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Review on Geothermal Direct Use Application as an Alternative Approach in Community Engagement at Early Exploration Phase in Indonesia

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ABSTRACT

There are several challenges that have been identified for geothermal development in Indonesia; one of them is the rejection by the local community that hinders the exploration or development phase. Common practices by field developer to engage with the local community in the early exploration phase is by holding socialization events and involving local people in exploration activities. However, these approaches have several limitations such as short exploration project period and the non-continuous nature of the socialization event, thus less effective and unable to give adequate understanding to the local people regarding the geothermal project.

An alternative approach to current practice that has been emerging recently and discussed in previous studies and publications is by utilizing and creating geothermal direct use facility to engage with the local community during the early phase of exploration. This approach is considered a promising idea, especially considering that currently geothermal direct use application in Indonesia is under-utilized compared to our vast geothermal potential, even compared with other countries. The purpose of this study is to summarize and discuss the current geothermal direct use applications in Indonesia and around the world. These various geothermal direct use application facilities are analyzed, and a preliminary concept of geothermal direct use as an alternative approach in community engagement during early exploration phase in Indonesia is proposed.

1. INTRODUCTION

As one of the countries that have considerable amount of geothermal energy potential for power generation, geothermal energy still has a minor contribution compared to the total electricity generated in Indonesia. Several researches and publications seem to come to an agreement for Indonesia's geothermal energy resource potential at around 29 Gigawatt electric (GWe), spread across 312 geothermal potential locations (Darma & Gunawan, 2015; Darma & Wirakusumah, 2015; Meier, Randle, & Lawless, 2014; Pambudi, 2017). Based on the latest formal publication of Direktorat Jenderal Energi Baru Terbarukan dan Konservasi Energi (Directorate General of New, Renewable Energy and Energy Conservation, EBTKE) in 2017 the total installed geothermal power plant capacity is 1698.5 Megawatt electric (MWe) (Figure 1).

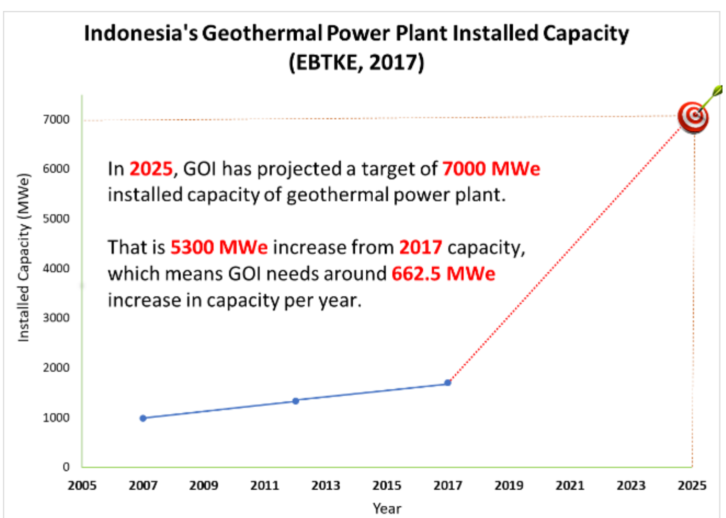

Figure 1. Indonesia's geothermal power plant installed capacity (EBTKE, 2016)

During 2006 until 2017 period, Indonesia's geothermal power plant capacity increased around 846.5 MWe (EBTKE, 2016; EBTKE, 2017), with the average rate of growth of 77 MWe / year. Figure 1 clearly illustrate the drastic increase in the rate of geothermal powerplant installed capacity growth; if Indonesia is about to achieve the target of 7000 MWe geothermal powerplant installed capacity in 2025, it needs to increase 5300 MWe capacity in 8 years, which is around 662.5 MWe increase / year, which is a very substantial increase from the mere 77 MWe from the previous decade.

Previously in 2005, Government of Indonesia (GoI) created roadmap for geothermal development that envisioned 9,500 MWe capacity for geothermal powerplant installed. However, this target was deemed unrealistic due to slow progress of development, so it was revised to 7,000 MWe capacity in 2025. Various law and policy have been established to improve the role of geothermal in total energy production in Indonesia, with the most recent was Law No. 21 in 2014 that was effectively replaced policy of Act No 27 of 2003. One significant point of this change is that geothermal development is not considered as mining operation anymore, thus permitting exploration and development on land set for conservation (Pambudi, 2017). However, with this change of status, there are still many problems and delays occur during exploration and development phase which the two common are project capital issue and the rejection from local community (Hekmatyar & Adiwibowo, 2015; Prayogo, 2010; Taqwim, Pratama, & Nugraha, 2015).

