

North Banjarmasin's distribution pump's electric energy audit at PT Air Minum Bandarmasih

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ABSTRACT

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This study aims to audit the electrical energy of the North Banjarmasin zone distribution pump at the Bandarmasih Drinking Water Company in Banjarmasin City. The case study method was used to find out the description of the problem conditions of the pump installation system and the existing distribution network. The largest electricity consumption is in the operation of distribution pumps. One of the distribution pumps is the Banua Anyar booster pump which serves the North Banjarmasin zone. Electricity consumption during 2022 on the Banua Anyar booster is 1,223,432 kWh at a cost of Rp. 1,521,737,167. The calculation of pump efficiency for the 3 new Banua booster pumps is 57.41%, 55.31% and 44.51% respectively. In this study, the most efficient pump and savings opportunities were obtained by increasing pump efficiency with pump improvements and obtained the financial feasibility of calculating the payback period in the second year with cumulative profit in the fifteenth year of 527,846,868 Rupiah.

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INTRODUCTION

The high cost of electricity or energy is caused by several things, namely the use of energy that is not for increasing production/distribution capacity, equipment life and inefficient energy use (Mulyono, 2020; Tan et al., 2021). High energy costs a lot, including making food unaffordable due to rising transport costs (Mahapatra et al., 2021), causing blackouts in factories resulting in the loss of essential goods (MollaNoroozi, 2023), and preventing children from studying due to a lack of electricity (Sule et al., 2022). Addressing the socioeconomic consequences of high energy prices requires understanding who is most impacted when energy prices rise (Nielsen et al., 2021; Soltani et al., 2021). Households at the very top of the global distribution use the most energy, but as a fraction of total consumption, the additional energy expenditure makes up a smaller and smaller part (Koot & Wijnhoven, 2021; Oswald et al., 2020). The share of energy consumption of non-food consumption is highest for the very poor, meaning that they are more vulnerable to rising energy prices. Moreover, high energy prices can lead to increased household bills, reduced business profitability, and slower economic growth.

The strong increases in natural gas prices have prompted substantial switching to the use of coal rather than natural gas to generate electricity in key markets, including the United States (Burney, 2020), Europe (Zakeri et al., 2022), and Asia (Chiappini et al., 2019), which in turn is driving up CO₂ emissions from electricity generation globally (Li et al., 2021). Many governments have taken measures to alleviate electricity bills, especially for vulnerable consumers (Pye et al., 2015). Rising power prices are already impacting operations of electricity-intensive industries, and several companies have temporarily curtailed production due to deteriorating margins caused by the sharp increase in gas prices (Krishnan et al., 2022). In addition, the current high coal and gas prices are not the result of a single "shock event" on the demand or supply side, but rather result from a combination of supply and demand factors that gradually tightened markets over the course of several months and even years.

Based on data from the performance assessment of BUMD Drinking Water conducted by the Directorate of Drinking Water (*Direktorat Air Minum*) in 2022, the Bandarmasih Drinking Water Company (PAM) Banjarmasin City has energy costs of Rp. 586/m³ much higher than the average energy cost of BUMD National Drinking Water of Rp. 355/m³ (*Direktorat Air Minum*, 2022). Some possible reasons for the higher energy costs in Banjarmasin City include energy use (The use of energy for purposes other than increasing production or distribution capacity can contribute to higher energy costs), inefficient energy use (Inefficient energy use can lead to higher energy costs, as energy is wasted or not utilized optimally), and equipment life: The life of equipment can impact energy costs, as older or less efficient equipment may require more energy to operate. The high energy costs in Banjarmasin City may be a factor in the overall cost of living and the economic development of the city.

One of the pumps that uses considerable energy at the Bandarmasih Drinking Water Company is the Banua Anyar booster pump. The cost of electricity usage in 2022 at the Banua Anyar booster reaches Rp. 1,521,737,167,-. Booster Banua Anyar distributes water to part of the North Banjarmasin line using pumps. The service to the North Banjarmasin line uses 3 Torishima brand pumps with a capacity of 500 m³ / hour each with a head of 60 meters operating every day. In 2022, the water distributed is 8,783,363 m³ with 27,631 SR subscribers. Therefore, in improving energy efficiency, a study is needed on the pumping system of the distribution network from the Banua Anyar booster pump to the North Banjarmasin service area. A study on the distribution network should be conducted to ensure the capacity and pressure of the pump can distribute water to customers.

