2018 and led to a total of 21 applications out of which seven passed the technical evaluation. The technical evaluation included a review of previous exploration data, the drilling and well testing program, the environmental and social impact documentation, and the business plan. Out of the seven projects, four are eligible for 60 percent coverage under the RSM as they are located in the less explored areas of Turkey, whereas the remaining three are eligible for 40 percent coverage. A total of 17 wells are planned under the seven exploration projects, with total commitments, i.e. the maximum pay-out in case all wells are unsuccessful, estimated at US$21 million. If, on the other hand, all exploration projects covered by the RSM successfully confirmed a viable geothermal resource, the total expected capacity that could result from these projects is 113.5 MW. As of July 2019, TKYB has started negotiations with the seven project sponsors and it is expected that all Beneficiary Agreements are expected to be signed by the end of August 2019. Given that about US$17 million from the RSM would remain uncommitted after the first round, a second round of applications will likely be launched in the first half of 2020 and a it is expected that a total of about 20 projects will be supported by the RSM during the five-year project implementation period.

It is expected that the RSM will help sustain the exploration drilling activity in the Turkish market at a time of economic and regulatory uncertainty. The macroeconomic situation has been unstable since mid-2019, also affecting investments in the geothermal sector, while the uncertainty on the support mechanism (i.e. feed-in-tariff) for post-2020 projects has brought most of the activity in the sector to a halt.

A loan facility supplements the RSM to provide concessional financing for downstream development as commercial financing has dried up at a time of macroeconomic uncertainty. The second component of the GDP, the Loan Facility, aims to address the financing gap that license holders face in the resource development stages of geothermal projects by providing debt financing for capacity drilling, steam gathering systems and power plant construction. The Loan Facility provides capital for two credit lines to financial intermediaries (Investment and Development Bank-TKYB, and Industrial Development Bank of Turkey-TSKB) with a total of US$250 million from the World Bank and additional co-financing of US$62 million from the financial intermediaries. Implementation of the credit lines has been very satisfactory, contributing to the financing of six projects (229 MW) as of July 2019, and it is expected that all the funds will be disbursed by December 2019.

DOMINICA

In Dominica, failed attempts to attract the private sector have required the Government to continue relying on the public financing for geothermal development. A small Island state situated in the Eastern Caribbean, Dominica has relied on public concessional finance to explore its Wotten Waven-Laudat geothermal field. To date, three slim-hole wells and two production/injection wells have been drilled. These efforts confirmed sufficient steam to develop a 7MW wellhead plant and indicate a field potential of up to 100MW. In 2010 the Government of Dominica issued an international tender to develop the wellhead plant. Despite entering into negotiations with qualified bidders, it was unable to close the deal. It became apparent that the small scale of the wellhead plant as well as resource and market risks remained a barrier for private investors.

The World Bank and other donors stepped in to support financing of the 7MW wellhead power plant. The Government of Dominica together with the World Bank and donors provided US$51.45m financing to (i) construct the 7MW wellhead power plant with associated steam above ground system and civil works (ii) provide contingent grant financing for additional/make-up production/injection wells should pressure from existing wells unexpectedly drop (iii) provide TA for advancing larger development of the field. The Government created the "Dominica Geothermal Development Company Ltd", a special purpose vehicle to construct and operate the power plant under a concession agreement. Electricity will be sold under a PPA to DOMLEC, a vertically integrated concessionaire that operates most of the power infrastructure.

Continued use of public funds for geothermal development in Dominica rests on a strong economic rationale. Total installed capacity on this island is a mere 27 MW, of which 20 MW is diesel-fired. Dependence on imported diesel has resulted in some of the highest electric tariff in the world at 33 cents/kWh (December 2016), which are thought to be a major impediment for business and make the economy of Dominica susceptible to oil price shocks. In this context, renewable resources offer and attractive alternative. Limited hydro resources have already been exploited in the form of three run-of-river hydro plants that make up the remainder of installed capacity. The country does have significant wind and solar electric potential, however geothermal has two

characteristics which give it an edge in terms of long-term economic viability: (i) it provides baseload power to a system which has limited capacity to integrate variable renewable power and (ii) it is less vulnerable to the extreme weather.

Dominica's energy infrastructure requires resilience to extreme weather events. In September 2017 Hurricane Maria hit the island with catastrophic affect. Damages to the island were estimated at 226% of GDP. At least 75% of T&D networks were damaged and while damage to generation assets varied, that to hydropower assets was severe. Meteorological events will continue to pose a threat to poverty reduction and economic development. Following Hurricane Maria, the Government of Dominica adopted the National Resilient Development Strategy which seeks to diversify energy supply. Geothermal power generation does not depend on hydrological conditions to provide baseload power. Furthermore, it is thought that geothermal generation assets would fare better in volatile weather conditions relative to wind and solar generation assets, even with the coming of age of battery-storage technologies. These qualities of geothermal power factor into the Government's net benefit calculation while they would not do so for a private geothermal developer. The market fails in that it does not value the benefits a resilient power system would bring to the economy.

Successful public development of the first wellhead unit could open the door to larger-scale commercial capital mobilization and private sector development and possibly electricity export opportunities providing an avenue for economic growth Public financing is very much intended as a proof of concept to attract private financing, contingent on confirmation that the Wotten Waven-Laudat field indeed has the potential for larger scale development. A geothermal resource that could substitute for imported diesel would provide a significant boon to the suffering economy. Lower electricity prices are seen as a vehicle to diversify the economy beyond the traditionally heave agricultural one, which has struggled to remain competitive. A resource that exceeds domestic demand would provide further economic growth opportunities as both Guadeloupe and Martinique have shown interest in importing electricity, supplied through under-sea cables.

