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The impact analysis of postage multi-tariff system on gas transportation through the pipeline to increase gas price efficiency as the attraction of more environmentally friendly power plant substitution

A Bawono[1] and E Kusrini[1]

[1] Department of Chemical Engineering, Faculty of Engineering Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia ; Corresponding Author: Tel.:62-85647166568, 62-21-7863516 Ext. 204; fax: 62-21-7863515;

E-mail: ajiagraningbawono@yahoo.com, ekusrini@che.ui.ac.id

Abstracy. The purpose of this study is to provide an analysis of the comparison and impact of changes in the model of Gas Transportation Tariff calculations through Pipes on the transportation of natural gas for fuel power plants in the region X. Which initially used a single tariff distance system that provides gas prices that are still not economically attractive, will be replaced with a more efficient multi-tariff postage stamp system. With the change of tariff calculation method, it will get the lower gas price and will inevitably increase the commercial appeal to be able to replace HSD (High-Speed Diesel) Generator which is expensive and cause more pollution. Initially, the substitution program is still less attractive because gas prices are still inefficient because the use of tariff calculation method is less precise. New tariffs are modeled by modifying cash flow and some variables with scenarios dividing tariffs into groups and re-modeling the volume of gas flowing in the pipeline through simulations using software and calculations. With the sensitivity test will also be done to provide the best scenarios to the efficiency of gas price formation. If gas prices are more efficient than fuel, it will further increase the attractiveness to accelerate fuel substitution of fuel with cleaner gas fuel and support Government programs. A comparison of the carbon decline will also be made to prove the substitution of diesel with gas to have a positive impact on the environment to provide an analysis of environmental issues. Finally, we propose that the application of a multi-tariff system will provide the best scenario for enhancing the efficiency of natural gas prices in the substitution of power generation from diesel into previously less attractive gas to be more efficient and more environmentally friendly.

1. Introduction

The Government of Indonesia is currently increasing the substitution program for the use of natural gas to replace fuel oil primarily for electricity generation and industry. From this program, people are expected to get fuel that is cleaner, safer, and cheaper [2]. One method for transporting the most common and most affordable gas from a source of production to a consumer center is through a pipeline. Provision of the infrastructure of natural gas pipelines is included in the type of general infrastructure activities such as electricity, telephone, and water business activities. The profit or income derived from the tariff payments is regulated by the Regulator [8] [10]. Profits are regulated through reasonable IRR (Internal Rate of Return) restrictions. Regulators or governments in some

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countries determine the maximum limits of IRR's fairness under the Cost of Capital or WACC (Weighted Average Cost of Capital) to determine the economics of return on investment [7] [11] [13]. The primary factor to support the program to increase the attractiveness of substitution of fuel oil source to natural gas for electricity and industrial needs, gas price should be lower and competitive. One important factor determining the price of natural gas through pipelines is the tariff for the transportation of natural gas. With a more efficient tariff, it will make gas prices cheaper and will help both electric and industrial companies to start switching to gas. It is worth noting that most of the tariffs for natural gas transportation through pipelines in Indonesia are determined by a single tariff distance system. Where tariffs are calculated by the number of pipelines passed by the gas. So that the actual gas volume in the same pipe is calculated by the sum of each pipe segment In the same pipe that is inefficient and causes the paid tariff to be more expensive, and it will reduce the attractiveness of the conversion of fuel oil to gas. Tariffs in Indonesia are also applied uniformly to all users of the pipe (shipper), so particular shipper that should get cheaper tariffs because its profit is limited to subsidies should pay the same tariff with profit-oriented shipper. To overcome the gas tariff to be more efficient it is necessary to study a tariff calculation with a new system. The proposed calculation system is postage stamp with a multi-tariff system. In this postage stamp system, several interconnected pipes are considered to be a single system. Multi-Tariff is the application of tariffs where in this case the transporter applies different tariff rates for each group of the shipper [9].

The purpose of this study is to provide an analysis of how the influence of the application of new model proposals in the calculation of tariffs for natural gas transportation through a pipeline that previously used. The method of distance single tariff system calculation compared with the new method of calculation of postage stamp multi-rate system. so that later will be obtained a proposed formulation can produce more efficient, fairer, more reasonable and cheaper gas prices as an attraction to encourage the conversion of cleaner, safer, and cheaper energy sources of fuel oil to gas.

2. Method

The research was conducted by simulating the case study of tariff calculation for natural gas transportation through the pipeline in open-access transmission pipe X consisting of four segments of the pipe section. Initially, the tariff for pipeline X was set with a single tariff distance system, so that the shipper transporting the gas to the end of the pipeline would pay four summed tariffs from each segment. Subsequent research is to change the system of tariff calculation which was initially using distance single tariff system was changed using multi tariff postage stamp system. Results obtained from both tariff calculation simulations, compared and analyzed.