The purpose of this preliminary study is to map the cause of the public rejection toward geothermal project in Indonesia and also provide alternative approaches to address community issues at geothermal exploration phase by comparing the geothermal direct use application around the world that involve local community, and try to propose an application that could be the most suitable applied in pre-explored area or areas that are still undergo exploration.

GEOTHERMAL DEVELOPMENT STAGES IN INDONESIA

Generally, a geothermal resource development can be divided into eight phases (IGA, 2014):

1. Preliminary Geology, Geochemistry, Geophysics (3G) survey
2. Exploration 3G (may include temperature gradient drilling survey)
3. Exploration drilling
4. Project review and planning
5. Field development
6. Power plant construction
7. Commissioning
8. Operation

Although some geothermal developers can have different number of stages, but the fundamental idea is similar. Several countries including Indonesia have its own general development stages according to their law and policy for granting concession to companies for developing geothermal resource.

As can be seen on the Figure 2, the company that win the concession has around 5-7 years to do detailed exploration, and it shall be followed by delineation drilling and power plant construction for 2-3 years (Poernomo et al., 2015). The exploration phase is the most critical phase in geothermal development in Indonesia, because at this phase the company should do exploration drilling / delineation drilling to validate the conceptual model created from the 3G survey. The result of the exploration drilling is very important for further development decision, whether to continue to construct power plant or abandon the geothermal area. The size and type of power plant that will be constructed also depends on the result of the exploration drilling. Therefore, any problems during exploration phase that can delay the drilling will have a detrimental effect to the whole project schedule.

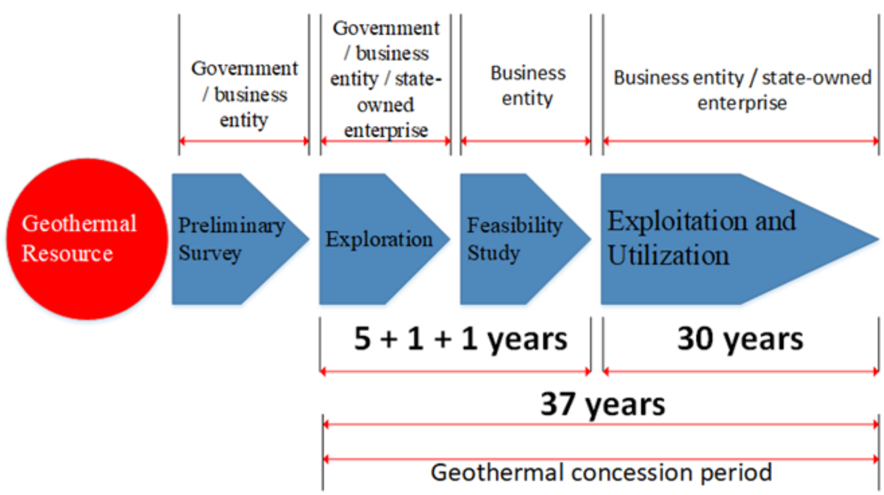

Figure 2. Indonesia's geothermal development process.

EXPLORATION ACTIVITY AND COST SIGNIFICANCE

Exploration phase objective is to economically obtain geoscientific data to minimize uncertainty in important reservoir parameters such as reservoir size, temperature, permeability, etc. prior to drilling. Exploration generally starts at wide or regional level and as more data are obtained, the exploration will focus on smaller area in the most promising location. The earliest phase in exploration activity is usually collecting new data and samples from recognized thermal surface manifestation. It then followed by further surface and subsurface evaluation using 3G methods which include geology, geochemistry, and geophysics. After sufficient data is gathered and analyzed, the resulting conceptual model must be validated by test drilling. Mobilization and contracting the drilling equipment is a significant financial commitment during the exploration phase due to its higher cost compared to the previous 3G survey combined (IGA, 2014).

ESTIMATION COST OF PROJECT DELAY

Table 1 below illustrates the impact of project delay during any stages of exploration phase:

Table 1. Cost estimate of project delay in several stages of exploration.