The case of Dominica illustrates a continued role for public sector finance where scale cannot be attained, and the market does not value broader social benefits of the technology. Despite the limited interest from the private sector thus far, the economic case for geothermal is strong. With climate resilience being high on the global agenda, the resilience of power systems will certainly receive much interest. For island states, solar, wind and hydro technologies will certainly continue to their own path and development and adaptation to extreme weather events. Where geothermal is available however, it can offer a climate resilient technology today.

A CONTINUED ROLE FOR MDBS IN GEOTHERMAL DEVELOPMENT

Going forward, the case for public financing of geothermal energy will persist. The use of scarce public funds for geothermal support should always be based on strong economic rationale. Incomplete and imperfect markets that characterize geothermal energy and the energy sector in general are unlikely to disappear but the need for concessional finance should be analyzed in specific context. Where the private sector has the capacity and resources to independently develop geothermal energy it should be given the space. Where the private sector is unwilling or unable to develop geothermal, the costs and benefits of geothermal will need to be compared with those of alternative technologies. It is with this frame that MDBs continue their support for geothermal energy, attending to global, national, and donor priorities.

Funding needs for geothermal development in developing countries will continue to grow. Installed capacity in World Bank client countries (as of June 2019) is 7.7 GW. This compares to the 17.8 GW which 82 of these countries are exploring or developing at 573 geothermal sites. Of the 17.8 GW, 1.5 GW is under construction, 1.9 GW at the feasibility stage; 8.2GW at the exploration stage and around 6.2 at the prospect stage. With capacity at the exploration and prospect stages standing at double currently installed capacity, the resources required for funding upstream development are huge. Figure 2 breaks down this data by World Bank lending region.

The pipeline under development in East Asia & Pacific exceeds that countries in other regions combined. Countries such as Indonesia and the Philippines still have tremendous opportunities for geothermal development and will draw on the bulk of resources committed to geothermal development to do so. At the same time, the scale of geothermal development in these countries brings expertise, reduced costs and other benefits which countries with smaller resources or reduced capacity in the sector do not have, which changes the nature of the required support.

MDBs will continue to provide tailored support for geothermal energy in developing countries to maximize development impact. The Global Geothermal Development Plan presents an evolution of the way MDBs are supporting the geothermal sector for maximum development impact. By shifting concessional financing towards upstream geothermal development, the GGDP hopes to accelerate upstream development while simultaneously unlocking private sector financing for downstream development. As the constraints and opportunities for geothermal development change, so will the role of Multilateral Development Banks. The pipeline of potential capacity additions in Figure 2 reflects the enduring challenge of geothermal energy for electricity generation. At the same time, a new horizon for the potential uses of geothermal heat in developing countries is coming into view, where ESMAP, the World Bank and other MDBs can continue to play an important role.

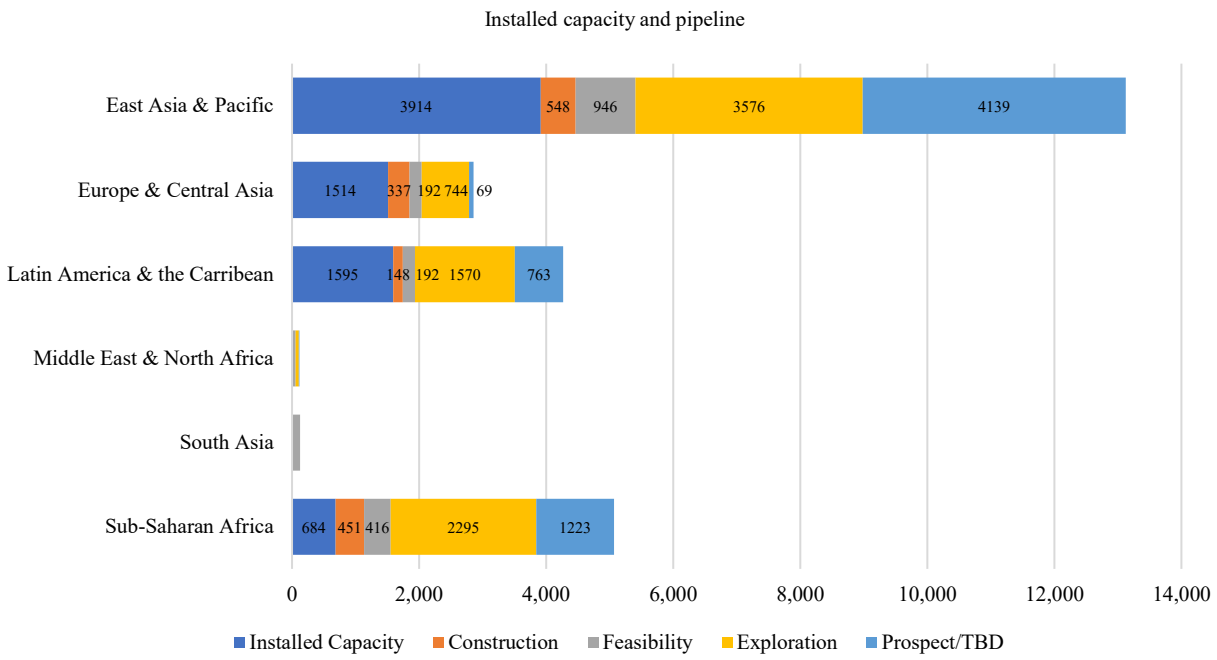

Figure 2: Installed capacity and pipeline of geothermal projects for electricity generation in World Bank Client countries.

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