6. Philippines

6.1 Current situation of geothermal energy use and national policy

The energy crisis in the early 1970s provided the impetus to initiate geothermal resource development in the Philippines. From 1976 to 1983, the geothermal power industry grew from zero to 981 MW_e. However, the growth of the geothermal power industry remained relatively stagnant until the 1990s when Republic Act 6957 or the Build–Operate–Transfer Law (BOT Law) was enacted, allowing the private sector to invest in infrastructure. The law provides assurance of cost recovery and ample profits. With the passage of the BOT Law, an additional 924 MW_e of geothermal power capacity was added to the Philippine grid system from 1996 to 2000.

Despite additional government interventions through the enactment of Republic Act 9136 or the Electric Power Industry Reform Act (EPIRA Law) in 2001, which was designed to bring down power rates and open the electricity sector to the private sector, and the Renewable Energy Act, enacted in 2008 to promote the development of renewable energy by granting fiscal incentives and feed-in tariff rates, the geothermal power industry grew only to its present installed capacity of 1906 MW_e.

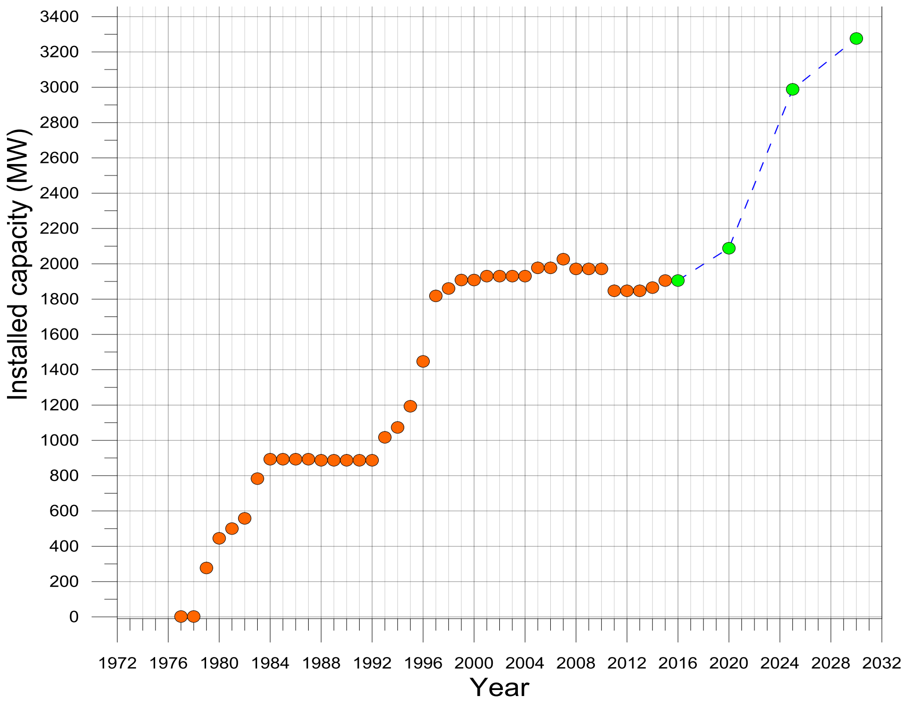
As of 2013, the Department of Energy (DOE) of the Philippines projected the installation of an additional 1090 MW_e through 2020, 1040 MW_e of which will come from the development of new areas while the remaining 50 MW_e will come from the expansion of existing geothermal production areas. To date, however, the target may not be met, judging from the current pace of geothermal resource development and power plant construction. Power plant construction to power plant commissioning normally takes two years, thus development and construction should have been actively started by now.

Geothermal resource concessions with estimated power potential of 1,124 MW_e were granted by DOE from 2010 to 2014. Despite this, only two of several concessions areas – Biliran and Naujan – have progressed to exploration drilling activities.

6.2 Target capacity estimation for geothermal power and direct use

Figure 3.6-3 shows the growth of installed geothermal capacities in the Philippines, comprising of trends of rapid growth, then stagnations that required policy reforms and interventions.

Figure 3.6-3. Trend of Installed Geothermal Capacity in the Philippines (1976–2016) and Projections to 2032



MW = megawatt.
Source: Philippine Department of Energy, 2016.