The research stages started from the economic and technical data collection from open access transmission pipe X, then conducted literature study to enrich the reference source of the research. From the data obtained then done the simulation of calculation with a method of making free cash flow suitable for the system of tariff calculation which initially use single tariff distance system as well as for multi tariff postage stamp system. The results obtained will be analyzed by comparison and their impact on the pricing of gas. Furthermore, to support and prove that the use of gas as substitution of fuel oil for specific industry and electricity generation, will also make the comparison of the cost needed in the use of energy source. A comparison of the reduced impact of carbon emissions will also be made to prove that the use of gas will have a better effect on the environment [6].

3. Result and discussion

3.1. Scheme of calculation of tariff for natural gas transportation

The tariff calculation for the X transmission pipeline case study is conducted using several scenarios. In the first scenario, the tariff is calculated by the distance single tariff system model by calculating the tariff for each pipeline on the transmission pipeline X, so that there will be four tariff rates for the pipe. The equation model used is the general tariff equation as follows [7] [10] [12] :

$$tariff_n = \sum_{i=1}^{t} \frac{Cost\ of\ service}{Volume_i} = \sum_{i=1}^{t} \frac{(d)_i + (O\&M)_i + (A\&G)_i + (T)_i + (L)_i + (WACC \times NBA)_i}{V_i} \quad (1)$$

Where,

O&M	: Operating and maintenance costs
A&G	: Administration and general fee
d	: Depreciation of CAPEX
T	: Tax costs
L	: Regulator levy
V	: Volume of natural gas flowing
NBA	: Asset base value (CAPEX)
WACC	: Weighted Average Cost of Capital = IRR

Weighted Average Cost of Capital is formulated with the following equation [10] [12]:

$$WACC = CoE \frac{E}{E+D} + CoD \frac{D}{E+D} \quad (2)$$

Where CoE is the Cost of Equity, CoD is the Cost of Debt, E is Equity, and D is a Debt. The cost of Equity (CoE) and Cost of Debt (CoD) can be calculated by the following equation [4] [5]:

$$CoE = Rf + \beta(ICRP + BPMEM) \quad (3)$$

$$CoD = i \times (1 - T) \quad (4)$$

Where Rf is Risk-Free Rate, US Treasury Bond, Beta (β) is a measure of an investment portfolio fluctuation compared with the market (stock market), ICRP is Indonesia Country Risk Premium, BPMEM is based premium for the mature equity market, I is the interest rate, and T is Tax.

In a tariff calculation scenario with a distance system, tariffs are calculated for each pipeline. Economic and technical data such as investment value, operating and maintenance costs, and gas volume are calculated from each segment [3]. The total tariff for transmission pipeline X is the sum of each tariff per pipeline (see figure 1).

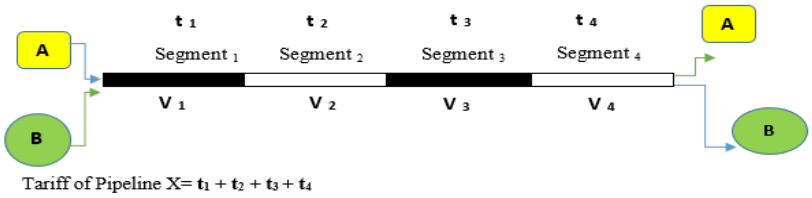

Figure 1. Distance system.

For the second scenario, the tariff is calculated using the postage stamp system model for single tariff as well as multi-tariff. For single postage stamp system tariffs are used equation (1). The difference is that the tariff for the postage stamp system is calculated by making several pipelines into one system. Economic and technical data such as investment value, operation, and maintenance cost are sums of each pipeline, while the volume used is the largest gas volume flowing in the X pipes (see figure 2).

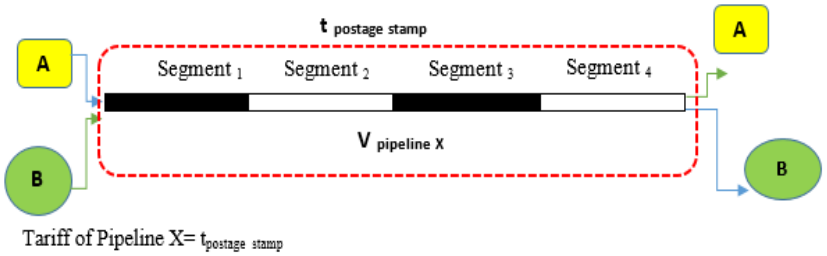

Figure 2. Postage stamp system.

The next scenario is the tariff calculation with multi tariff postage stamp system. The equation model used is the development of the previous calculation model that is as follows [1]:

$$multi-tariff_{(n)} = \sum_{i=1}^{t}\left(\frac{(d)_i + (O\,\&\,M)_i + (A\,\&\,G)_i + (T)_i + (L_{total})_i + (WACC \times NBA)_i}{V_1^{\,2} + V_2^{\,2} + V_3^{\,2} + \ldots\ldots\ldots\ldots + V_{n-1}^{\,2} + V_n^{\,2}}\right)\cdot (V_n)_i \qquad (5)$$

Where n is the division of classes.

In the application of this multi-tariff system, the transporter (plumbing owner) applies different tariff rates for each shipper group, where specialized shippers requiring subsidies such as electricity generation and specialty industries will pay lower rates than profit-oriented shippers.

