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INNOVATING THE RESEARCH MAP OF DIRECT USE OF GEOTHERMAL ENERGY IN HIGHER EDUCATION IN INDONESIA

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ABSTRACT

The main objective of this paper is to develop and identify the relevant research topic of direct use of geothermal energy in higher education or university level in Indonesia. To achieve it, several steps were conducted. First is to compare the needs of direct Use of geothermal energy in Indonesia select priority of the topic or application. It was conducted to evaluate all possible study subjects. It was found that in Indonesia, agriculture and aquaculture has bigger priority as research object compared to other subjects. The second is to identify the feasibility of that topic is researched in university environment including the related obstacles. These obstacles are divided into human resource and facility and equipment factors. Human resource factors include student's research interest, and duration of research. The facilities & equipment factors include research area-field and equipment, sustainability and maintainability, better access to industrial application, and economical factors. The third step, the study identifies the topic that is not well studied by previous investigators. This was achieved by creating a matrix of type and applicability of the studies. Immediate application is preferred by many researchers and the basic/pure science and knowledge related to Direct Use of Geothermal Energy is found to be less investigated. This map hopefully can give description of situation of research study in Indonesia higher education and can encourage better approach and solution to Direct Use of Geothermal Energy problem.

INTRODUCTION

Based on the enthalpy values of well-production, geothermal energy utilization can be divided into two categories: electric power production, and direct-use application. Electric power normally is generated when the fluid temperatures is above 150^0 C. At lower temperature, electrical power can still be generating by applying binary fluid power plant (Fridleifsson, 1996). Direct use applications, such as space heating, agriculture, aquaculture, and industrial drying process are using the temperature lower than 180^0 C. The type of steam can be liquid-vapor mixture or superheated.

Indonesia has one of the largest geothermal resources in the world with a potential of more than 17,000 MW. In 2010, the utilization in Indonesia is about 1179 MW and mostly used for the electric power production only. Many of geothermal resources are located in mountainous areas close to the area with a huge potential for direct-use applications. However it is found the implementation of direct use in Indonesia is considerately low. (Taufan, 2010) The utilization is Indonesia is considered low because the common perception that Indonesia is rich in energy and the typical climate temperature relative considerate. Therefore the awareness to use geothermal energy effectively and efficiently must be improved among Indonesian.

Many studies on direct use of geothermal energy utilization have been conducted. These involve many participants from government agency, universities, private and personal institution. The university as a higher education institution has an important role to education to direct use utilization not only as part of formal education related to direct use application but as place for research and development of direct use utilization as well. Institut Teknologi Bandung (ITB) for example offers master degree in geothermal engineering. In this program, one elective class offered is direct use utilization. Considerably interest is also come from some undergraduate students in mechanical engineering students.

The main objective of this paper is to develop and identify the relevant research topic in order to have feasible research map in direct use utilization for higher education or university level in Indonesia. By developing the research map, there will more focus-oriented research combined with formal higher education and advanced studies to secure the proper development of direct use utilization in Indonesia. A

research map is expected to have impact as (i) guidance for internal researchers to find loophole and knowledge gap in current direct use utilization research in Indonesia, and (ii) guidance for external institution in participating the research and education at university level.

DIRECT USE UTILIZATION EVALUATION IN INDONESIA

It is important to select the direct use application that will give the best interest Indonesian society. Table 1 is developed to evaluate the rank of urgency of application. Direct use utilization, in general, can be divided into several applications, such as aquaculture, agriculture, space heating, swimming and bathing, heat pump, and industrial drying. Table 1 has been analyzed based on factors such as: (i) how the utilization affects basic life need for Indonesian (food, water, and energy), (ii) how the utilization can make better life quality, (iii) how much values for money investment and return, and (iv) how the utilization can affect technological advances in the related area. Each factor is given equal value to ensure each direct use utilization party such as user, investor, and researcher has fair consideration. The leveling is made by three levels: 3 (important), 2 (somewhat important), 1 (not important). Table 1 can give description how different application of direct use utilization can affect the consideration of type of utilization. The values selection is conducted after observing the application objective and discussion with the peers.

Table 1: Evaluation of application of direct use utilization

	Basic life need	**Life quality**	**Value for money**	**Technological advance**	**TOTAL**
Agriculture	3	1	3	2	9
Aquaculture	3	1	3	2	9
Space Heating/Cooling	1	3	2	2	8
Swimming/Bathing	2	3	3	1	8
Industrial Drying	1	1	3	3	8
Heat Pump	1	1	2	2	6

Table 1 shows that agriculture and aquaculture have the highest total values for consideration. They are related to increasing food production using better method of air or water conditioning using geothermal energy for example by using greenhouses. Increasing food production also means better income for the farmers. Both agriculture and aquaculture development can also affect technological advances through the collaboration with other disciplines such as in heat transfer and fluid machinery. Space heating/cooling has the highest value in increasing the life quality. It is clearly because the use of heating/cooling in Indonesia is mostly used to increase comfortability of the resident. Along with swimming/bathing application, space heating/cooling can also contribute to the development of tourism of neighboring area. Industrial drying is expected to have little impact to fulfillment of people basic life need and better life quality, while it is better in value of money aspect. The industrial drying utilization also has close relation in developing better technological advances since it relates with other disciplines such as process engineering and heat transfer.