1973–1976: Creation of Unocal–Philippine Geothermal Inc. and Philippine National Oil Company–Energy Development Corporation with a mandate to develop indigenous energy resources as government response to the oil crisis;

1977–1984: Rapid increase in geothermal resource development with the commissioning of the Tiwi, Makban, Tongonan, and Palinpinon geothermal power stations;

1985–1992: Stagnation as newly commissioned fields and operations mature;

1993–1997: Additional capacities brought online through the efforts of Philippine National Oil Company–Energy Development Corporation with the build–operate–transfer partnerships with various companies as government response to the 1991 power crisis that resulted in electricity shortage and long power outages;

1998–2016: Stagnation as build–operate–transfer plants awaited transfer of ownership, and developers and investors await interventions from government to spur the next wave of geothermal resource development in the country;

2017–2032: The overall target growth by DOE is for an additional 1,371 MW (for a total of 3,277 MW) installed capacity by 2030. This is broken down into an additional 183 MW by 2020, then a rapid increase of 900 MW by 2025, and an additional 288 MW by 2030.

These targets can be achieved through initiatives highlighted in the Philippine geothermal roadmap such as development of low-enthalpy resources, small-sized systems (<50MW), acidic reservoirs, enhanced geothermal systems, and geothermal heat pumps. However, these will not materialise without innovative ideas and measures to remove the barriers to geothermal power generation development in the Philippines. The geothermal energy industry will need government support to develop additional capacity and achieve the target of 3,280 MW by 2030, especially if fossil fuel prices remain low. Policy and regulatory platforms, including government incentives, will be the spark to drive the third wave of geothermal development to fully realise the significant geothermal resource potential in the country.

The target geothermal power capacity in this project, which may be achieved by removal of all barriers, is projected from the trend shown in Figure 3.6-3. The 1,360 MW target is set as additional capacity, which is ready to be developed by 2025 if all barriers are removed.

6.3 Barriers to geothermal power generation and necessary innovations

6.3.1 Barriers to geothermal power generation

A survey of domestic experts on barriers to geothermal power generation in the Philippines was conducted and the result are shown in Table 3.6.3-1 and Figure 3.6.3-1.

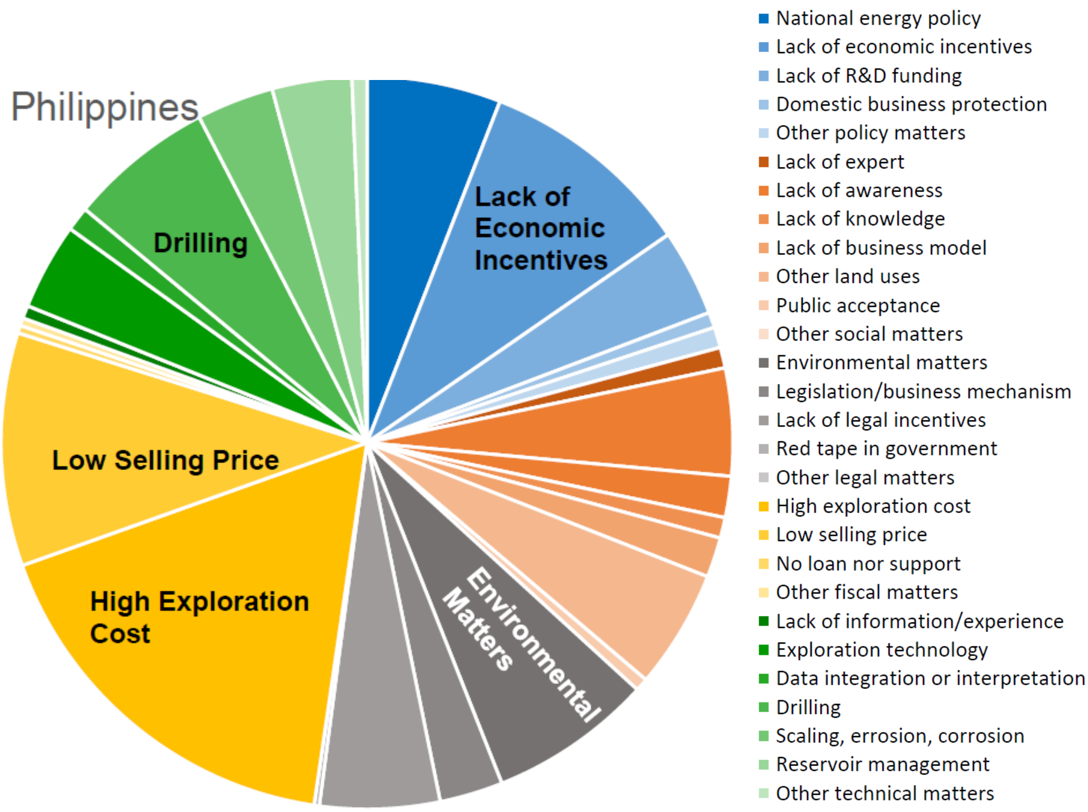
Table 3.6.3-1 Results of Inquiry to Domestic Experts on Barriers to Geothermal Power Generation in the Philippines

