A Study Natural Gas Transport for Power Plant in Kangean

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Abstract- Currently total capacity of power plant in Kangean Islands is 3.6 MW. However, to fulfill the demand for electricity in Kangean Island, the electricity power should be increased to 13,71 MW. Since Kangean Islands is considered close to natural gas resources, natural gas power plant could be one option for electricity in this islands. This study aims to determine an optimal method to transporting natural gas from Pagerungan to two power plants located in Sapeken and Kangean. Three transportation methods are examined such as LNG , CNG barge and subsea pipeline. Using AHP and TOPSIS methods, the CNG barge is selected as the optimal method for transporting natural gas with total investment is estimated 18 million dollar.

Keywords: AHP, natural gas supply chain,natural gas power plant, TOPSIS

INTRODUCTION

Two diesel power plants are utilized to supply Kangean's electricity with capacity of 2.90 MW in BatuGuluk and 0.7 MW in Sapeken. Thus, total power generated is 3.6 MW [1]. The number households in Kangean is 47,958 of with only 7,947 are fully electrified whereas the other 40,011 householdshas no access to electrified [2]. State-owned electricity company (PLN) still lacks 10.11 MW electricity from a total of 13.71 MW. To counter this issue, a gas power plant is considered fit to be constructed. This due to that the background of Kangean Islands itself which location is near natural gas resources. The construction of gas power plant should be equipped with facility to transport natural gas from gas well to the power plant. The facilities include: gas transportation mode (CNG vessel, LNG vessel, or Pipelines) as well as its supporting facilities such us gas receiving terminal and gas storage tanks. AHP (Analytic Hierarchy Process) and TOPSIS (Technique for Order of Preference by Similarly to Ideal Solution) method are used to determine optimal transport method [5], [6]. Ship routing is using milk and run method [3], [4].

METHOD

In this study, selection of the most optimum gastransportation modes utilizes. AHP method and TOPSIS [5], [6], Steps of using AHP method are as follows: computing the vector of criteria weights, computing the matrix of option scores, ranking the options, and checking consistency. Calculation using TOPSIS method includes six steps: Firstly–calculating the normalized matrix using the vector normalization, Secondly– multiplication of normalized matrix elements with normalized weight coefficients; Thirdly– determining the ideal and anti-ideal points in n-dimensional criteria space;Fourthly– calculating of Euclidean distance $S_i^*$of each alternative a_i, from the ideal point and s_i^-, of each alternative a_i from the anti-ideal point A^-; Fifthly– calculating the relative similarity of the alternatives from the ideal and anti-ideal points; Sixthly– setting up the rank according to C_i , meaning that the bigger C_i is - the better the alternative would be. After calculation using TOPSIS and AHP methods are completed, comparison between the results is performed. After the most optimum transportation method is selected, the natural gas supply chain design including vessel capacity, sailing time to each power plant, receiving terminal design, etc.

In feasibility study, calculation on the selected mode of transportation is carried out. The criteria are: NPV (Net Present Value), IRR (Internal Rate of Return) and PBP (Pay Back Period).

RESULT AND DISCUSION

There are three alternatives of technologies that can be used as transportation method: CNG technology, LNG technology, and pipeline technology. Using AHP and TOPSIS method, the first step is determining some criterias from each alternative of technologies for transportation. As a result, CNG technology is elected as the most optimum alternative of transportation method. Figure 1 shows the calculation result comparison between using AHP method and TOPSIS method.

. Figure 1 illustrates that calculation using AHP and TOPSIS methods both continuously placing CNG as the most optimum option. Using AHP method, CNG weighs at the highest point of 0.51, with mini LNG vessel and pipeline are following consecutively at the value of 0.28 and 0.20..TOPSIS method results CNG ranks first at the value of 0.59, LNG ranks second at the value of 0.50 and lastly pipeline with the value of 0.41. Therefore, according

to the result of TOPSIS and AHP methods, transportation using CNG vessel is selected.