3.2. Results and tariff calculation analysis

After simulation of the calculation on the data transmission pipe open access X (see table 1) with various scenarios that have been made, then obtained the following results (see table 2 and table 3):

Table 1. Economic and technical data of transmission pipeline X

No	Pipeline Segment	specification		NBA (USD)	O&M (USD)	Volume (MMSCFD)
		Diameter (Inch)	Lenght (Km)			
1	Pipeline Segment 1	28	369,7	107.183.618	35.980.269	278
2	Pipeline Segment 2	28	52,63	15.258.518	5.122.172	278
3	Pipeline Segment 3	10	4,65	481.475	161.627	92
4	Pipeline Segment 4	24	3,42	849.881	285.298	92
	Total	90	430,4	123.773.492	41.549.366	

Parameter	Value
Depreciation Time and Inflation rate	10 Year and 1.31 %
Rf, BP MEM, ICRP, and β	2.14% , 5.70%, 3.24%, and 1.070
Coe and CoD	11.71% and 0%
D	0 %
E	100%
Tax and interest (i)	25% and 0
WACC	11.71%

Table 2. Calculation Result of single tariff system and tariff comparison

No	Pipeline Segment	Specification		Single Tarif (USD/Mscf)	
		Diameter (Inch)	Lenght (Km)	Distance System	Postage Stamp System
1	Pipeline Segment 1	28	369,7	0,584	**0,674**
2	Pipeline Segment 2	28	52,63	0,083	
3	Pipeline Segment 3	10	4,65	0,008	
4	Pipeline Segment 4	24	3,42	0,014	
			Total	**0,689**	

Table 3. Calculation Result of multi-tariff system and tariff comparison

Parameter	Gas Volume (MMScf/day)	Postage Stamp Tarif (USD/MScf)	
		Single Tarif	Multi Tarif
Category 1 (Power Generation or Special Industries)	92	0,674131239	0,401
Category 2 (Profit Industries)	186		0,809
Total Revenue (USD)		683.184.822	683.093.598
Δ Revenue			0,013%

From the results obtained can be seen that the tariffs generated by the method of calculating the single distance system tariffs produce the largest total tariff of 0.689 USD / MScf (see table 2). This condition happens because in this system the gas volume is calculated from each segment. The volume of gas flowing in a pipe consisting of several segments can be considered as one system (postage stamp). With the postage stamp system, the resulting tariff will be lower than the distance system which is 0.674 USD / MScf (see table 2). And to make the tariff more efficient again for the particular class, the multi-tariff system will get more efficient tariff that is 0.401 USD / MScf so that it will further increase cost savings and increase the attractiveness of substitution of the energy source of fuel oil to natural gas.

3.3. Fuel price calculation, price comparison for specific shipper energy source and carbon emisison
To prove that the use of natural gas through the pipeline can improve the efficiency of production cost, it is calculated the energy cost required to generate electricity by using High-Speed Diesel (HSD) compared to using natural gas flowed through pipeline X. Comparison of carbon emissions resulting from burning some The fuel will also be made so that it is known to affect the environment [6]. The results are as follows (see table 4 and table 5):

Table 4. Result of calculation and gas price comparison for pipe X with several scenarios.

Parameter	Production Gas Price (USD/MMBtu)	Transmission Tarif (USD/MMBtu)	Distribution Cost (USD/MMBtu)	Tax	Total Gas Price (USD/MMBtu)
Distance System	5,44	0,6887		0,0689	6,1976
Postage Stamp System					
Single Tarif	5,44	0,6741	0	0,0674	6,1815
Multi Tarif	5,44	0,4016	0	0,0402	5,8817

Table 5. Fuel price calculation, comparison and carbon emisison energy source.

Energy Source	Volume (MMScf/d)	Energy Requirement (MMBtu/d)	Price (USD/MMBtu)	Total Cost (USD/day)	CO2 emitted (pound per milion Btu)	Total CO2 emitted (pound/day)
High Speed Diesel (HSD)			26,00	2.392.000	161,3	14,8396
Natural Gas Distance	92	92.000	6,198	570.181		
Postage stamp					117	10,764
Single Tarif			6,182	568.702		
Multi Tarif			5,882	541.121		

It can be proven that the use of natural gas as an energy source will result in more efficient production costs compared to the use of fuel oil. Also, it can also be proven that the use of natural gas will produce carbon emissions as a result of lower combustion when compared with fuel oil, so it can be concluded that the use of natural gas as a substitution of fuel oil resources will have a good in economic and environmental benefits.

4. Conclusion

The use of natural gas as an alternative energy source for the substitution of fuel oil for the needs of power plants and other industrial needs will have a good impact. The application of multi-tariff postage stamp method in tariff calculation for natural gas transportation through the pipeline will increase efficiency and decrease natural gas price compared to single tariff method and single tariff postage stamp. With the use of natural gas will reduce production costs while increasing efficiency and more environmentally-friendly. Finally, it is expected to increase the attractiveness of more expensive and more expensive substitutes of fuel oil to cheaper and environmentally-friendly natural gas.

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