Policy	21%	National energy policy	5.93%
		Lack of economic incentives	9.48%
		Lack of R&D funding	3.84%
		Domestic business protection	0.68%
		Other policy matters	0.91%
Social	16%	Lack of experts	0.91%
		Lack of awareness	4.75%
		Lack of knowledge	1.82%
		Lack of business models	0.91%
		Other land uses	1.77%
		Public acceptance	5.25%
		Other social matters	0.57%
Legal	16%	Environmental matters	7.23%
		Legislation/Business mechanism	2.80%
		Lack of legal incentives	5.30%
		Red tape in government	0.23%
		Other legal matters	0.00%

Fiscal	28%	High exploration cost	17.27%
		Low selling price	10.30%
		No loan nor support	0.34%
		Other fiscal matters	0.34%
Technical	20%	Lack of information/experience	0.57%
		Exploration technology	3.84%
		Data integration or interpretation	1.07%
		Drilling	6.43%
		Scaling, erosion, corrosion	3.41%
		Reservoir management	3.52%
		Other technical matters	0.66%
TOTAL (%)	100%		100.1%

Source: Authors.

Figure 3.6.3-1. Results of Inquiry to Domestic Experts on Barriers to Geothermal Power Generation in the Philippines



Source:Authors.

The major barriers in each category are explained below.

1) Policy: Lack of economic incentives

The Philippines has no feed-in tariff (FiT) incentive for geothermal electricity producers, unlike the FiT incentives provided by the Renewable Energy Act to the other renewable energy technologies like solar, wind, hydro, and tidal energy, because when the Act was crafted by Congress, geothermal energy technology was considered a mature technology that does not need additional incentives. In contrast, the other renewable energy technologies were considered new and emergent technologies that require incentives for developers and investors.

2) Legal: Red tape in government

As a result of the inquiry, environmental matters appear as the biggest legal barrier. However, when considering underlying problems, red tape in government delays processes. Instead of spurring interest from investors and developers, government regulations tend to become major barriers in the exploration and development of geothermal resource areas. Five government institutions supervise geothermal power generation development in the Philippines:

(1) Department of Energy. Selects, awards, and monitors geothermal development activities.

(2) Department of Trade and Industry. Issues tax incentives for renewable energy commercialisation.

(3) Local government units. Issue permits and licences specific to geothermal reservation areas.

(4) Department of Environment and Natural Resources. Issues Environment Impact Assessments for Environmental Compliance Certificate and tree-cutting permits.

(5) National Commission on Indigenous People. Issues permits in areas within ancestral domains.

The usual problems encountered by geothermal resource developers with these government agencies/institutions are: (1) prior and periodic consultations which developers must conduct with local governments; (2) approval from the Indigenous People Council that must be obtained before work within ancestral domains can be undertaken; (3) absence of clear-cut rules; (4) obtaining environmental compliance certificate prior to commencement of the project and repetitive tree cutting permits; (4) obtaining passage of law from Congress to undertake exploitation and utilisation of geothermal resources located inside protected areas. These multiple requirements from different government agencies result in significant delays in the start of exploration and/or expansion projects. For the 150–200 permit requirements alone, processing could take anywhere between 3 to 5 years.