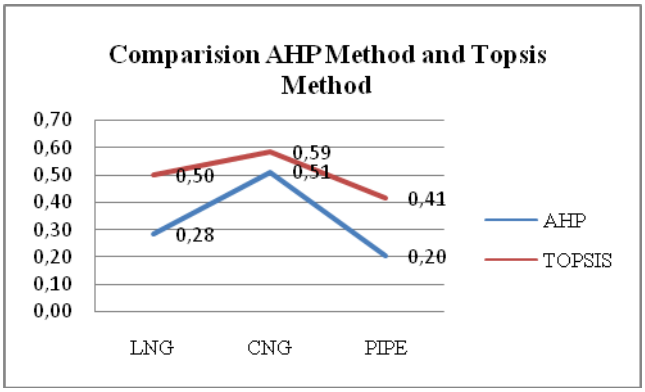

FIGURE 1.COMPARISON BETWEEN CALCULATION RESULT USING AHP AND TOPSIS METHOD

Since distribution process employs vessels, calculation regarding vessel itself needs to be performed so that each vessel would be efficient in its utilization. Parameters which take into account for determining the optimal number of vessels are : vessel capacity, vessel speed, distance from gas well to designated location, and gas loading/unloading time[7].

Currently CNG ship is still on design phase, because of this, modified CNG barge is used in this study. The type of ship is SPCB-geared vessel with capacity of 25 TEUs and service speed of 8 knot [8]. CNG barge vessel is equipped with CNG container tanks to store the natural gas, each with a capacity of 25 m^3 CNG. A vessel is designed to be loaded up to 25 container units with total capacity of gas can be transported is 625 m^3.

According to calculation result, CNG supply chain can be modelled as illustrated in Figure 2.

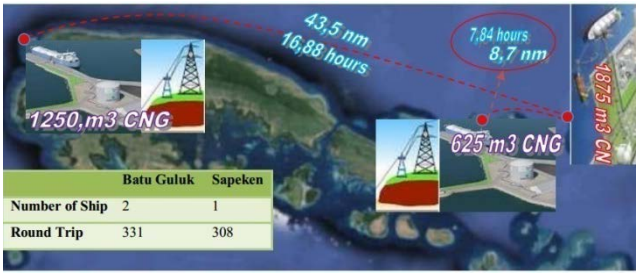

FIGURE 2. SHIP ROUTING MODEL

For supplying 1,250 m^3 CNG, two vessels need to be deployed to BatuGuluk. Shipping distance is 43.5 nautical miles with estimated time for one trip is 16.88 hours (including loading/unloading time), number of trip in a year is 331 trips.For supplying 625 m^3 CNG demand in Pagerungan, one vessel is employed. Shipping distance is 8.7 nautical miles with duration of each trip is 7.84 hours (including loading/unloading time). Number of trip in a year is 308 trips.

Total capital cost for investment is estimated 18,9 million dollar while annual operation cost is estimated 0.62 million dollar. Financing system for this project are supported 20% by self-funding and 10% by bank loan. Return process will take 20 years with margin selling price as USD 5.00, income would be paid back after 9,6 years. Therefore, the economical of this project is feasible. For more detail is shown in Table1.

TABLE 1. INVESTMENT ANALYSIS.

	Objective	Units	Value
NPV	NPV > 0	$	2.800.612
IRR	IRR > Inflation	%	10,73%
PP	PP < life time	year	9,57
PI	PI > 1		1,68

CONCLUSION

In selection of technology for transporting natural gas from Kangean well to the electricity generation plant, CNG vessel technology is selected as the most optimum mean of transportation..Capacity of each CNG vessel is 625 m^3. Number of ship for supplying gas demand in Batu Guluk and Sapeken is 2 units and one unit consecutively.

In the economical feasibility calculation, total investment required for construction and procurement of CNG technology facilities is estimated, if project is deemed feasible, gas can be sold at price of USD 12.8 with selling price margin of USD 5.00. With this margin, investment cost will return on 9.6 years.

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