Delay on Activity/Phase	Cost Impact
Project socialization and public consultation	Standby manpower (low)
3-G survey (geology, geochemistry and geophysics)	Standby manpower and 3-G survey equipment (low)
Land acquisition	Standby manpower (low)
Access road and well pad construction	Standby manpower and heavy equipment (medium)
Exploration drilling	Standby manpower, heavy equipment and rig (high)

Low = standby cost US$ 3,000 – 10,000 per day
Medium = standby cost US$10,000 – 25,000 per day
High = standby cost US$ 25,000 – 100,000 per day

The illustration on cost impact above is only a rough estimate, it will depend on the field size and the scale of the operating company, but the idea is that field developers will face significant financial consequences due to delay in exploration phase, especially during critical stages such as drilling. Any delay during construction and drilling stages are significantly higher than other stages in exploration phase, therefore, it should be avoided or mitigated proactively from the planning phase. Usually the long delay is not associated with technical problem but more with the case of non-technical issue such as local community rejection.

The financial consequences of project delay are proven catastrophic to the field developer, but schedule-wise, the implication is on much grand scale; the possibility of concession revoke due to the developer inability to finish exploration during 7 years period could potentially hamper the GoI target of reaching 7000 MWe installation capacity in 2025.

COMMUNITY REJECTION IN INDONESIA

Previous experiences in various countries have shown that community rejection or public opposition can significantly delay or even stop the geothermal powerplant project (Reith, Kölbel, Schlagermann, Pellizzone, & Allansdottir, 2013; Wallquist & Holenstein, 2015), and Indonesia is no exception. Several cases of community rejection of geothermal development in Indonesia is summarized in Table 2, compiled from various national or local news website, as for the recent event it is difficult to find any academic publication regarding the public protest that is specific to one project area.

From the community rejection summary in Table 2 it is clear that the public opposition usually starts during the end of exploration phase, where the company must do the test drilling to validate the conceptual model and ensure the total resource capacity of the geothermal field. It raises an alarming concern, because the test drilling is very critical for the whole project, both schedule-wise and financially. And as the company obligates to do test drilling at the end of exploration phase period (7 years), the failure to do so will causing the concession permit to be revoked, and the GoI or EBTKE must do re-tender for the geothermal field. The start over for the whole process is very detrimental to the GoI plan to increase the power production and electrification ratio in Indonesia by using renewable energy, thus will be a threat to Indonesia’s energy security (Darma & Wirakusumah, 2015).

Literature Review and Probable Cause of Community Rejection in Indonesia

It is widely accepted around the world that the essence of geothermal energy utilization in the future lies in how to obtain agreement or at least acceptance by local people living in the project area (Cataldi, 2001). Cataldi defines the social acceptance or social consensus of geothermal project as: “Social acceptability of a profit-purported project is the condition upon which the technical and economic objectives of the project may be pursued in due time and with the consensus of the local communities; consensus to be gained by acting in consonance with the dynamic conditions of the environment, and in the respect of the people’s health, welfare, and culture”.

In principle, Cataldi argues that the main conditions to gain such consensus are:

- Prevention of bad effect on people’s medical condition or health
- Minimalization of environmental impact

- Creation of direct benefit for the local community.

It is clear from Table 2, the three main conditions above are more or less the root cause of the community rejections on the geothermal development area. For example, the fear of adverse effects to both people's health and environment during geothermal exploration and development is due to the lack of public knowledge and awareness to the concept of geothermal energy and how to utilize it prudently. The geothermal exploration can be easily mistaken to the petroleum activity due to the similar drilling activity, and most people still fear that any mistake during geothermal drilling might induce any mud volcano blowout similar to what happened in 2006 in Sidoarjo, as can be seen in the reason for public opposition during drilling in Sorik Marapi and Sokoria field. It is also possible that the same fear looms in the mind of many local communities around other geothermal fields, but it requires future study to clearly assert that if it is the case. The land acquisition process is also proven problematic, because people will hesitate to sell their land to the company due to the absence of immediate direct benefit for them.

Various geothermal development community rejection issues from several parts of the world that have been concluded from previous studies are presented in Figure 3. Although some detailed studies are required in order to accurately assess the root cause of community rejection especially in Indonesia, but from the summary of various studies that have been conducted in some parts of the world shows that the Cataldi’s definition and main condition to gain consensus with the local people is applicable to some extent.