This study aims to conduct an optimization study that can improve energy efficiency in distribution pump installations so as to reduce energy consumption in the Banua Anyar booster pump distribution system to North Banjarmasin. It calculates pump efficiency and then look for suitable energy saving alternatives, as its contribution to help a better implementation of energy distribution.

METHOD

This research used a qualitative descriptive method with a survey and case study approach. Meanwhile, the survey method was carried out by observation in the field. The case study method was used to find out the description of the problem conditions of the pump installation system and the existing distribution network.

The location of the study is at the Bandarmasih Drinking Water Company in Banjarmasin City in May 2023. The formulation of electricity tariff patterns made by the government or authorized service authorities is expected to educate the public or a company to use electrical energy wisely. Energy consumption management strategies can be done in several ways, namely:

- 1) Reduction in the use of electrical energy at peak load times;
- 2) Shifting the operating time (pump) beyond peak load time;
- 3) Energy conservation such as improving pump performance, operational systems, selection of supporting equipment and application of technology.

Electrical energy audit is the first step in determining opportunities for saving electrical energy. Energy audits need to be carried out by PAM Bandarmasih to obtain opportunities or strategies taken for energy efficiency.

Evaluation of pump performance was carried out to determine the existing condition of pump consumption and efficiency as well as energy saving opportunities that can be done. The problems discussed were obtained by identifying existing conditions at the research location related to energy efficiency problems in the Banua Anyar booster pump to the North Banjarmasin service area. The results of the identification are used as more detailed questions and will be the basis for research objectives.

RESULTS AND DISCUSSION

Pump Performance Analysis

The calculation of the total efficiency of the pump is carried out to find out whether the pump can still work efficiently or not, where the calculation results of the pump efficiency compared to the pump efficiency standard which is >60%. The results of this pump efficiency analysis can be used as a recommendation for the existing condition of the pump. Pump power can be calculated based on the results of discharge and pressure measurements on the pump.

Calculating Input Power (Pi)

Input Power or input power is electrical power that is input into the pump motor in kW. The input power can be calculated from the measurement results of the average current (Amperes) and voltage between the three phases (Volts) of the three phases, and the power factor. The formula used for three-phase motors:

$$P = 1,73 \times V_p \times I \times \cos \varphi / 1000$$

- P : Input power to the motor in kW
 V_p : Average voltage between phases in Volts
 I : The average current of all three phases in Amperes
 Cos φ : Power factor

Calculating Hydraulic Power (Ph)

Hydraulic power is the power used to push water from one point to another and because of the resistance of the piping system, a certain pressure (head) is formed. The formula used is:

$$Ph = Q \times H \times g \times \rho$$

- Ph : Hydraulic power in kW
 ρ : 998 kg/m³
 g : 9,8 m/s²
 H : Head pump in meters
 Q : Water debit in m³/second

Calculating pump efficiency (ηt)

The formula for calculating pump efficiency:

$$\text{Efisiensi pompa total, } \eta_t = \frac{\text{Phidrolis}}{\text{Pinput motor}} \times 100\%$$

Based on the formula for calculating input power, hydraulic power, and pump efficiency, the Banua Anyar booster pump is obtained as follows:

Table 1. Banua Anyar Booster Pump Efficiency

Pump	Ain (Ampere)	Vin (Volt)	Head (m)	Debit (m ³ /det)	P (kW)	Ph (kW)	ηt
1	150,67	407,43	18	0,28	85,06	48,83	57,41
2	152,97	405,33	18	0,27	85,91	47,52	55,31
3	138,23	403,97	14	0,25	77,38	34,44	44,51

Table 2. Recommended Action on Decreasing Pump Efficiency

Pump Efficiency Criteria (ηt)	Action
ht > 60 %	The pump is still good, no action is required
ht = 55-60 %	Impeller resetting, cleaning
ht = 50-55 %	Reconditioning, impeller repair and readjustment
ht < 50 %	Total overhaul of the impeller or overall pump replacement

Source: Energy Efficiency Handbook in PDAMs

In table 1, it can be seen that the efficiency of Banua Anyar booster pump for P1 = 57.41%, P2 = 55.31% and P3 = 44.51%. So that the treatment that can be given to the three pumps is in accordance with the table. 2 is by reconditioning, impeller repair and readjustment for the three pumps. In several studies that have been conducted, pump optimization carried out can increase pump efficiency by 5.87%, so that pump production is also increasing.