3) Fiscal: High exploration cost and low selling price

Despite improvements in exploration technology, the cost of developing geothermal energy is not competitive especially with the declining oil and coal prices. High-surface development (steep and difficult terrain, pipeline routes, roads and pads, power plant location, far off-grid transmission) and drilling cost with attendant high risk on greenfield projects deter investors and developers from embarking on geothermal exploration, drilling, and development. Moreover, with almost all bigger-sized resources in the Philippines discovered and developed already, the next prospects are the low-to medium-enthalpy systems and high-enthalpy, acidic reservoirs that require higher development and operating costs due to higher drilling and well costs, use of special materials to mitigate corrosive effects of acid fluids, and less conversion efficiency for binary power plants in low- to medium-enthalpy developments.

Electricity price from geothermal power producers is also being steeply challenged by low-selling electricity from coal power plant operators. With oil and coal prices at a record low in the world market, coal-plant power producers are able to sell their output at low price, pushing geothermal power producers to compete for markets and forcing them to reduce their electricity selling price, thus affecting the profitability and sustainability of their operations. Since there is no mandate from the government to prioritise renewable energy in the energy mix and in the priority dispatch, every producer has to compete for market based on selling price, which is artificially low for coal plants as externalities are not being considered (like impact to environment and air pollution).

4) Technical: Exploration technology; scaling, erosion, corrosion; and reservoir management

Exploration technologies, techniques, and methods still need to advance to de-risk geothermal prospects and make them attractive for developers and investors. Some of these technical barriers result in higher operation and maintenance costs on existing and new geothermal fields due to resource management issues and climate change. These deter existing operators and developers from embarking on future expansion and development plans.

Some geothermal fields in the Philippines experience these technical resource management challenges: (1) injection returns (from brine and power plant condensates), (2) cold peripheral and groundwater inflow, (3) pressure drawdown and boiling that increase operation and maintenance drilling requirements, (4) well feed sharing and production interference, (5) well integrity issues on old and damaged wells (making workover and well repair costs escalate), (6) acid fluids causing well and line corrosion damage, (7) mineral scaling (calcite, silica, etc.), (8) erosion from fine solids entrained in high-velocity steam from drawn-down dry fields, and (9) effects from extreme weather (e.g. recurring super-typhoons) that result in landslides and damage to surface and power plant facilities.

6.3.2 Innovative ideas and measures to remove barriers

1) Legal barriers

Simplify the permit and authorisation requirements and process

To reduce or eliminate red tape in government, there is a need to simplify the permit and authorisation requirements and process. This would hopefully reduce the 150–200 permits that need to be processed and secured from various government agencies before exploration and development works can commence. Some of these permit and authorisation requirements might be overlapping in jurisdictions, particularly those required by local government units with those of national government agencies. By simplifying and reducing the permit and authorisation requirements and process, the soonest can geothermal projects start exploration and development works. This would also reduce the gestation period to commercial operations.

Establish a one-stop shop for permit and authorisation processing and filing

With five government agencies supervising the geothermal development in the country, there is a need to set-up a one-stop shop for the permit and authorisation filing and processing. As these government agencies hold office at national and local levels, transacting with them is already a major effort and cause of delays. If their geothermal resource development permitting sections/divisions are placed under one roof, the process will be shortened.

Declare geothermal development as a project of national interest

DOE should declare renewable energy projects, including geothermal resource development, as projects of national interest, to imbue them with a sense of national importance and urgency and insulate them from government red tape, corruption, court injunctions and challenges, and other causes of delays. Right of way acquisitions for roads, pipeline routes and pads, and transmission line routes should not be hampered by delays.

The provisions on the National Integrated Protected Areas Systems and the Indigenous Peoples' Rights Act should also be harmonised with the Renewable Energy Act so that geothermal resource development inside protected areas and indigenous peoples' lands could still proceed.

2) Policy barriers

Provide feed-in tariff support for electricity produced from geothermal energy

Geothermal power developers and investors will need market and tariff support from the government in the form of FiT, given the high costs and risks of exploration and development and market uncertainties and volatilities. Congressional amendments to the Renewable Energy Act are required for geothermal energy to be included in the renewable energy technologies qualified for FiT award (similar to solar, wind, hydro, and tidal energy technologies). There is a debate if large-scale geothermal energy projects should be awarded FiT given that geothermal technology is already an established and mature one and not anymore needing incentives for large-scale commercial utilisation (as has been practised in the Philippines since the 1970s). The proposal is to award FiT only to emerging technologies such as low-enthalpy utilisation, acid resource development, and small-scaled geothermal development (<50 MW). With this proposal, the full-scale inventory of geothermal resources in the Philippines needs to be updated and classified to further quantify the overall potential of conventional (large scale vs small scale) and non-conventional (low enthalpy) resources, as well as acid resources, to be able to determine the installation targets and quantify the FiT rate that can be awarded.