Therefore, any local community engagement activities from the company should be able to address these issues:

- Provide enough education for the local community regarding how geothermal exploration and development work;
- Might provide or open sustained job opportunity or the chance for economic development for the people near the geothermal location to provide them with direct benefit.

Current Approaches by Field Developer

Based on industry best practices and author’s experience, the most common approach to engage local community by field developers are:

- Holding socialization event to explain and educate people regarding the geothermal energy and how to exploit it.
- Involving local people in exploration activities such as; field survey, access road construction, and drilling activity

However, there are several shortcomings in those current approaches, such as:

- Mostly the socialization events are not continuous and only held for several occasions, thus making it less effective and unable to give adequate understanding to the local people.
- Short exploration project period (field survey, access road construction) makes the job opportunity is not sustainable for a long time.
- The requirement for skilled or educated workforce for further activities such as drilling and power plant construction that is often not met by local people near the area makes the them unable to participate, and they won’t get direct benefit from the exploration and development activities.

THE CONCEPT OF GEOTHERMAL DIRECT USE FACILITY DEVELOPMENT DURING EXPLORATION PHASE

Geothermal direct use application Indonesia is pale on comparison to worldwide direct use trend, and even very small compared to the Indonesia’s geothermal electricity generation application, even though having vast resource potential. (Taqwim et al., 2015). Various studies have been conducted for proposing the use of geothermal direct application to increase social acceptance or give education to the community regarding the geothermal energy utilization.

Taqwim et.al (2015) propose that the geothermal direct use may be a mandatory action before conducting full scale geothermal power generation development with several hypothetical benefits due to its smaller scale compared to full-scale geothermal power plant development.

Shoedarto et al. (2016) assess the possibility of geothermal direct use in Indonesia, especially thermal bathing to be used for increasing public awareness and acceptance of geothermal development. They also discussed the feasibility of using geothermal fluid from several field in Indonesia to be used for thermal bathing.

Utami et al. (2011) proposes the development of integrated geothermal education park in Lahendong geothermal field. The concept is to create an integrated facility to give people better understanding regarding geothermal energy and its exploitation. Even though Lahendong field is already developed with already operating power plant, but the concept is hypothetically possible to be applied in the green field where there is no power plant or exploration activity yet.

Since direct use developments have smaller level of activity with not much or even minimum number of heavy machinery to disturb people nearby, it can reduce the "shock effect" in the community, and at the same time could also potentially be used as a medium to introduce early awareness and understanding on how geothermal energy exploitation works (Shoedarto et al., 2016; Taqwim et al., 2015). Overall, there are several possible advantages of using direct use during exploration phase in order to increase social acceptance and minimize community rejection:

- Less disturbance and reduce shock effect during early construction of direct use facility.
- Possibility to involve local people at earlier stage of development in a more sustainable manner.
- Possibly stimulate economic development by involving local people in the operation of direct use facility and the opening of geothermal tourism object.
- The presence of direct use facility as tourism object could be used as educational facility to educate and further socialize the benefit of geothermal energy to broader range of people, for example is the Lahendong Geothermal Education Park (Utami et al., 2011).

Table 2. List of several community rejection issue on geothermal development in Indonesia compiled from various news website.

Field	Gunung Rajabasa	Sorik Marapi	Tangkuban Perahu	Gunung Talang	Baturaden	Gunung Lawu	Sokoria
Location	Lampung	North Sumatera	West Java	West Sumatera	Central Java	East Java	East Nusa Tenggara
Month	May 2013	December 2014	November 2013	July 2017	October 2017	November 2016	February 2017
Developer (EBTKE, 2017)	PT Supreme Energy	PT Sorik Marapi Geothermal Power	PT Tangkuban Parahu Power	PT Hitay Daya Energy	PT Sejahtera Alam Energy	PT Pertamina Geothermal Energy Lawu	PT Sokoria Geothermal Indonesia
Estimated Potential Resource (EBTKE, 2017)	200 MWe (probable reserve)	200 MWe (probable reserve)	90 MWe (probable reserve)	66 MWe (probable reserve)	175 MWe (probable reserve)	195 MWe (probable reserve)	145 MWe (hypothetic al resource)
SK WKP (EBTKE, 2017)	18 February 2009	30 December 2008	27 December 2007	3 June 2014	8 April 2010	13 August 2012	30 January 2012
End of Exploration Phase Period	2016	2015	2014	2021	2017	2019	2019
Community Issue	Fear of forest destruction, losing people's source of income	Fear of environmental impact and mud blowout	Fear of impact to water source	Fear of environme ntal impact and damage to water source	Fear of environmental impact and damage to water source	Fear of environmenta l impact and damage to water source	Protest to land acquisition compensati on
Source	tempo.co	beritasumut.com	detik.com	mediasum bar.com	okezone.com	okezone.com	voxntt.com