RESEARCH APPLICABILITY FOR HIGHER EDUCATION IN INDONESIA

The next question is whether the utilization from Table 1 is applicable for research in higher education in Indonesia. The applicability of type of utilization shown in Table 1 will depend on how a higher education institution can resolve some obstacles appearing during the research process. The obstacles can be divided into human resources factor (faculty member and students), and from facilities & equipment factors. The following are description of obstacles and possible solution from human resources factor:

1. Direct use in multidiscipline
   To develop the direct use, many aspects are involved. Only few students have already the capability and experience to deal with these issues. Only few students are willing to spend more time to learn something different from their discipline. At the same time, the time duration to finish their degree is limited. Possible Solution: dividing the research into smaller idea and grouping altogether at the end.
2. Study duration
   Some direct use utilization researches require extra time before the object of research develop, for example the research in agriculture area might need extra time to grow the plant. This can be obstacles for student to take the research on direct use utilization. Possible solution: (a) breaking down the research into smaller portion with shorter time to finish, (b) starting the research as early as possible.
3. Remote area
   Many of geothermal resources are located at remote and mountainous region, while many higher

education institutions (including ITB) are located in bigger cities. The transportation becomes a big issue. Many students are still taking their class while doing their research simultaneously. Possible solution: (a) moving some actual field issues to lab-scale research, for example the steam produced from low pressure boiler at the lab can be used to simulate the steam flow from geothermal resources. (b) Rearrange the students time, so that he/she can spend more time in the geothermal field and then it will reduce the transportation issue.

4. More student interest in geothermal power generation
   Many students are well-exposed to the idea of the power generation using geothermal energy. Rarely, they have enough information to direct use utilization. Better job remuneration in the area of power generation after their graduation also becomes reason that the research in direct use attracts only few students. Possible solution: (a) more promotion to direct use (b) asking for more commitment from private companies and local government.to the development of direct use utilization.

The following are some obstacles and barriers from facilities & equipment factors:

1. Area and equipment for research
   Even if the transportation issue is solved, educational institutions have limitation to acquire an land area for the research and research equipment. Some regulation and social barrier will appear and limit the freedom in conducting a research topic. Possible solution: more mutual research and development collaboration with private companies or local government/institution.
2. Sustainability and maintainability
   Faculty member and students prefer the idle location for the research. It is difficult to achieve the continuous improvement the facility is kept moving. Research is not the same as a project that can move from one place to the other. This issue also relates to the maintenance to research equipment. It is important to ensure that the research equipment are always in proper use and well maintained. Possible solution: more mutual research and development collaboration with private companies or local government/institution.
3. Better access to industrial application
   Many industries involved in direct use are small industries. They almost never reveal their involvement in development of direct use utilization. This make somewhat difficult to measure the current technological development related to industry.
4. Financial problem
   The last but no the least is about financial problem. Without a support from private companies or local government/institution, direct use utilization is merely a dream. Possible solution: increasing collaboration with private companies and local government.

From obstacles mentioned above, it is clear that students can conduct any direct use utilization topic in higher education level in Indonesia. The problem is not about the topic, but it is more about limited human resources (faculty member and students), and facilities, and equipment.

Table 2. The description and type of researches.

	Applicative Research	**Basic Research**
Analytical	- new analytical solution usually requires a strong mathematical and theoretical background on a particular problem. - applying already-available analytical solution to engineering problems is more common - almost non-existent in current publication	- new analytical solution usually requires a strong mathematical and theoretical background on a particular problem. - applying already-available analytical solution to engineering problems is more common. - almost non-existent in current publication
Experimental	- requires proper facilities and equipment - needs extra time for preparation and data acquisition - most of publications fall in this segment	- require proper facilities and equipment - needs extra time for preparation and data acquisition - publication is still rare, might be appeared at other discipline publications
Computational	- requires numerical method such as Finite Element, Finite Difference, and Finite Volume methods - publication is still rare, might be appeared at other discipline publications	- requires numerical method such as Finite Element, Finite Difference, and Finite Volume methods - publication is still rare, might be appeared at other discipline publications

Listing the obstacles does not mean to become pessimistic about the future of direct use utilization research. It becomes encouragement to make the research more realistic and systematic.

IDENTIFYING KNOWLEDGE GAP AND RESEARCH OPPORTUNITIES

The engineering type of research problems can be divided into applicative and basic researches. Applicative research usually involves the research that can be used directly by people. The results of basic research on the other hand usually take some steps before can be felt by public. In Indonesia, the applicative research usually originates from a project. These engineering problems can be solved using three approaches: analytical or mathematical, experimental, and computational solutions.

A Matrix consists of aspects of type of research problems and type of approaches was developed in Table 2. The matrix explains description aspect of research for each segment and investigation to type of previous papers appearing in previous geothermal proceeding conferences in Indonesia such as Proceeding World Geothermal Congress 2010, Bali (2010), Proceeding PIT API 12th Bandung 6-8 Nov 2012, and ITB Geothermal Workshop, 2013, Bandung.

This matrix is conducted to identify the knowledge gap that can be filled by the research in the higher education. Table 2 indicates there are still so many research loopholes and opportunities. Only experiments in applicative research have started to develop. The other research topics need to get more attention in the future.

CONCLUSIONS

Several key outcomes of this study are:

(1) Agriculture and Aquaculture have huge potential are to be investigated since related closely to the fulfillment of human basic needs.
(2) Some obstacles in developing the direct use utilization in higher education level have been identified. They are divided into human resources and facility & equipment problem.
(3) There are so many research topic needs to get more attention in the future. Only the experiments in applicative research have started to develop in Indonesia.

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