Provide for the right energy mix with emphasis on renewable energy

The Electric Power Industry Reform Act provides the right energy mix in the energy policy of the country. The initial proposal was to allocate 30% of the total installed capacity to renewable energy technologies (to include geothermal energy). However, this was challenged by some developers (particularly coal power operators). Thus, the government has not been able to implement the rules and regulations pertaining to this provision of the EPIRA law. It would serve the interest of geothermal resource development in the country if this barrier is removed and the EPIRA Law is fully implemented.

Priority dispatch for geothermal power plants generation outputs

With electricity supply currently in excess of peak demand, the national grid operator follows a protocol allocating dispatch for all generators. Some electricity output is also traded in the Wholesale Electricity Spot Market. While solar and wind energy are already priority dispatch, geothermal output, having no FiT allowance, has no such priority. Thus, DOE and Philippine Electric Market Corporation should classify geothermal power plant generation outputs as priority dispatch since they are capable of baseload generation and have very low CO_2 emission.

Priority interconnection of geothermal projects to the national grid

Most geothermal resource prospects are located in mountainous areas and are off the current grid infrastructure. Thus, DOE should compel the national grid operator to prioritise the interconnection of geothermal resource projects to the national grid. This will free the geothermal energy developers of the burden of connecting their projects to the grid and thus lower their development costs. The national grid operator is allowed to recover its capital expenditures for transmission projects from its wheeling fee charged to electric distribution utilities, which also pass this on to consumers.

3) Fiscal barriers

Government to assume initial exploration activities

One of the major challenges in bidding for geothermal resource concessions in the Philippines is the lack of available exploration data. With resources spread thin amongst developers and bidders, some get unpromising prospects, thus lowering their appetite to explore and spend more in other prospects after failing initial exploration results. If the government undertakes or spends for the initial exploration activities, developers and bidders will have more data to base their decisions on when bidding for concessions. The more promising prospects (based on data from initial exploration activities) get selected, the earlier will advanced exploration activities and drilling happen. This will also shorten the time to development and commercial operations.

Provide fiscal support to exploration drilling from green funds

One of the most expensive costs in geothermal resource development is drilling, and more so if it is still exploration drilling because of the high risks involved that may lead to failure in investment. Thus, if the government can give support and concessional loans from some green funds and even share the risks of exploration drilling, then more developers will be aggressive enough to explore.

Fiscal support against fluctuation in energy prices in the international market

Geothermal energy development needs policies that would manage energy price risks specifically price of geothermal steam and electricity as it is currently benchmarked with international price of coal. With market volatility and low coal prices, sales of geothermal steam and electricity are at a disadvantage since fixed costs in geothermal power are high, and margins are squeezed every time coal and oil prices fluctuate down. If the government can provide price stabilisation fund, then developers and investors will be protected of their investments and more will be encouraged to invest in geothermal resource development.

Award additional tax incentives

Geothermal power developers and operators enjoy the 10% income tax rate as afforded by the Renewable Energy Act. However, with coal price at all time low at current competitive markets, the geothermal power industry will need tax holidays and tax exemptions on capital equipment importation. There are provisions for these; the incentives will just have to be reviewed and strengthened.

Tax carbon emission from coal plants

Coal power plant operators can offer their electricity at low price because externalities are not considered in their pricing. Thus, the government, in compliance to the provisions of the Clean Air Act, should initiate taxation of carbon emission from coal power plants. Its harmful effects to the environment and community should also be considered and levied on the operations of these power plants. Provisioning and including these costs in electricity pricing of coal power plants will make geothermal power cost-competitive with coal. With a level playing field, consumers will have better choices and can opt for the electricity source (green energy option) that does not harm the environment and is available at baseload whole year round.