Various Direct Use Application Around the World

The direct use of natural heat flow from beneath the ground for cooking, bathing, etc. is the oldest form of geothermal energy utilization. Even after human started to utilize geothermal energy to generate electricity, the direct use application is still continuing today, however nowadays the direct use application mostly utilized in a low temperature / low enthalpy geothermal area or an area where the electricity generation from geothermal energy is not economically feasible.

Table 3 provides brief summary of various modern geothermal direct use application around the world. From the Table 3 it can be seen that geothermal direct use is not only limited to low-temperature / low-enthalpy geothermal resource, and it also shows the possibilities of using geothermal surface manifestation as a tourism facility that combine the thermal feature with local culture as main attractions to the facility (Neilson et al., 2010).

Table 3. Various geothermal direct use application around the world.

Direct Use Application	Utilization	Example	Geothermal Fluid Temperature	References
Tourism	Recreational swimming	Darajat, Batukuwung (Indonesia)	70-80 ℃	(Shoedarto et al., 2016)
	Bathing/spa	Waikita Thermal Spring (NZ)	98 ℃ (discharged from spring)	(Jones, Renaut, & Rosen, 1996)
	Integrated tourism & cultural village	Whakarewarewa Thermal Village (NZ), Blue Lagoon (Iceland)	220-240 ℃ (reservoir temperature)	(Gudmundsóttir, Brynjólfsdóttir, & Albertsson, 2010; Neilson, Bignall, & Bradshaw, 2010)
Agriculture	Timber drying	Tauhara Field (NZ)	300 ℃ (reservoir temperature)	(Mannington, O'Sullivan, & Bullivant, 2004)
	Palm sugar plant	Lahendong (Indonesia)	80-98 ℃ (shallow well temperature)	(Taufan, Jatmiko, & Andri, 2010)
	Mushroom cultivation	Kamojang (Indonesia)	150 ℃ (well temperature)	(Suyanto, Agustina, Subandriya, & Surana, 2010)
	Copra & cocoa drying	Way Ratai (Indonesia)	92-95 ℃ (temperature discharged from manifestation)	Suyanto et al., 2010)
	Prawn farm	Huka Prawn Farm (NZ)	97 ℃ (from the reinjection brine)	(Thain & Carey, 2009)
Space Heating	Hospital	Rotorua Hospital, Taupo Hospital (NZ)	130-160 ℃ (wellhead temperature of the well)	(Steins & Zarrouk, 2011)

In Figure 4, the natural thermal manifestation is used as tourism activity, with the main attraction is the bathing using the natural thermal water. The facility concept is still looked unrefined compared to Waikite thermal pool shown in Figure 5, or even compared to Blue Lagoon, Iceland (shown in Figure 6), even though it should be noted that the Blue Lagoon facility was constructed on already operating power plant, not during the exploration phase.

Figure 3. Cipanas (West Java) thermal bathing using natural surface feature.

Whakarewarewa Thermal Village in New Zealand (Figure 7) combines the presence of thermal manifestation (mud pool, geysers, spring) with the local culture of Maori people that lives around there. The result is a nice cultural village that can attract many tourists every year, giving indigenous people direct benefit (creating job opportunity, improving local economy) and also preserving their cultural value and spiritual bond with the thermal manifestation such as geyser and hot spring.

Figure 4. Waikite thermal pools, New Zealand. The geothermal fluid is from Te Manaroa spring, Waikite geothermal system (www.nzhotpools.co.nz)

Figure 5. Blue Lagoon, Iceland. Note that the facility is located next to the Svartsengi power plant (www.landsvirkjun.com)

Figure 6. Whakarewarewa Thermal Village, Rotorua, New Zealand (newzealand-indepth.co.uk)

Preliminary Concept of Integrated Direct Use Facility

From the literature review of previous studies about geothermal development rejection by local community in Indonesia and all over the world, it is clear that public acceptance especially by local community that lives near the project area is very critical to the geothermal development project. Any protest or rejection by the locals during any stage of the project can significantly delay the project and will cost both the field developer and also the GoI, financially speaking and schedule-wise.