The increase in production of Banua Anyar booster pumps can be calculated as follows:

- HT = ηt first + increase (5.87 %)
 P_{final} = ηt x P (Watt)
 Q_{final} = Pw final / (Hxgxp)

Table 3. Increased Efficiency of Banua Anyar Booster Pump

Pump	η (%)	Pw Final (watts)	Hxgxp	Final Q (m3/sec)
1	63,28	53.825	176.047	0,31
2	61,18	52.561	176.047	0,30
3	50,38	38.982	136.926	0,28

Table 3 shows the discharge generated after impeller repair and readjustment of the three Banua Anyar booster pumps increased by 0.03 m³ / second. The cost of pump repair in the form of reconditioning, impeller repair and pump adjustment is Rp. 120.000.000,- for the three pumps and is carried out within a period of 3 years.

Cash Inflow and Cash Outflow Calculation

The calculation of cash inflow and cash outflow is carried out on each action that will be taken to improve and improve energy efficiency in the distribution network served by Banua Anyar booster pumps. This calculation will later be used to calculate the value of Payback Period (PP). PP is the period needed to cover the investment costs incurred to determine the feasibility of investment for each action to be taken. In this case, pump repair steps are mandatory steps taken by the Bandarmasih Drinking Water Company of Banjarmasin City to improve the use of electrical energy.

The calculation of cash flow from pump repair is done by calculating cash inflow through energy savings as a result of improved pump performance and pump arrangement patterns. The cash outflow component is the investment value spent on pump repairs every 5 years with a calculation of an increase of 15 percent in a period of every 5 years, while cash inflow is the potential income obtained by the company when improving the performance of Banua Anyar booster pumps. Cash outflow and cash inflow are calculated for 15 years according to the life of the pump.

The discharge generated after repairing the pump increased by 0.03 m³ / second. Data for 2022 shows an average tariff of Rp. 7,832/m³ with a cost of goods produced of Rp. 7,651 / m³. With improvements in pump performance, there is a potential income of Rp. 109,129,739 for billing effectiveness of 98.21% according to the PDAM performance book in 2022.

Table 4. Pump Repair Cash Flow and Pump Arrangement Pattern

Year	Cash Inflow (Rp)	Cash Outflow (Rp)	Profit (Rp)	Cumulative Profit (Rp)
0	-	120.000.000	(120.000.000)	(120.000.000)
1	109.129.739	-	(10.870.261)	(10.870.261)
2	109.129.739	-	109.129.739	98.259.478
3	109.129.739	-	109.129.739	207.389.217
4	109.129.739	-	109.129.739	316.518.956
5	-	138.000.000	(138.000.000)	178.518.956
6	109.129.739	-	109.129.739	287.648.695
7	109.129.739	-	109.129.739	396.778.434
8	109.129.739	-	109.129.739	505.908.173
9	109.129.739	-	109.129.739	615.037.912
10	-	158.700.000	(158.700.000)	456.337.912
11	109.129.739	-	109.129.739	565.467.651
12	109.129.739	-	109.129.739	674.597.390
13	109.129.739	-	109.129.739	783.727.129
14	109.129.739	-	109.129.739	892.856.868
15	-	182.505.000	(182.505.000)	527.846.868

In Table 4, it can be seen that the payback period for pump performance improvement occurs in the 2nd year and the profit obtained until the 15th year with periodic pump repairs every 5 years is Rp.527,846,868,-.

CONCLUSION

The existing condition of the Banua Anyar booster pump for the three pumps that distribute water to North Banjarmasin shows a pump efficiency value below 60%. Improvements in pump performance in the form of reconditioning, impeller repairs and pump readjustments need to be done to increase pump efficiency. Cost investing in improved pump performance and setting pressure patterns needs to be done. Payback period occurs in the second year with periodic maintenance every 5 years with cumulative profit in the 15th year of Rp.527,846,868,-.

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