4) Technical barriers

Develop new technologies for exploration surveys

Since exploration survey is one of the key determinants in the success or failure of a geothermal prospect, advanced methods of appraisal should be developed to increase the likelihood of finding promising resources. Technologies that use micro-earthquakes and soil gas compositions to explore permeable areas are already being used in the Philippines. Surveying methods using light detection and ranging and even unmanned aerial vehicles or drones can refine or prepare structural maps, detect thermal manifestations, and point to geohazards or areas unsuitable for road and pipeline routes and pad developments.

Collaborative research on scaling, erosion, and corrosion

Common problems in steam fields in the Philippines and other Asian countries are scaling (calcite, silica, etc.), erosion from formation particles (from drawn-down high-enthalpy dry fields), and corrosion from acidic or low-pH resources. Thus, Asian countries engaged in geothermal power generation should work together and invest in industry-collaborative research in optimising resource and steam-field management with available technologies or, when needed, to specifically develop technologies for these resources. Needed solutions include specialty alloys (e.g. corrosion-resistant alloys) or chemical mitigation (NaOH or corrosion inhibitors) that can withstand the fluid characteristics. Acid resources will require reinforcement of surface facilities for safety and reliability, and an intensive asset reliability monitoring programme will require more frequent workovers, downhole monitoring, and use of scrubbers for the acid steam.

Other fronts on Asian collaborative research will be on devices (two-phase flow metres and sensors for big data capture), robotics (for intrusive inspections), materials for corrosive environment (e.g. metal alloys and advanced polymers), and well workover and maintenance technologies without using rigs (e.g. broaching, coiled tubing unit, bullhead acidising, etc.).

Share best practices on reservoir management

Asian countries generating geothermal energy also experience common resource-related issues that are managed adequately and properly by reservoir management scientists and engineers. It would be beneficial to all if these best practices on reservoir management are shared so countries do not have to ‘reinvent the wheel’, and to shorten the learning curves of geothermal power operators.

Some best reservoir management practices that can be shared are managing (1) injection returns (from brine and power plant condensates), (2) cold peripheral and groundwater inflow, (3) pressure drawdown and boiling, (4) well feed sharing and production interference, (5) well integrity issues on old and damaged wells, (6) acid fluids causing well and line corrosion damage, (7) mineral scaling (calcite, silica, etc.), and (8) erosion from fine solids entrained in high-velocity steam from drawn-down dry fields.

6.4 Benefits of geothermal power generation use in the Philippines

The benefits of geothermal energy use in the Philippines include a) baseload generation, b) low CO_2 emission, c) local employment generation, and d) driving local economic development. These were quantitatively analysed following the procedure shown in Section 2.4.2.1 b.

1) CO_2 mitigation

CO_2 mitigation by additional geothermal capacity of 1371 MW was calculated at 5,165,584,597 kg-CO_2/year (Figure 3.6.4-1).

Figure 3.6.4-1. CO_2 Mitigation by Additional Geothermal Power

Power Source	Power Supply Ratio: A	Unit CO_2 Emission: B	A x B
unit		(g-CO_2/kWh)	
Coal	48.0%	1,000	480.00
Oil	6.0%	778	46.68
LNG	22.0%	443	97.46
Nuclear	0.0%	66	0.00
Hydro	9.0%	10	0.90
Solar PV	1.0%	32	0.32
Wind onshore	1.0%	10	0.10
Geothermal (natural system)	12.0%	13	1.56
Geothermal (HDR)		38	0.00
Small-hydro	0.0%	13	0.00
Biomass	1.0%	25	
Total	100%	-	627

←CO_2 Emission by all electricity sources (g-CO_2/kWh)

CO_2 mitigation by geothermal electricity per kWh is:

627 - 13 = 614 (g-CO_2/kWh)

Target capacity: C	1,371	MW
Capacity factor: D	70%	

Total CO_2 mitigation by additional geothermal electricity is:

614 × 1,371 × 24 × 365.25 × 0.7

= 5,165,584,597 (kg-CO_2/year)

CO_2 = carbon dioxide, g-CO2 = gramme of carbon dioxide, HDR = hot dry rock, kWh = kilowatt-hour, LNG = liquefied natural gas, PV = photovoltaics.
Source: Authors. Data source for column A: Department of Energy, Philippines, 2017; B: Benjamin K. Savacool, 2008.