Based on author's experience and recent protest events in Indonesia, it can be argued that the current approach methods by field developer still have difficulties to address and mitigate the occurrence of widespread public protest. This study proposes the alternative approach by utilizing direct use of geothermal energy in an integrated facility that theoretically could address the three causes of community rejection explained in earlier part of this paper. The proposed integrated facility combines various direct use concept around the world in both tourism and agricultural application that can be tailor-made to suit the specific need and condition in the development area, and attempts to address the shortcoming of current approach methods applied by field developer, while at the same time tries to fulfill the requirement concluded by Cataldi to gain public consensus in geothermal development. The proposed facility concept is summarized in Table 4.

Therefore, instead of relying on the same conventional approach only, the field developer can consider other alternative approach offered in this paper. It is inevitable that the field developer should be prepared to spend some capital in order to construct the facility, but even in current common practices most of the developers have spent a lot of money for community engagement activities, and this proposed integrated facility theoretically offers a more sustainable community involvement compared to the current approaches conducted by many developers.

BENEFITS AND CHALLENGES

Several advantages that potentially created by this integrated facility proposed in this study are:

1. Since this facility concept will be built during the early phase of exploration, it will give immediate direct benefit in the form of job opportunity to the local community, in which they will be involved from the early set-up and construction of the integrated facility instead of waiting for drilling activity or power plant construction that will be conducted 3 – 7 years after the geothermal developer company start the exploration activity.
2. If the integrated direct use facility includes the training center for local community, there will be enough time to provide them with adequate skills to be involved in the latter phase of development and real physical construction activity such as drilling, power plant construction, or even operation. This way the local people will not feel marginalized on their own land.
3. The local community continuous involvement nature of this facility, from the construction phase to the running the facility will ensure that people will not lose job or income where there is no physical activity on the site (e.g. during planning stage or still waiting for heavy equipment or drilling equipment mobilization).
4. The relatively smaller-scale nature of this facility setup and construction will not create major shock effect to the local people compared to the drilling and power plant construction, thus can be used to test the water regarding the local's response before the developer starts to commence more massive and more expensive activity such as drilling and civil construction.
5. This facility might become the physical testament of trust and good will from every stakeholder in geothermal development, from local community, local government, and field developer, hence if in the future there are any dispute or disagreement between stakeholders, this facility could be used as a meeting or assembly venue and act as a reminder on how geothermal development could bring mutual benefit to every side.
6. The proposed integrated facility concept explained in this paper offers a more sustained local community involvement compared to current conventional approach conducted by many field developers, and the cost to build and set this integrated direct use facility is relatively low compared to the cost of project delay during crucial activity such as civil construction or drilling. However, it still requires further study and a pilot project as a proof-of-concept to assess and evaluate its real-world effectivity.

Despite of the potential advantages brought by this facility, there are also several challenges in making this facility concept happens:

1. Geothermal developer company may hesitate in allocate money or human resource to build this kind of facility in the early stage of exploration phase due to high uncertainty level of the geothermal resource at that time.
2. The permitting and concession process to local government might take longer time due to various different facilities to be installed, thus may require different permitting process from more than one offices or instances in province or district level.
3. Finding a suitable location near surface thermal manifestations with sufficient space and access to build the facility complex might be problematic.
4. Usually the surface thermal features in Indonesia are still inside local community land (private property). Based on author experiences, negotiations process for land acquisition with traditional or local land owner can become complicated matter as the owner want a high compensation because they will perceive that their land contains a very valuable resource.
5. Access road upgrade might need to be commenced earlier to support this facility.