2) Other benefits

Other benefits are calculated following the procedure in Section 2.4.2.1 for the target capacity. Expected benefits by removal of each barrier category are calculated based on barrier contributions shown in Table 3.6.3-1. Again, note that these barriers are interrelated and removal of one barrier may stop further geothermal development. Nevertheless, this estimation gives insights to policymakers on the significance of benefits by barrier removal. Table 3.6.4-1 summarises the calculated benefits.

Table 3.6.4-1. Direct Benefits and (Expected) Indirect Benefits of Geothermal Power Generation by Removal of Barriers

Item		Unit	Barriers significance and benefits by removal of each barrier					Total benefit	Remarks
			Policy	Social	Legal	Fiscal	Technical		
Barrier significance		%	14	32	22	15	17	100	
Target capacity		MW	191.94	438.72	301.62	205.65	233.07	1,371	*W*
Target capacity factor		%						70%	*Cf*
a) Power generation		MWh/year	1,177,782	2,692,074	1,850,801	1,261,910	1,430,164	8,412,730	*W* x 24 x 365.25 x *Cf*
b) Annual fuel saving	by oil	barrel/year	1,490,796	3,407,534	2,342,680	1,597,281	1,810,252	10,648,543	11,096 *W x Cf*
	by LNG	kg/year	176,968,699	404,499,884	278,093,670	189,609,321	214,890,563	1,264,062,137	1,317,143 *W x Cf*
		Million Btu/year	8,717,106	19,924,814	13,698,310	9,339,757	10,585,058	62,265,045	0.04926 *W*
c) Saving foreign currency	by oil	US$/year	89,447,764	204,452,031	140,560,771	95,836,890	108,615,142	638,912,597	60.0 US$/Barrel
	by LNG	US$/year	43,585,532	99,624,072	68,491,550	46,698,784	52,925,288	311,325,225	5.0 US$/Btu
d) CO_2 mitigation		(tonne-CO_2/year)	723,182	1,652,987	1,136,429	774,838	878,149	5,165,585	from "CO_2" Table
e) Local employment		persons	530	1,212	833	568	644	3,788	2.71*W*+73
f) Saving lands compared to solar PV		m^2	21,404,765	48,925,177	33,636,059	22,933,677	25,991,500	152,891,178	111,518 *W*
(g) Expected profit of additional businesses		US$/year	343,281	784,642	539,441	367,801	416,841	2,452,006	1,788 *W*
(h) Expected local employee by additional businesses		persons	96	219	151	103	117	686	0.5 *W*
(i) Expected local economic effect of the additional		US$/year	429,178	980,978	674,422	459,833	521,145	3,065,556	2,236 *W*

Btu = British thermal unit, CO_2 = carbon dioxide, cf = coefficient factor, kg = kilogramme, LNG = liquefied natural gas, MW = megawatt, MWh = megawatt hour, PV = photovoltaics. For symbols *Cf* and *W*, please refer to equation (1) in section 2.4.2.1.
Source: Authors.

6.5 Summary of barriers to and benefits of geothermal power generation

The most significant barriers to geothermal power use in the Philippines are environmental matters and red tape in the government (legal); lack of economic incentives (policy); high exploration cost and low selling price (fiscal); and exploration technology, scaling, erosion, corrosion, and reservoir management (technical). Innovative ideas and measures to remove the barriers are as follows:

Legal aspect

- Simplify the permit and authorisation requirements and process
- Establish a one-stop shop for permit and authorisation processing and filing
- Declare geothermal energy development as a project of national interest

Policy aspect

- Provide FiT for electricity produced from geothermal energy
- Provide for the right energy mix with emphasis on renewable energy
- Prioritise dispatch for geothermal power plants generation outputs
- Prioritise interconnection of geothermal projects to the national grid

Fiscal aspect

- Urge government to assume initial exploration activities
- Provide fiscal support to exploration drilling from green funds
- Provide fiscal support against fluctuation in energy prices in the international market
- Award additional tax incentives
- Tax carbon emission of coal plants

Technical aspect

- Develop new technologies for exploration surveys
- Undertake collaborative research on scaling, erosion, and corrosion
- Share best practices on reservoir management

Note that the benefits of geothermal energy use in the Philippines include baseload generation, low CO_2 emission, generation of local employment, and driving local economic development.

Reference

Department of Energy, Philippines (2017), 2016 Philippine Power Situation Report.