Cataldi's arguments on main conditions to gain public consensus	Proposed features to be included in the facility concept	Purpose of the facility	Direct-use application	Facility example (existing)
Prevention of bad effect on people's medical condition or health	Health care facility/Clinic	1. Create a baseline of community's health condition before geothermal project commenced. 2. Regular monitoring on community's health condition during the project lifetime. 3. Provide free health care service for the surrounding local community.	1. By using heat exchanger technology, the hot geothermal water could be utilized for domestic use such as: laundry (sheets, towels, etc.), bathing and medical equipment sterilization. 2. Hot geothermal water can be used for space heating.	Taupo Hospital, NZ
	Ambulance	Provide faster access from the health care facility to a better equipped hospital	Geothermal direct-use is not applicable for this feature	
Minimization of environmental impact / minimize the negative perception of public on geothermal development impact in environment	Plant Nursery	1. Provide facility for plant seed propagation or mushroom cultivation to support local agriculture industry. 2. Provide counselling regarding local agriculture potency to increase the quality of local agriculture sector.	By using the heat from hot geothermal water combined with glass house or greenhouse structure method, it can be utilized to condition the desired temperature for nursery.	1. Gourment Mokai, Taupo, NZ 2. Mushroom cultivation, Kamojang, Indonesia
	Agriculture and farming product	1. Provide drying facility for various local agriculture product or dairy product	The heat from hot geothermal water can be utilized to dry some agriculture product such as: copra, cocoa, palm sugar and also for mushroom cultivation. It will depend on the popular product from the particular area.	1. Miraka Dairy, NZ 2. Copra drying, Way Ratai, Indonesia
	Geothermal Education Park	Give local people or tourist a better understanding regarding geothermal energy and the various stage of development, thus encourage people to embrace the concept of geothermal energy as a environmentally friendly, renewable, and sustainable energy source.	1. Using the geothermal surface manifestation as the tourist attraction. 2. Using the surface manifestation as visual aid to demonstrate how geothermal system works.	Lahendong Geothermal Education Park, Indonesia
Creation of direct benefit for the local community	Thermal bathing and spa for tourism attraction	1. To attract tourist, both domestic and overseas, to visit the area and feel the sensation of geothermal hot pools. 2. To improve local economic by creating job opportunities from geothermal tourism.	Build a good quality hot pools by either using geothermal hot water directly or using a heat exchanger.	1. Polynesian spa, Rotorua, NZ 2. Cipanas bathing, Indonesia
	Local art and cultural performance for tourism attraction, including souvenir shop and restaurant		1. Using one of the geothermal surface manifestation in the area as the background of the stage to increase the dramatic effect of the performance. 2. Using the heat from geothermal water for timber drying which is the material to produce souvenirs 3. Use the heat for cooking for the traditional restaurant at the facility	Whakarewarewa or Tamaki Maori Village, New Zealand
	Training centre for unskilled labor	Create a training center to provide local community with basic skills and health safety education required to participate in various stages of geothermal development such as: access road and wellpad construction, drilling, power plant construction and operation.	Geothermal direct-use is not applicable for this feature	

DISCUSSION AND PATH FORWARD

Several discussion results from this study are as follow:

1. GoI target to achieve total 7000 MWe geothermal power plant installed capacity in 2025 requires substantial effort from every stakeholder due to its significant installed capacity growth rate increase from around 77 MWe/year in last decade into 662.5 MWe/year in 8 years until 2025 to achieve additional 5300 MWe installed capacity.
2. One of the biggest challenges in geothermal development in Indonesia is how to gain public consensus or social acceptance by local people or community. Cataldi suggests that there are 3 things to consider in order to gain social acceptance from local people: impact or bad effect to local people's health condition, adverse impact to environment, and perception of direct benefit to local community. Literature study finds that there are many evidences from various geothermal fields around the world that support the Cataldi's argument on the issue.
3. This study attempts to propose early concept of an integrated geothermal direct use facility that can accommodate those three factors suggested by Cataldi, and in the future is expected to be able increase local community acceptance to geothermal development and at the end of the day will support the completion of the project in timely manner.
4. This proposed concept is theoretically feasible to be applied in Indonesia as an alternative approach for geothermal field developer to engage with local community during exploration phase and reducing the risk of opposition and rejection of geothermal power plant development

This study is admittedly still in the very early phase, therefore there are still further works and studies required if this facility concept is about to be applied:

1. Further detailed social study of geothermal development public acceptance is required to accurately map the root cause of community rejection.
2. It is essential to conduct a more detailed survey and social study in the geothermal area to be developed in order to map which facility is urgently needed in that area and Indonesia in general. The survey can be done by using questionnaire and interview method in various geothermal area in Indonesia.
3. A detailed risk assessment is required for this facility concept from health, safety, environment, and socio-economic perspective.
4. A feasibility study for a pilot project of the proposed facility needs to be done by the field developer and local government altogether to get important feedbacks for any future improvement and application.

Finally, the authors welcome any feedback or discussion about the proposed concept presented in this paper

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